

ASTR394: Spectroscopy in Astronomy

Spring 2014: January 13–May 17
MWF 1:00 PM–1:50 PM, Room: STB 225

Draft 2: May 16, 2014 (subject to change)

Instructor: Kathy Cooksey, STB 219; kcooksey@space.mit.edu; 321-252-8492

Office Hours: M 2–3 PM, W 3–4 PM, R 10–11 AM, and by appointment

Website: Laulima ASTR-394-001

Prerequisites: ASTR 181, PHYS 171; concurrent or previous enrollment in: PHYS 270 (Modern Physics) is desirable; and ASTR 250 (Observational Astronomy) is useful.

Course Description: In-depth examination of how spectroscopy is used in astronomical research. Topics include: basics of how spectrographs work; types of spectra and properties of the electromagnetic spectrum; how different wavelengths are used in the study of e.g., planets, galaxies, large-scale structure; and hands-on analysis of spectra. (CRN: 15029, Section: 001)

Course Goals:

1. Understand and explain the importance of spectroscopy in modern astronomical research.
2. Develop an intuitive understanding of the content, structure, and evolution of the universe.
3. Given a typical astronomical spectrum, identify the object and basic properties—high or low redshift, dusty or not, hot or cold, star-forming or not, etc.
4. Identify the constraints on spectroscopic observations and how they affect the analysis of the spectra.
5. Practice and improve presentation, scientific reading and writing, and figure-making skills.

Email, “Textbook,” and Websites:

1. UHH considers email and Laulima an official form of communication; students are responsible for receiving and returning information in a timely manner.
2. The student must ensure that the instructor has her/his correct email address.
3. There is **no textbook** for this course. We will use a collection of scholarly articles, reviews, and online material. Make sure you can access journal articles through Mookini Library.
4. The Laulima course website is listed under ASTR-394-001. This site will be the hub for all course information.
5. It is recommended you sign up for a VoxCharta account at <http://uhhilo.voxcharta.org>. This is an astro-ph server that allows voting, and the vote counts are helpful in finding articles that many astronomers find interesting/important.

Class Rules:

1. Students are responsible for their own learning, which includes preparing for class, submitting work, asking questions, seeking additional help.
2. Students should be respectful and supportive of their peers’ learning, which means *helping* each other with difficult concepts but *not* just giving the answer.

3. Students should convey (either in person, by email, through an intermediary, or somehow) to the professor questions, comments, and concerns about the course.
4. The professor should be receptive to and respectful of the students' needs and interests and should generally follow the class rules as detailed for the students.
5. **Sign in each class.** There will be an attendance sheet. Participation is part of the grade, and this is one component of that.
6. A calculator is not necessary for every class, though it may often come in handy.

Broad Course Topics:

1. **Properties of the electromagnetic spectrum:** how and what astronomers learn about stars, planets, galaxies, quasars, and large-scale structure, with spectroscopy.
2. **Spectra taxonomy:** blackbody/continuous, emission, and absorption spectra; typical spectra of various astronomical objects: stars, galaxies, quasars.
3. **Spectrometers and observations:** basics of spectrographs; resolution; sensitivity; saturation; observational bias.
4. **Analyzing spectra:** measuring absorption and emission lines; stacking analysis; Doppler effect; universal expansion and Hubble's Law.

Course Outline (*Subject to Change*):

Week 1: January 13–17: basics of electromagnetic spectrum

- Writing assignment **due Monday**, January 20th (even though it's MLK Day with no class). See Laulima Wiki for details.

Week 2: January 22–24 (20th: MLK Day): why spectroscopy; spectrograph basics

Week 3: January 27–31: spectroscopy (observational) basics

Week 4: February 3–7: stellar spectra

Week 5: February 10–14 : stellar spectra (cont'd)

Week 6: February 19–21 (17th: President's Day): galaxy spectra

Week 7: February 24–28: galaxy spectra (cont'd)

Week 8: March 3–7: galaxy spectra (cont'd)

Week 9: March 10–14: observational techniques

Week 10: March 17–21: content synthesis

Spring Break: March 24–28

Week 11: March 31–April 4: active galactic nuclei (AGN)

Week 12: April 7–11: AGN (cont'd)

Week 13: April 14–16 (18th: Good Friday): large-scale structure

Week 14: April 21–25: quasar absorption-line (QAL) spectroscopy

Week 15: April 28–May 2: QAL spectroscopy (cont'd)

Week 16: May 5–7: in-class presentations

Finals Week: May 12–16: Final is Monday, May 12th, 11:50AM–1:50PM

Grading:

- The grade depends on the following items: homework assignment(s) (45%); in-class presentation(s) (20%); in-class participation (20%); and tests/quizzes (15%);
- **There will be no make-up work** other than the final exam.
 - If you are excused, any graded work will *not* be included in your final grade. For example, if you are excused from a lecture with a quiz, neither the in-class participation nor quiz points will be included in your total points.

- * If you must miss a class for a “reasonable reason,” email the professor *before* the start of class time.
 - Defining “reasonable reason” is tough because Life happens in diverse ways—illness, emergencies, utter transportation fails.¹ However, these Life happenings are *irregular*, not *patterns*.
- * If you are unable to email in advance due to *extreme* circumstances, contact the professor as soon as possible. Such instances will be judged on a case-by-case basis.
- * If you manage to be excused from all points in a given category, the percentage of the other categories will be increased to fill the void.

- **Homework assignments are never excused** since their due dates are known in advance. If you are unable to hand in your assignment, it is your responsibility to get it in somehow, either by giving it to another student to submit or by scanning and emailing it to the professor.
- **Late homework is accepted within 24 hours of the deadline** for 75% credit.
- Group work is encouraged in class and for homework assignments. However, all submitted work must be in your own words *and* writing with reference to whom your partners were.
- All references (e.g., websites, textbooks, etc.) used to complete assignments must be cited, including numbers, techniques, facts, etc.
- **Cheating is not tolerated.** Any question of cheating will be tested with an oral exam, to see whether the student(s) involved understand the material.
- The letter grade will be given based on the chart below:

Advising: Advising is a very important resource designed to help students complete the requirements of the University and their individual majors. Students should consult with their advisor at least once a semester to decide on courses, check progress towards graduation, and discuss career options and other educational opportunities provided by UH Hilo. Advising is a shared responsibility, but students have final responsibility for meeting degree requirements.

Grade	% Required
A	≥ 93
A-	[90, 93)
B+	[87, 90)
B	[83, 87)
B-	[80, 83)
C+	[77, 80)
C	[73, 77)
C-	[70, 73)
D	[60, 70)
F	< 60

where e.g., [90, 93) means $\geq 90\%$ and $< 93\%$.

¹“Mental health days” are totally understandable, but they aren’t an excusable reason.