AST 4723: Observational Techniques Part 2

Fall 2020

Instructor:	Prof. Adam Ginsburg	**Time:**	M/W 17:10 – 18:00, W 17:10-
Email:	adamginsburg@ufl.edu	**Place:**	Bryant Basement Rm 7
Office:	Bryant 218	**Office Hours:**	17:00 - 18:00 T/Th
TA:	Jared Cathey	**Office Hours:**	Tuesdays 9:00-10:00
Email:	jaredcathey@ufl.edu		

Course Pages:

1. https://ufl.instructure.com/courses/

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") CCD 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 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. Use python for astronomical spectroscopy
2. Use python for statistical analysis and modeling
3. Reduce a spectroscopic observation
4. Perform a spectroscopic measurement
5. Understand a spectrograph
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

Main References:

- Matt Craig and Lauren Chambers, *CCD Data Reduction Guide*, https://mwcraig.github.io/ccd-as-book/00-00-Preface.html
- Phil Massey, *Astronomical Spectroscopy*, https://home.strw.leidenuniv.nl/~franx/technicalresearchinformation/AstronomicalSpectroscopy.pdf or https://arxiv.org/abs/1010.5270
- 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/ugrad/current/regulations/info/grades.aspx
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. Some material will be taught in a 'flipped' classroom approach, where the lectures will be homework due before class and the class work will be an interactive asssignment.

Labs will generally be in-person, either at the basement lab or the Campus Teaching Observatory. 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.
- We will use Slack (ast4723fall2022.slack.com) for synchronous communication in class. You are expected to use Slack to communicate with one another and with the instructor when synchronous communications are needed but Zoom is not available. However, your grade will not depend in any way on Slack usage. You can join at: https://join.slack.com/t/ast4723fall2022/shared_invite/zt-1dnzwf675-pHHXYb7UAZ_bVbRIzub~dw

- 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

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.

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: Site Characterization for Radio Astronomy
2. Lab 2: Radio Astronomy in the lab. Calibrate an RTL-SDR-based radio telescope.
3. Lab 3: Radio Astronomy. Using the RTL-SDR, perform a scan of the sky in the HI Atomic Hydrogen line
4. Lab 4: Spectroscopy. Lab characterization of a fiber-fed 'long-slit' and echelle spectrograph

5. Lab 5: Spectroscopy. Using the Pepito spectrograph, obtain spectra of a star and a nebula and reduce them.
6. Lab 6: JWST PSF Photometry. Given a small image, reduce from raw data, track errors, plot HR diagram and make catalog.
7. 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 2, 3, or 4 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, 30, Sep 1): Re-introduction to python, observing
  Homework: Python refresher (group)
- Week 2-5 (Sep 6, 8, 13, 15, 20, 22): Radio Astronomy (single-dish)
- Week 6-10 (Sep 28, 30, Oct 5, 7, 12, 14): Spectroscopy & Spectrographs
- Oct 19, 21, 26, 28, Nov 2, 4: Detectors, statistics
- Nov 9, 16, 18, 23, 30, Dec 2, 7, 9: Radio Interferometry, X-ray imaging & Spectroscopy

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

- August 31 - Introduction to lab equipment (radio, spectrograph)
- September 7 - In lab, practice with spectrographs, radio telescopes
- September 14 - Spectroscopy Observing Run 1
- September 21 - Spectroscopy Observing Run 2
- September 28 - Spectroscopy Observing Run 3
- October 5 - radio observing
- October 12 - radio observing
- October 19 - radio observing
- October 26 - radio observing
- November 2 - data processing / final project
- November 9 - data processing / final project

- November 16 - data processing
- November 30 - no new activity
- December 7 - no new activity

General topics covered

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