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ASTR 362.01: Observational Astronomy

Nathan T. McCrady
University of Montana - Missoula, nate.mccrady@umontana.edu

Astronomy 362: Observational Astronomy

University of Montana, Fall 2018
T/Th 3:00 – 4:50 pm, CHCB 227
Course Number 74559

Professor Nate McCrady
e-mail: nate.mccrady@umontana.edu
Office: 122 CH Clapp Building
Office Hours: M/Tu/F 11am – noon, Th 1 – 2pm, and by appointment
Course website: available via UMOnline / Moodle

Course Description

Observational astronomy relies heavily on application of advanced technology. The quest to observe fainter, farther and deeper has placed astronomers on the forefront of technological advances such as digital imaging, precision spectroscopy and adaptive optics with deformable mirrors. Modern astronomy is dominated by the CCD and related pixel array detectors: digital devices with unprecedented sensitivity to light. Detecting faint signals in the presence of noise requires a wide range of skills. The astronomer's most valuable tool is the computer, used in data acquisition, numerical simulations and image processing and analysis. In this course, we will investigate the probabilistic behavior of light, learn the fundamental statistical tools, build the imaging and analysis skill sets required for astronomical research, and gain experience in the proper forms of written and oral presentation of scientific results.

Course Objectives

My goals in this course are to…

1. Develop students' practical skills in astronomical data reduction and analysis.
2. Provide students the basic tools used in uncertainty analysis and error propagation.
3. Develop student competence in scientific writing and presentation of scientific results.

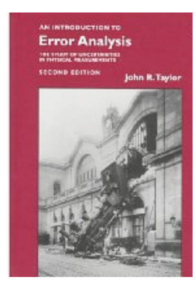
Optional Texts

There is one assigned textbook for this course:

An Introduction to Error Analysis, 2nd Ed.
By J.R. Taylor

The following textbook is a useful reference:

Observational Astronomy, 2nd Ed.
By D.S Birney, G. Gonzalez & D. Oesper



Expectations of the Professor

This laboratory course is intended for physics majors with a concentration in astronomy. The designated pre-requisite courses are Astronomy 132 or 142 (introductory astronomy) and Physics 212 (physics with calculus). You should also be comfortable working with logarithms, scientific notation and the Greek alphabet!

This course is scheduled to meet on Tuesday and Thursday afternoons from 3:00 – 4:50 pm. As you are no doubt aware, however, the stars are only observable at night. At least three of the five labs in the course will require some nighttime observing and data acquisition. Night observing will be on dates determined by the participants (students and instructor) and the prevailing weather in Missoula. It is to your benefit to take advantage of good observing conditions when they occur, as *poor weather is not considered a valid excuse in astronomy*. Don't wait to take your data!

Time in the classroom is an essential part of this course, and it will be to your benefit to attend class sessions. In addition to presentation of new material by the professor, classtime will feature quizzes over programming topics, and **show & tell** (15-20 minutes), wherein a student will present interim results from their lab group. These presentations will be an opportunity for students to share ideas and discuss what they have learned on the current lab, as well as develop oral presentation skills in a workshop environment.

This course is a collaborative effort – please ask questions, offer your ideas and be prepared to participate in the discussion. Written work submitted in this course must be expressed in your own words. I specifically encourage students in this course to work together, but each student must write up her or his own lab report. This step is essential to your learning – writing up the report requires you to understand the methods and conclusions of your group, whereas transcription of the work of another does not. When in doubt, please ask me what is acceptable.

Pedagogical Philosophy of the Professor

My primary goals in teaching an upper division lab course are to provide students with experiences in the activities of observational astronomy, and to develop practical student research skills that can be applied in undergraduate projects on campus or in summer internships such as the National Science Foundation's REU program. During the labs, you will learn about data acquisition, instrumental calibration, uncertainty analysis, and collaborative science. In presenting your results, you will gain experience with oral presentation, science writing and graphical presentation of data.

Grading Policy

This course and each assignment within it will be graded on the University's traditional letter grade system. Your grade will be based on the five lab assignments (15% each), several quizzes on Unix and programming (10% total), two Python programming assignments (5% each), and your "show & tell" presentation (5%). Note that there will be no final exam. I have not determined in advance how many As, Bs, etc will be assigned. A-level work will be rewarded with an A grade regardless of the performance of other students.

Each of your five lab writeups will be in the form of a scientific journal article. You will be graded on your presentation, specifically including figures, plots and captions, as well as the results of your work. Lab reports must be written in LaTeχ, must include all relevant images and plots, and must be turned in by midnight on the due date posted on the course website. Your writeups will be submitted electronically, in the form of a PDF document. Late reports will NOT be accepted except in the case of *prior* permission from the professor.

Course Schedule

			Related Activities
		THE TOOLS OF THE ASTRONOMER	
Tu	Aug 28	Introduction, optical telescopes	Telescope tour
Th	Aug 30	CCD operation & digital imaging	Unix tutorial
Tu	Sept 4	Basics of scientific programming	Python tutorial, sect. 1-2
Th	Sept 6	Errors and uncertainties, significant figures	Python tutorial, sect. 3
Tu	Sept 11	Celestial sphere and coordinate systems	Meet in UM Planetarium
Th	Sept 13	Charts and catalogs, planetarium programs	
		STATISTICAL ANALYSIS	
Tu	Sept 18	Mean, standard deviation, SDOM	Python tutorial, sect. 4-5
Th	Sept 20	Distribution functions & histograms	Python tutorial, sect. 6-7
Tu	Sept 25	Distributions: Poisson & Gaussian	
Th	Sept 27	Basics of scientific writing	LaTeχ tutorial
Tu	Oct 2	Error propagation	
		CCD PHOTOMETRY	
Th	Oct 4	CCD calibration	Lab 1 due
Tu	Oct 9	Least squares fitting	
Th	Oct 11	*Student work day*	
Tu	Oct 16	Flux and the magnitude scale	Lab 2 due
Th	Oct 18	Stellar photometry, PSF	
Tu	Oct 23	Effects of the atmosphere	
		BROADBAND CCD IMAGING	
Th	Oct 25	Filters and colors	
Tu	Oct 30	Thermal (“blackbody”) emission	
Th	Nov 1	Astrometry	Lab 3 due
Tu	Nov 6	*Election Day – No Class*	
Th	Nov 8	Image mosaicking	
Tu	Nov 13	Main sequence fitting and cluster age	
		SPECTROSCOPY	
Th	Nov 15	Introduction to spectroscopy	
Tu	Nov 20	Spectroscopy calibration	Lab 4 due
Th	Nov 22	*Thanksgiving Day – No Classes*	
Tu	Nov 27	Curve fitting	
Th	Nov 29	RV detection of exoplanets	
Tu	Dec 4	*Student work day*	
Th	Dec 6	*Student work day*	Lab 5 due