AST 4723: Observational Techniques Part 2

Fall 2025

Instructor:	Prof. Keri Hoadley	**Time:**	M/W 17:10 – 18:00, W 17:10-
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Course Page: https://ufl.instructure.com/courses/544992

Objectives: This course is primarily intended for advanced undergraduate students in astronomy and astrophysics, and will provide a detailed introduction into the techniques used in modern observational astrophysics. The focus of the course will be on electromagnetic observations.

The goal of this course is to provide a foundation in observational techniques for the student who intends to work in observational astronomy and/or pursue graduate studies in astronomy or astrophysics. You will learn:

- To perform astronomical spectroscopic measurements
- To process ("reduce") spectrometer data using python
- To acquire "single-dish" radio spectroscopic data
- To analyze spectroscopic measurements to determine doppler shift
- About types and tradeoffs of astronomical detectors
- To fit models to data

Expected background knowledge You should already know how to:

- Operate an optical telescope and CCD system
- Plan an observing run
- Process ("reduce") CCD imaging data using python
- Perform astronomical photometric measurements

Learning Goals of the course

1. Understand a spectrograph
2. Use python for astronomical spectroscopy
3. Perform a spectroscopic measurement
4. Reduce a spectroscopic observation
5. Use python for statistical analysis and modeling
6. Lead a supervised independent project

Ancillary goals:

1. Meet your peers in the astronomy track (network)
2. Write a scientific paper
3. Practice public speaking
4. Practice proposal writing for observational data

Main References: There is no required textbook for this course. Instead, we provide a restricted list of various interesting and useful books that will be touched during the course. You are advised to consult them occasionally.

- Stuart Littlefair's PHY241 course
  http://slittlefair.staff.shef.ac.uk/teaching/phy241/
  (previously PHY217: https://sheffield-mps.github.io/PHY217/index.html)
- Matt Craig and Lauren Chambers, *CCD Data Reduction Guide*,
  https://www.astropy.org/ccd-reduction-and-photometry-guide/v/dev/notebooks/00-00-Preface.html
- Phil Massey, *Astronomical Spectroscopy*,
  https://home.strw.leidenuniv.nl/~franx/technicalresearchinformation/AstronomicalSpectroscopy.pdf or https://arxiv.org/abs/1010.5270
- Adam Ginsburg, Kelle Cruz, Lia Corrales, Jonathan Sick, and Adrian Price-Whelan, *Spectroscopic Data Reduction Basics*,
  https://learn.astropy.org/tutorials/index-spectroscopy.html
- C.R. Kitchin, *Astrophysical Techniques*,
  https://ui.adsabs.harvard.edu/abs/2013aste.book.....K/abstract

Grading Policy: There will be no exams in this course, but occasional quizzes will be given during class. The grade will be primarily based on your lab effort. The breakdown is:

- Class Assignments and Participation (30%)
- Observing Projects / Labs (70%)

More information on grades and grading policies is here:
https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/ Given the above scoring (total of 100 points), the following grades will be assigned:

Grade	Minimum Score
A	93
A-	90
B+	87
B	83
B-	80
C+	77
C	73
C-	70
D+	67
D	63
D-	60

Attendance: Class attendance is required. Since this is a laboratory-based course, attendance to labs and associated lectures are necessary to complete the assignments given for the class. Some material may also be taught in a 'flipped' classroom approach, where the lectures will be homework due before class and the class work will be an interactive assignment. Expect that class assignments will be posted at the start of class and due for submission on the course webpage at the posted due date.

Labs will generally be in-person, either at the basement lab or the Campus Teaching Observatory (CTO). For the Radio Astronomy lab, it will be necessary to check out equipment and bring it to an observing site (which can be CTO, but may be somewhere else).

For scheduled labs, the following policy applies: We will not permit you to make up a lab unless permission is granted beforehand or there is a serious emergency. If you feel that you have a situation that may allow for a make-up, contact the TA immediately via email. If you are absent without being excused, you will receive a zero for the lab.

Some of the observing can be done independently outside of class hours on Saturday and Sunday evenings (other days of the week are reserved for other classes).

Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Course Policy:

- We will use Canvas for announcements and other digital communication, so you are expected to regularly check Canvas.
- Regular attendance is essential and expected (see above).

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the UF Disability Resource Center (352.392.8565) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodations. Students with disabilities should follow this procedure as early as possible in the semester.

See https://disability.ufl.edu/get-started/.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Class Demeanor

Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Opinions held by other students should be respected in discussion, and conversations that do not contribute to the discussion should be held at minimum, if at all.

Because this is a lab course that depends on the weather, it is crucial that students show up on time for lab sessions, especially those held at the observatory. Makeup sessions for missed labs cannot be guaranteed.

In-class Recording Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal education use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and deliver by an instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentation such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or guest lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless, of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Materials and Supplies Fees

There are no additional fees for this course.

University Honesty Policy

UF students are bound by The Honor Pledge which states, '*We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity by abiding*

by the Student Honor Code. On all work submitted for credit by Students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."'

The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TA in this class.

Counseling and Wellness Center

Contact information for the Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc/Default.aspx, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Lab Report and Project Due Dates (subject to change)

Submit via Canvas by the assigned deadline

1. Lab 1: Spectroscopy. Lab characterization of a 'long-slit' spectrograph
2. Lab 2: Site Characterization for Radio Astronomy
3. Lab 3: Spectroscopy. Obtain optical spectra of a star and a nebula and reduce them.
4. Lab 4: Radio Astronomy in the lab. Calibrate a Software-Defined-Radio (SDR) radio telescope.
5. Lab 5: Radio Astronomy. Using the SDR, perform a scan of the sky in the HI Atomic Hydrogen line
6. Final Project. Several candidate projects are below, but which of these is available will depend on the state of our observations by October. These projects will use data acquired in Lab 3 or 5 to make scientific measurements.
    - Create a mosaic (an image cube) of all of the acquired HI data.
    - Measure the age of a cluster from its Hertzsprung-Russell diagram
    - Measure the rotation curve of a Galaxy and infer its mass (profile)

Preliminary Schedule for Class & Lab Topics (subject to change)

- Week 1 (Aug 25, 27): Re-introduction to python, observing
  Homework: Python refresher (group)
- Week 2-6 (Sep 3, 8, 10, 15, 17, 22, 24, 29, Oct 1): Radio Astronomy (single-dish)
- Week 7-10 (Oct 6, 8, 13, 15, 20, 22, 27, 29): Spectroscopy & Spectrographs
- Week 11-12 (Nov 3, 5, 10, 12): Detectors, statistics
- Week 13-15 (Nov 17, 19, Dec 1, 3): Radio Interferometry, X-ray imaging & Spectroscopy

Lab dates (tentative/subject to change pending weather):

- Week 1 (Aug 27) - Introduction to lab equipment (radio, spectrograph)
- Week 2 (Sept 3) - In lab, practice with spectrographs, radio telescopes

- Week 3 (Sept 10) - Radio Observing
- Week 4 (Sept 17) - Radio Observing Spectroscopy Observing Run 2
- Week 5 (Sept 24) - Radio Observing Spectroscopy Observing Run 3
- Week 6 (Oct 1) - Radio Observing
- Week 7 (Oct 8) - Spectroscopy Observing Run 1
- Week 8 (Oct 15) - Spectroscopy Observing Run 2
- Week 9 (Oct 22) - Spectroscopy Observing Run 3
- Week 10 (Oct 29) - Data Processing / Final Project / Back-up for Spectroscopy Observing
- Week 11 (Nov 5) - Data Processing / Final Project / Back-up for Spectroscopy Observing
- Week 12 (Nov 12) - Data Processing / Final Project / Back-up for Spectroscopy Observing
- Week 13 (Nov 19) - Data Processing
- Week 14 (Nov 26) - HOLIDAY - No Lab
- Week 15 (Dec 3) - Final presentations
- Week 16 (Dec 8) - NO FINAL EXAM

General topics covered

- Radio Telescopes: Antennae, beam patterns, heterodyne systems
- Detectors: Types of Detectors, Fundamentals of Charge Coupled Devices, Read Noise, Dark Current, Exposure Times
- Spectroscopy: Obtaining and reducing grating spectra
- Spectroscopy: Modeling and fitting spectral lines
- Data Analysis: Statistics and Error Analysis as applied to spectra