Image credit: Universe Today

AST221H1 - Stars and Planets

Professor Rachel Friesen

MWF 12:10 - 1:00pm, GB221(M), GB244(W/F)

Aim of the course

This is a required course in all of the Astronomy & Astrophysics programs. In this course, students will learn to apply basic physical concepts and simple mathematical tools to develop an understanding of planets and stars. Topics covered include bodies in our Solar system, planet formation, the internal structure of planets and stars, star formation and stellar evolution. Prerequisites: PHY132/152, MAT136/137/157; Exclusions: AST 101H1, AST 201H1

Contacts

Prof. **Rachel Friesen**
Office: Astronomy Building (AB), Room 211, 50 St. George St.
Email: friesen@astro.utoronto.ca
Office hours: Wed. 2-3pm, AB211, or by appointment

TAs

Jessica Campbell - campbell@astro.utoronto.ca
James Lane - lane@astro.utoronto.ca
Fei Li - fli@astro.utoronto.ca
Alysa Obertas - obertas@astro.utoronto.ca

Help sessions: group work, Wed. 4-5pm, MP134
Office hours: individual drop-in, Wed. 5-6pm, MP134

Email policy: I will usually respond to emails within two business days - this means last minute questions about assignments may not be answered in time! Please include the class code (AST221) in the subject line when emailing.

Assessment/Grading

- Problem sets (40%)
- Term report (10%)
- Presentation & participation (5%)
- Term Test (15%)
- Final examination (30%)

There will be **5 problem sets** due Fridays at the start of class. You can either bring them to the Friday lecture, or slip them under my office door (AB 221) before noon. The **late penalty** is a 15% reduction per day. You are strongly encouraged to collaborate on the problem sets, but must write up and submit your own work. The University has strict guidelines and grave punishments for academic misconduct.

In the second half of the term, students will be tasked with writing a short report (3-5 pages) and give a 1 minute 'flash' presentation on an approved topic related to the course. Suggested topics will be posted online. No more than two students can research the same topic. You can inform me of your topic choice starting Oct. 7 (8am), and no later than Oct. 11 (5pm). Students are strongly recommended to discuss a report outline with a TA during the normal TA office hours. TAs are happy to provide guidance on the report and presentation.

The **mid-term** (Oct. 25th, usual hour/room) will be an in-class, open-booked exam of 1 hour duration; the **final exam** will be a closed-book exam of 3 hours duration (calculator allowed, no cheat-sheet) during the exam period.

Resources

Textbook and other readings

Introduction to Modern Astrophysics, Carroll & Ostlie, 2nd edition, 2006

Relevant sections of C&O are listed beside the topics for each week in the calendar below. Additional readings will be posted to Quercus ahead of lectures.

Tutorials and blackboard sessions

Friday lecture/tutorials: Fridays will often be more informal blackboard-style lectures. Please do not confuse these with help sessions! During these hours, we will discuss specific issues that are related to the lectures, but are typically not covered by the lectures. The issues discussed are flexible (I am open to suggestions), and the format is intended to be as interactive as possible. **Topics covered in tutorials may be included in the midterm and final exams.**

Weekly Help sessions: These will be led by a TA. During the session, you could sit together with a small group of friends and collaborate on the problem set. TAs will be in the room to explain the concepts, and to provide diagnostics. If a common problem emerges, the TA will hold a short tutorial during the help session. These help sessions are the best way to interact with the TAs and your fellow students.

Quercus

We will be making use of Quercus, the online course management system. You are responsible for monitoring the course Quercus page and your @utoronto.ca email address for announcements, assignments, etc. on a daily basis. Please check right away that you can log in and seek help if you cannot.

Accomodations

Emergencies and life circumstances do happen. Please contact me **in advance** via email (friesen@astro.utoronto.ca) if you know you will miss the midterm test. A student who is unable to write the term test because of illness will be allowed to take a make-up test provided they notify me no later than one week after the test date, and provide a receipt of medical documentation on the University's standard form, available at:
http://www.illnessverification.utoronto.ca
Exceptions due to a non-medical emergency require a note from your college's registrar.

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability or health consideration that may require accommodations, please feel free to approach me and/or the Accessibility Services Office (416-978-8060; accessibility.utoronto.ca) as soon as possible. The Accessibility Services staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. The sooner you let

them and me know your needs, the quicker we can assist you in achieving your learning goals in this course.

Learning outcomes

Some of the main learning outcomes of this course are listed below. Note that this is not exhaustive, and we will cover many topics relevant to stars and planets!

1. By the end of this course, students will be able to explain the concepts of hydrostatic and virial equilibrium, and apply them to our understanding of stellar structure and evolution.
2. Students will examine sources of energy for stars like our Sun, and will be able to describe the evolution of a Solar-mass star, from the start of its hydrogen-burning phase to its end state.
3. Students will differentiate between the flux and luminosity of astronomical sources. Students will predict the magnitude of sources in the sky based on their flux and distance.
4. Students will use equilibria concepts to examine how stars form, along with their associated planets.
5. Students will learn the techniques by which astronomers identify extrasolar planets, and discover what types of planets are detectable with current telescopes and missions.
6. Students will engage in problem solving, and apply critical thinking to examine their solutions for accuracy and plausibility.

Weekly Calendar

Week	Topic	Readings	Assignments
Sept. 6	Overview & distances	C&O 3.1	
Sept. 9-13	Gravity: Orbital mechanics, Kepler's laws, virial theorem	C&O 1.2, 2.1-2.4	
Sept. 16-20	Gravity: binary and n-body orbital motions Gravity: Tides and moons	C&O 19.2, 18.1 (up to 'classes of binary systems')	Assignment 1 due
Sept. 23-27	Stars: hydrostatic equilibrium Stars: virial theorem	C&O 10.1, 10.2 C&O 2.4, 10.3	
Sept. 30-Oct. 4	Stars: nuclear fusion Flux & luminosity Light: Blackbody radiation Light: Spectral lines	C&O 10.3 C&O 3.2, 3.6 C&O 3.3-3.5 C&O 5.1-5.3	Assignment 2 due
Oct. 7-11	Stars: basics Stellar evolution: massive stars	C&O 3.6, 8.2, 10.6, 13.1 C&O 13.2, 15.1	

	after core H-burning		
Oct. 16-18 (Thanksgiving week, no Monday lecture)	Stellar evolution: post-main sequence for low mass stars (guest lecture: Alysa Obertas)	C&O 16.1-16.4	Assignment 3 due
Oct. 21-25	Stellar evolution: neutron stars & black holes Solar system overview	C&O 16.6, 17.3 C&O 19.1, 19.3 (temperatures only)	**Oct. 25:** **in-class midterm**
Oct. 28-Nov. 1	Giant planets Terrestrial planets	C&O 21.1, 21.2 C&O 20.1-20.3, 20.5	Flash presentations
Nov. 4-8 *Drop date: Nov. 4*	Reading week - no class		
Nov. 11-15	Star formation Planet formation	C&O 12 C&O 23.2	Assignment 4 due Flash presentations
Nov. 18-22	Planet formation cont. Extrasolar planets	C&O 20.4 C&O 23.1	Nov. 22: report due Flash presentations
Nov. 25-29	The Kuiper belt, asteroids, meteorites	C&O 22.3, 22.4	Assignment 5 due Flash presentations
Dec. 1-4	Chemistry & astrobiology, briefly Final review		Flash presentations (Mon)