ASTR 21200: Observational Techniques in Astrophysics

Spring 2024, University of Chicago

Class Hours: T/Th 5.00-6.20pm
Class Room: TBD

Instructor: Bradford Benson
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Course Website: https://github.com/bradfordbenson/ASTR21200_2024
Course Wiki: https://github.com/bradfordbenson/ASTR21200_2024/wiki

Course Description

Astronomers explore the universe by detecting and analyzing light from all over the electromagnetic spectrum. This is an observational lab course, focused on obtaining and analyzing astronomical data with optical telescopes, namely the Stone Edge Observatory.

Students will work in groups of 3-5 students to conduct observational experiments via labs. For all the labs, the students will be responsible for scheduling the observations, analyzing the resultant data, and reporting their work in lab reports.

1. Lab 1: Students will measure properties of astronomical CCD cameras and develop a calibration scheme for optical imaging.
2. Lab 2: Students will acquire color images of galaxies, measure their angular size and radial profile, and infer the expansion rate of Universe (i.e., the Hubble constant)
3. Lab 3: Students will propose their own project and undertake observations.

The course will include a lecture component, that is intimately intertwined with the experimental aspects of the course. The students will learn the basics of practical observational astronomy, such as determining the observability of selected targets, telescope and detector technology, the use of photometric and spectroscopic techniques, and methods of error, statistical, and time-series analysis. A limited number of homework sets will be assigned to facilitate comprehension of the lecture material. Data analysis will be performed using standard astronomy software packages, as well as one general-purpose programming language such as python. In addition, students will need to familiarize themselves with standard Linux tools. Tutorials will be provided during class-time and/or as homework. Towards the end of the course, the students will prepare a final oral presentation on their final Lab Project.

Course Website and Textbooks

All course materials will be available on the class webpage:
https://github.com/bradfordbenson/ASTR21200_2024

This wiki includes pdfs of the Lectures, Homeworks, Tutorials, Labs. In addition, I **strongly recommend** this textbook for the course:

1. Observational Astronomy, Birney, D. Scott / Gonzalez, Guillermo / Oesper, David (Cambridge University Press, 2006)

However, I will aim to provide essential material from this course, drawn from a range of textbooks. I do not expect that there will be any assigned reading, however these will be useful references to learn about specific topics and I can potentially make pdf version of some of them available to you.

1. Measuring the Universe: A Multiwavelength Perspective, G. Rieke (Cambridge University Press, 2012)
2. Practical Statistics for Astronomers, J.V. Wall & C.R. Jenkins (Cambridge University Press, 2008)
3. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington & D. K. Robinson (McGraw-Hill Higher Education, 2003)

Grading Policy

The final course grade will be based on three homeworks, four lab reports, and a final presentation, using the following weighting:

1. Homeworks: 30% (10% each)
2. Lab Reports: 60% (20% each)
3. Final Presentation: 10%

The overall course grade will range from 0-100, however a curve will be applied to assign letter grades.

Lab Report Grading

Lab reports are also scaled on a scale of 0-100. For Labs 1-2, the lab reports are to be submitted as a Jupyter[1] notebook, including documentation, code, and plots. For Lab 3, in addition to the lab report, students will present a final group presentation about their project during the final week of the quarter.

Attendance

Class attendance is mandatory, unless a student is feeling sick or in isolation / quarantine. In this case, the student must inform the instructor ahead of time, so that attendance / recording through zoom can be arranged. For every lecture or data analysis class missed, one point (on a scale of 100) will be subtracted from your final score.

[1] https://jupyter.org

Syllabus

Week	Day	Lecture	Homework/Lab	
			Assign	Due
1	Mar-19	Intro to Astro Observing	HW1	(Due Mar-26)
	Mar-21	Practical Observing		
2	Mar-26	CCDs and Astronomical Images	HW2	(Due Apr-2)
	Mar-28	Intro to Stone Edge		
3	Apr-2	Intro to Labs and Lab1	Lab-1	(Due Apr-16)
	Apr-4	((Analysis and Help/Hack Session)		
4	Apr-9	Statistics		(Due Feb-7)
	Apr-11	(Analysis and Help/Hack Session)	HW3	(Due Apr-23)
5	Apr-16	Introduction to Lab 2	Lab-2	(Due May-2)
	Apr-18	(Analysis and Help/Hack Session)		
6	Apr-23	(Analysis and Help/Hack Session)		
	Apr-25	(Analysis and Help/Hack Session)		
7	Apr-30	Introduction to Lab 3, Project Ideas	Lab-3	(Due May-16)
	May-2	(Analysis and Help/Hack Session)		
8	May-7	(Analysis and Help/Hack Session)		
	May-9	(Analysis and Help/Hack Session)		
9	May-14	Scientific Writing and Presentations		
	May-16	(Analysis and Help/Hack Session)		
10	TBD		Lab-3	Presentations

Table 1: Preliminary Course Schedule. Note: The Lab-3 group presentations will occur during the finals time and location (TBD).