NORTHERN ARIZONA UNIVERSITY

College of the Environment,
Forestry, and Natural Sciences

Department of Astronomy and Planetary Science
AST 391 — Astrophysics: Stars
Fall 2019

Course Information (BBLearn tab: Contacts & Hours)

- Meeting Times & Location: TTh 2:20 — 3:35 pm, Blgd. 19, Rm. 111
- Credit: 3 credit hours
- Instructor & Email: Dr. Lisa Chien
- Email: Lisa.Chien@nau.edu
- Office Location: Blgd. 19, Rm. 311
- Office Hours: MW 11 am - 12 pm and Thu 1 - 2 pm
- Grader: Solvay Blomquist (sab598@nau.edu)

Course Prerequisites

AST 280 and PHY 263 (also PHY 265 preferred)

Course Description, Objectives, & Structure

This is an upper-level undergraduate course in stellar astrophysics, which is generally divided into two parts: the outsides of stars (*stellar atmospheres*) and the insides of stars (*stellar interiors*). The atmosphere component contains an introduction to radiative transfer, which is useful in all areas of astrophysics. The topic of *stellar evolution* is also covered. If time permits, related topics such as *star formation*, *star clusters* and *interstellar medium* will also be discussed.

At the end of this course, you should be able to
i) explain the key concepts of stellar atmospheres, interiors, and evolution;
ii) apply basic physics such as the Boltzmann and Saha equations;
iii) write computer programs to explore and illustrate some of the key concepts;
iv) interpret the output from those programs to demonstrate physical principles;
v) comprehensively read articles in professional journals such as *Astronomical Journal, Astrophysical Journal, Annual Reviews of Astronomy and Astrophysics*, etc.
vi) have an educated and intelligent conversation, with confidence and sincerity, to an astronomer.

This will be a lecture course that includes in-class exercises, reading assignments, and homework of writing small codes and using programs to plot and interpreting the results of those programs.

Textbook & REQUIRED Materials (BBLearn tab: Syllabus & Info)

- ***An Introduction to Modern Astrophysics***, 2nd ed. by Carroll and Ostlie (*a.k.a.* BOB)
- **Calculator**
- **Laptop** or an accessible computer
- **Programming/graphing software** of your choice (free! See https://in.nau.edu/its/software/)— **Microsoft Excel, MATLAB, Mathematica,** Python, etc.

Evaluation & Grading System

Classes missed	Effect on grade
≤ 3	None
4 — 6	Lowered by 5%
≥ 7	Lowered by 10%

Assessment	Percentage
Participation	10%
Reading Quizzes	5%
In-class work & Homework	**45%**
Midterm Exam	15%
Final Exam	15%
Group Project	10%

Grade	Score
A	90 – 100
B	80 – 89
C	70 – 79
D	60 – 69
F	0 – 59

i) **Attendance & Participation:**

- Attendance is taken every class and you are responsible for signing in. Missing class will affect your grade according to the policy above. Documented illness and institutional excuses will be accepted.
- Please bring your calculator and laptop (with programming/graphing software) to class whenever you can.
- **I *ask* that you participate in-class at least once every class (ask a question, answer a question, make some intelligent, sensible sounds, etc)**, and I will keep track of that to make sure that everyone is participating and at the same pace. **Asking at least one question is especially *required* when we have a guest lecturer in the class.**

ii) **Reading quizzes:**

- This course requires A LOT OF physics and math, so in order to keep up with the class, **I strongly urge you to read the textbook, especially before the class**. Coming to class prepared is crucial since many of in-class exercises depend on your reading background.
- In order to guarantee that you do the reading, there will be **a reading quiz *every time we finish a chapter (actual dates to be announced in class).*** The quizzes are open-book and solely based on the textbook (in any format you have) during the reading quizzes. You will only have **10 minutes** to finish it, so you need to know where your materials are. They will be online quizzes on BBLearn.
- You can skip the sections that are not covered in the class, and I will not test you what is not discussed in the class. I do not drop any reading quizzes.

iii) **In-class Exercise & Homework:**

- **You *cannot* make up the in-class exercise if you miss the class.** In-class exercises often will become your homework assignment. Late assignments will be accepted only with my *previous* permission. No credit will be awarded for homework after it is due.
- I encourage you to work with other students on the assignments, but you must turn in your work ***in your own words,*** including **any programming/plotting codes** you wrote (see Academic Integrity Policy below). Homework that is copied or suspiciously similar will receive a zero for *all students* involved.
- In order to receive full credit for computing problems, you need to turn in both a paper copy of the code and any output. Any plots must have the *axes labeled, with units*. Your code needs to be *commented*. At the very least, the comments should include your name and the date, and what units each variable is carrying.

- This is the biggest part of your grade, so please **expect constant assignments and dues, and heavy workload during the semester**. If you have not taken a class that covers the basics (PHY 265, PHY 321 etc), come work with me in person when you have difficulties. I do not drop any in-class work or homework.

iv) **Exams:** Exams will consist of both qualitative and quantitative questions. Makeup exams are not given except with official excuses. You must provide documentation and arrange with me to take it at a different time before the exam. Exams will be open-book/open-notes style, including access to BBLearn, however you are not allowed to access search engines.

v) **Group Project:** After midterm exam, you will choose a group of 3-4 people and a project on a topic related to any course materials or current research. Your group will write up an one-page outline with bullets (single line-spacing, figures and references) and make a presentation during the scheduled classes. We will determine the order of presentation a week before. Report is due the morning of your presentation. There will be intermediate deadlines to make sure that you are making sufficient progress.

University Policies

- Academic Integrity Policy
  Simply two words— no tolerance. *All students* involved will receive zero points on that assignment or exam. If cheating/plagiarism continue, you will receive an F in the class and the Dean's office will be notified.
- Student Institutional Excuses Policy
  Also see the new Faculty Notification Request form if you must miss classes.

Brief Learning Guide

i) Be diligent, proactive, and ask questions.

Stellar astronomy is a very much ongoing research, especially when applying to extrasolar planet studies, and it is an excellent field to apply fundamental physics. The materials are not hard but require diligent learning and practice, which will in turn repay you with lots of fun and accomplishment. Many difficulties may rise simply due to not knowing some *jargons* (definitions, symbols, names etc). But as long as you are patient and willing to learn, you can be an excellent stellar astronomer as well!

ii) Think big and accept approximations.

One of the reasons that I love astronomy is because even though it is not as precise as physics, it turns physics into *beautiful objects* such as stars, galaxies, and even dark matter. Much of astronomy is empirical or based on observations, and observations can be limited due to technology or natural conditions. So even in stellar astronomy, one of the most well-studied fields in astronomy, our knowledge of stars can still be evolving. We also approximate many calculations and you have to accept that. Astronomy is not like physics or chemistry, or math, where we can find precise equations and rules to describe everything we see.

iii) Keep making progress and know where to find your resources.

The Universe is so big (like a puzzle) and there is no reason to believe that I know *everything*. I will do my best to guide you through stellar studies, and provide you ways to resources, but at times we may have to learn about new observations or theories together. Please feel free to share and participate, and do not worry about making mistakes. We all learn and advance from making mistakes.

Week		Tu	Th	Text	Topic
1	Aug	27		Ch3	Class introduction, the continuous spectrum of light
			29		
2	Sep	3		Ch5	The interaction of light and matter
			5		
3*		10			
			12	Ch7.1-7.3	Binary systems & stellar parameters
4		17			
	Sep		19		**Guest Lecture: Dr. Phil Massey (Lowell Observatory)**
5**		24		Ch8.1	Spectrographs & formation of spectral lines
			26		
6	Oct	1			
	Oct		3		**Guest Lecture: Dr. Jeff Hall (Director of Lowell Observatory)**
7		8		Ch8.2	The Hertzsprung-Russell diagram
	Oct		10	**MIDTERM EXAM: Ch 3, 5, 7, 8**	
8		15		Ch9	Stellar atmospheres
			17		
9		22			
			24		
10		29		Ch 10	The interiors of stars
			31		
11	Nov	5			**Guest Lecture: Prof. Ty Robinson**
			7		
12		12		Ch 12.2-3	Formation of protostars & Pre-main-sequence evolution
			14		
13		19			
			21	Ch 13.1-2	Evolution on the main sequence & late stages of stellar evolution
14		26			
			28		**HAPPY THANKSGIVING!**
15	Dec	3			
			5	**GROUP PRESENTATIONS**	
16	Dec		12	**FINAL EXAM: 12:30 — 2:30 pm**	

9/5: Add & drop deadline; 11/1: Course withdrawal deadline

* 9/11 Wed, 1-4pm, Lowell Observatory: Flagstaff Astronomy Symposium

** 9/20 - 9/29: Flagstaff Science Festival, 9/25 Wed, 1-4pm, DuBois Center: Northern Arizona STEM Poster Session