Astr 451 - Astrophysics I: Sun and Stars
Fall 2019 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 423

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	Thursdays: 4:00 pm – 5:00 pm
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 2019

Topics to be Covered

M	Aug 26	Introduction to Stars and Observing Tools	G1,3-4
W	Aug 28	Radiation: Terms and Definitions I	G5
F	Aug 30	Radiation: Terms and Definitions II; Black Bodies	G5-6
		Labor Day	
W	Sep 4	Radiative and Convective Energy Transport I	G7
F	Sep 6	Radiative and Convective Energy Transport II	G7
M	Sep 9	The Continuous Absorption Coefficient I	G8
W	Sep 11	The Continuous Absorption Coefficient II	G8
F	Sep 13	The Model Photosphere I	G9
M	Sep 16	The Model Photosphere II	G9
W	Sep 18	Stellar Continua	G10
F	Sep 20	The Line Absorption Coefficient I	G11
M	Sep 23	The Line Absorption Coefficient II	G11
W	Sep 25	Spectral Lines I	G12-13
F	Sep 27	Spectral Lines II	G13
M	Sep 30	Radii and Temperatures	G14
W	Oct 2	Stellar Temperatures	G14
F	Oct 4	Pressure in the Atmosphere	G15
M	Oct 7	Chemical Analysis I	G16
W	Oct 9	Chemical Analysis II	G 16
F	Oct 11	Turbulence in the Atmosphere	G17
M	Oct 14	Midterm Recess	
W	Oct 16	Rotation and Advanced Topics	G17 & handouts
F	Oct 18	Intro to Stellar Structure & Pressure of Perfect Gas	C2.1
M	Oct 21	Mechanical Pressure of a Perfect Gas II	C2.1
W	Oct 23	Homologous Stellar Models	C2.4
F	Oct 25	Polytropes I	C2.4
M	Oct 28	Polytropes II	C2.4
W	Oct 30	Quasistatic Changes of State I	C2.2
F	Nov 1	Quasistatic Changes of State II	C2.2
M	Nov 4	The Ionized Real Gas	C2.3
W	Nov 6	Energy Transport: Radiative Diffusion	C3
F	Nov 8	Energy Transport: Convection	C3
M	Nov 11	Nuclear Reaction Rates I	C4.1-4.2
W	Nov 13	Nuclear Reaction Rates II	C4.8
F	Nov 15	Proton-proton Chains	C5.1-5.3
M	Nov 18	CNO Cycle	C5.4
W	Nov 20	He Burning	C5.5
F	Nov 22	He Burning and Beyond	C5.5-5.7
M	Nov 25	Calculations of Stellar Structure	C6.1-6.3
W	Nov 27	Pre-Main Sequence Stellar Evolution	C6.5 & handouts
F	Nov 29	Thanksgiving Break	
M	Dec 2	The Main Sequence	C6.6 & handouts
W	Dec 4	Post Main Sequence Evolution	C6.7 & handouts
F	Dec 6	Compact Objects & Stellar Pulsation	C6.7 & handouts