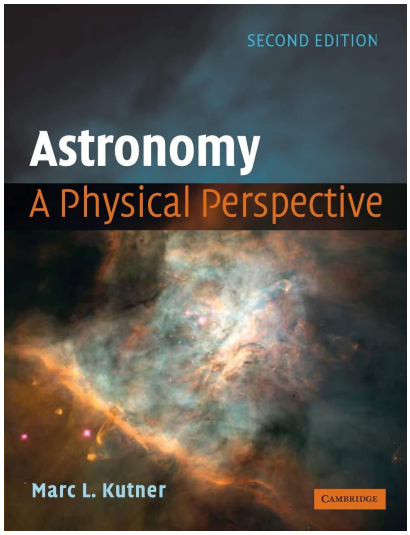
Introduction to Astrophysics (AST-272)
Advanced Astrophysics (AST-302)

Spring 2022, MWF 10:30-11:20am, @ DC1343 or Zoom.

Framing a bright emission region, this telescopic view looks out along the plane of our Milky Way Galaxy toward the nebula rich constellation Cygnus the Swan. Popularly called the Tulip Nebula, the reddish glowing cloud of interstellar gas and dust near the center of this image, is about 8,000 light-years distant and 70 light-years across. Ultraviolet radiation from young energetic stars near the center of the nebula ionizes the atoms and powers the emission from the Tulip Nebula. Also framed in the field of view is microquasar Cygnus X-1, one of the strongest X-ray sources in planet Earth's sky. Driven by powerful jets from a black hole accretion disk, its fainter visible curved shock front lies above and right, just beyond the cosmic Tulip's petals. *Image credit: Ivan Eder. Image caption adapted from Astronomy Picture of the Day on 2017 February 16.*

Course Goals: In this class we will attempt to understand the physics of stars. We will study our current understanding of fundamental questions like: Why and how do stars shine? How do we find out the compositions of stars? How massive are stars? Where and how are stars born? How do stars live their life? What happens when stars die? How do stars affect the rest of the universe?

Course Book: *Astronomy: A Physical Perspective,* by Marc L. Kutner 2nd edition, and additional handouts or online readings. The bookstore should have copies of the text.



Website: An onCourse site has been established for the course; DM will post course materials there.

DM's Drop-in Hours: Monday, Wednesday, Thursday 1-2pm. Discovery Center Room 1330 or Zoom link for the class. Also, come anytime my doors are open!

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Attendance Policy: Class attendance and participation is expected. Absences for school-sanctioned events will be excused. Please know that it is your responsibility to inform me in case of absence due to serious or prolonged illness.

Grading scheme/ Grade items	Percentage of final grade
● **Scholarly activities:** ○ Critical reading of textbook and supplementary materials ○ Question, debate, discuss. Question everything. ○ Applications and problem solving.	 5 5 15
● Astronews	5
● Labs	10
● Exams (three, 20%+20%+20%)	60

Scholarly activities: Weekly reading assignments will be posted on onCourse. You will be expected to have read the material critically, making detailed notes (e.g., of what you understood and what you didn't) as you go through the material. We will have discussions (group and individual) during the first half of each class where we will discuss issues that were not clear. The second half of the class (or sooner, if discussions finish early) will be devoted to solving problems. Submit solved problems for grading before next class. Solutions typeset in LaTex, e.g. using the overleaf website, will receive a bonus point.

Astronews: Present an astronomy or astrophysics-related recent news to the class.

Labs: We will often be doing labs where we will reinforce astrophysical concepts and ideas using astronomical data as well as numerical computations. Labs will be done in groups, and lab results will need to be handed in online within a week of the lab.

Exams: There will be 3 exams over the course of the semester. See the course calendar below for the dates. There will be no make-up exams under ordinary circumstances, so please plan accordingly.

Extra-credit challenges: We want you to get inspired and have new experiences, and to learn science and astronomy through trying new things. So, throughout the term, we will issue special challenges to the class. These challenges will include solving challenging problems, sometimes analytically or sometimes numerically. You are also strongly encouraged to attend **Physics/Astronomy Seminars** held during the semester. Submitting a 1-page write-up of what you learned during the seminar, within a week of the seminar, will earn you 1% extra credit.

AST272 (Introductory) vs. AST302 (Advanced): We will not have any extra class(es) for AST302. But given the advanced (exalted!) background/wisdom of the AST302 students, they will usually

(a) have an additional, slightly advanced, HW problem,
(b) take a slightly different exam,
(c) be expected to take a more leading role during group activities such as problem solving.

Grading Scale: You will not be graded on a curve. Your test grades will be scaled according to the table on the right. This absolute scale is designed, in part, to encourage you to work together. Please help one another inside and outside of class!

Grade	+		-
A	**>96**	**92-96**	**88-92**
B	**85-88**	**81-85**	**77-81**
C	**72-77**	**67-72**	**63-67**
D	**60-63**	**56-60**	**52-56**
F	**<52**		

Late Work Policy: Except in case of lateness due to illness or school-sanctioned events, homework and labs must be turned in by the stated deadline to get full credit. Every week's worth of delay will cost 10% of the maximum score. E.g. if you turn in a HW (that is originally worth, say, 10 points) 3 weeks late, then you can get only 7 points max for that HW.

Academic Integrity and Honor Code: I encourage you to work together on homework assignments, but straight copying of someone else's work is a violation. When in doubt, please acknowledge the work of the students that you studied with. On the other hand, while you can consult class notes and the textbook during the exam, you cannot collaborate with, or seek help from others during the exams. You will be asked to sign the Wheaton College Honor Code statement for the exams.

Accommodations: Wheaton is committed to ensuring equitable access to programs and services and to prohibit discrimination in the recruitment, admission, and education of students with disabilities. Individuals with disabilities requiring accommodations or information on accessibility should contact Autumn Grant - Associate Director for Accessibility Services at the Filene Center for Academic Advising and Career Services. ~ accessibility@wheatoncollege.edu or (508) 286-8215

Tentative Class Schedule			
Week	**Date**	**Topics**	**Reading chapter/section**
1	1/26	Class logistics; Magnitude and fluxes; Colors of Stars	2.1-2.3
	1/28	Thermal/blackbody radiation; Planck's law and derivation of Wien's law and Stefan-Boltmann laws	2.4-2.7
2	1/31	Computing blackbody spectra	
	2/2	Stellar spectra: Origin and formation of spectral lines	3.1-3.3
	2/4	Formation of spectral lines; spectral types	3.3-3.4
3	2/7	Spectral types; the HR diagram	3.4-3.5
	2/9	Sun: Basic structure and introduction to radiation transport	6.1, 6.2
	2/11	Photosphere, Chromosphere, and Corona	6.3-6.5
4	2/14	Corona; Solar activity	6.5-6.6
	2/16	**Mid-term I. No class. Take home exam. Submit completed work by 9am on 2/18**	2, 3, 6
	2/18	Hands-on spectroscopy	
5	2/21	Stellar structure and evolution: On the Main Sequence --- I	9.1, 9.2
	2/23	Stellar structure and evolution: On the Main Sequence --- II	9.3, 9.4
	2/25	Stellar structure and evolution: On the Main Sequence --- III	9.5, 9.6
6	2/28	Introduction to MESA	MESA
	3/2	Stellar structure and evolution: After the Main Sequence --- I	10.1, 10.2
	3/4	Stellar structure and evolution: After the Main Sequence --- II	10.3, 10.4
7	3/7	Creating stellar models with MESA	MESA
	3/9	Exercises in numerical astrophysics	
	3/11	Further exercises in numerical astrophysics	
8	3/14-3/18	*Spring break --- No classes!*	
9	3/21	Stellar structure and evolution: Stellar Remnants --- I	10.4, 11.1
	3/23	*MAP day --- No classes!*	
	3/25	**Mid-term II. No class. Take home exam. Submit completed work by 9am on 3/28**	9, 10
10	3/28	Stellar structure and evolution: Stellar Remnants --- II	11.2, 11.3
	3/30	Stellar structure and evolution: Stellar Remnants --- III	11.4, 11.5
	4/1	Pulsars and tests of general relativity	8.1, 8.3
11	4/4	Black holes --- stellar	11.4, 8.4
	4/6	Black holes --- supermassive	19.4

	4/8	Evolution in Close Binaries --- I	12.1, 12.2
12	4/11	Evolution in Close Binaries --- II	12.3, 12.4
	4/13	SS 433 and X-ray binaries	12.4, 12.5
	4/15	Gravitational waves	
13	4/18	Problem solving	12
	4/20	Star formation --- I	15.1, 15.2
	4/22	Star formation --- II	15.3, 15.4
14	4/25	Star formation --- III, back to MESA	15.5
	4/27	Star formation --- IV	15.6, 15.7
	4/29	Clusters of stars --- I	13.1, 13.2
15	5/2	Clusters of stars --- II	13.3, 13.4
	5/4	Clusters of stars --- III	13.5
	5/6	Problems and review	
16	Finals week	**Final Exam. Take home. Submit completed work by 5/14**	Material covered since midterm II.