

## **Astr 451 - Astrophysics I: Sun and Stars** **Fall 2017 Course Information & Syllabus**

**Course Description:** This lecture course covers the physics of stellar atmospheres and interiors as well as concepts of stellar evolution. The Sun will be used repeatedly as an example since it is the best studied star; however, this course will not specifically address the subject of solar physics. Those interested in studying solar physics in detail should consider also taking Astr 554. As it is, there is a large amount of material to cover in this course. As a result, we will not cover the entirety of the two required texts below, but we will cover the essential material from both fields.

**Course Objectives and Learning Outcomes:** This is primarily a content driven course – the student is expected to learn the content covered in the lectures listed on following page. By then end of the course, the student should understand how the spectrum of a star forms and how observations of the spectrum can be used to infer physical properties of the star. The student will also understand the general internal physical structure of a star from the time it first forms until the end of its life. The student will understand how this structure is computed and what causes it to change throughout the life of a star.

**Meeting time and place:**

MWF 11:00 am – 11:50 pm  
Herman Brown 254

**Instructor:**

Prof. Christopher M. Johns-Krull  
Department of Physics and Astronomy  
Office: 352 Herman Brown  
Phone: (713) 348-3531      E-mail: cmj@rice.edu

**Office Hours:**

Mondays: 1:00 pm - 2:00 pm                      Wednesdays: 10:00 am – 11:00 am  
Tuesdays: 11:00 am – 12:00 pm                  Or by appointment

**Required Texts:**

Title: “The Observation and Analysis of Stellar Photospheres” (Third Edition), hardback or paperback  
Author: David F. Gray  
Publisher: Cambridge Univ. Press

Title: “Principles of Stellar Evolution and Nucleosynthesis” (Second Edition), paperback  
Author: Donald Clayton  
Publisher: Univ. of Chicago Press

**Additional Texts:**

“Stellar Atmospheres” by Mihalas, Freeman Press  
“An Introduction to the Study of Stellar Structure” by Chandrasekhar, Dover  
“Structure and Evolution of the Stars” by Schwarzschild, Dover  
“Introduction to Stellar Astrophysics, Vol. 1-3” by Bohm-Vitense, Cambridge (BV)

**Grading:**

|                                      |                            |
|--------------------------------------|----------------------------|
| Homework (approx. 6 - 8 assignments) | 66%                        |
| Final Exam                           | 34% (take home, inclusive) |

**Absence & Late Policy:**

If a class is missed, the student is expected to get notes from someone else in the class and may copy the instructor’s notes. Homework assignments must be turned into the professor by the end of class on the due date, which will be given on each homework set. Late homework can be turned in for partial credit. If the assignment is turned in by the end of the next class, the penalty is 25%; by the end of the next class, 50%; and so on. The late penalty will be excused with a doctor’s note if class is missed due to illness.

**Students with Disabilities:**

If you have a documented disability that will impact your work in this class, please contact the professor to discuss your needs. Additionally, you will need to register with the Disability Support Services Office in the Ley Student Center.

### Honor Code:

The final exam is pledged. Homework assignments are meant to help you understand the material, so you are free to discuss the general nature of the concepts with anyone. However, the actual description of the answer and any specific calculations should be done individually. If you are in doubt about how much to ask/divulge about a specific problem, you might work through a problem that is conceptually similar to the one assigned. Copying down someone else's answer (or allowing someone to copy yours) is an honor code violation.

## Fall 2017

### Topics to be Covered

|   |        |  |                      |
|---|--------|--|----------------------|
| M | Aug 21 | Eclipse!   |                      |
| W | Aug 23 | Intro & Radiation: Terms and Definitions I           | G1, 3-4              |
| F | Aug 25 | Radiation: Terms and Definitions II                  | G5                   |
| M | Aug 28 | Harvey   |                      |
| W | Aug 30 | Harvey   |                      |
| F | Sep 1  | Harvey   |                      |
| M | Sep 4  | Labor Day  |                      |
| W | Sep 6  | Radiation: Terms and Definitions III                 | G5                   |
| F | Sep 8  | Blackbodies; Radiative & Convective Energy Transport | G6, G7               |
| M | Sep 11 | The Grey Atmosphere                                  | G7                   |
| W | Sep 13 | The Continuous Absorption Coefficient I              | G8                   |
| F | Sep 15 | The Continuous Absorption Coefficient II             | G8                   |
| M | Sep 18 | The Model Photosphere I                              | G9                   |
| W | Sep 20 | The Model Photosphere II                             | G9                   |
| F | Sep 22 | Stellar Continua                                     | G10                  |
| M | Sep 25 | The Line Absorption Coefficient I                    | G11                  |
| W | Sep 27 | The Line Absorption Coefficient II                   | G11                  |
| F | Sep 29 | Spectral Lines I                                     | G12-13               |
| M | Oct 2  | Spectral Lines II                                    | G13                  |
| W | Oct 4  | Radii and Temperatures                               | G14                  |
| F | Oct 6  | Stellar Temperatures                                 | G14                  |
| M | Oct 9  | Midterm Recess                                       |                      |
| W | Oct 11 | Pressure in the Atmosphere                           | G15                  |
| F | Oct 13 | Chemical Analysis I                                  | G16                  |
| M | Oct 16 | Turbulence in the Atmosphere                         | G17                  |
| W | Oct 18 | Rotation and Advanced Topics                         | G17 & handouts       |
| F | Oct 20 | Intro to Stellar Structure & Pressure of Perfect Gas | C2.1                 |
| M | Oct 23 | Mechanical Pressure of a Perfect Gas II              | C2.1                 |
| W | Oct 25 | Homologous Stellar Models                            | C2.4                 |
| F | Oct 27 | Polytropes   | C2.4                 |
| M | Oct 30 | Quasistatic Changes of State I                       | C2.2                 |
| W | Nov 1  | Quasistatic Changes of State II                      | C2.2                 |
| F | Nov 3  | The Ionized Real Gas                                 | C2.3                 |
| M | Nov 6  | Energy Transport: Radiative Diffusion                | C3                   |
| W | Nov 8  | Energy Transport: Convection                         | C3                   |
| F | Nov 10 | Nuclear Reaction Rates I                             | C4.1-4.2             |
| M | Nov 13 | Nuclear Reaction Rates II                            | C4.8                 |
| W | Nov 15 | Proton-proton Chains                                 | C5.1-5.3             |
| F | Nov 17 | CNO Cycle  | C5.4                 |
| M | Nov 20 | He Burning and Beyond                                | C5.5-5.7             |
| W | Nov 22 | Calculations of Stellar Structure                    | C6.1-6.3             |
| F | Nov 24 | Thanksgiving Break                                   |                      |
| M | Nov 27 | Pre-Main Sequence Stellar Evolution                  | C6.5 & handouts      |
| W | Nov 29 | Main Sequence and Post Main Sequence                 | C6.6, 6.7 & handouts |
| F | Dec 1  | Compact Objects & Stellar Pulsation                  | C6.7 & handouts      |