

# Astronomy 362: Observational Astronomy

University of Montana, Fall 2016

T/Th 3:00 – 4:50 pm, CHCB 227

Course Number 74857

## Professor Nate McCrady

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Office: 122 CH Clapp Building

Office Hours: MWF 11am-noon, Thurs 1-2pm, and by appointment

Course website: available via UMOonline / 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, interferometry 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 no assigned textbook for this course.

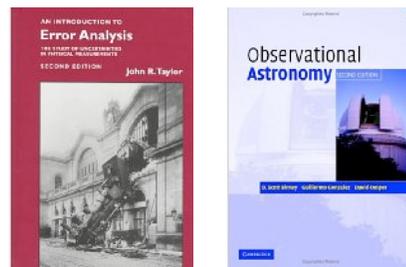
The following textbooks are useful references.

*An Introduction to Error Analysis, 2<sup>nd</sup> Ed.*

By J.R. Taylor

*Observational Astronomy, 2<sup>nd</sup> 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. Four 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.

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 programming (10% total), two Python programming assignments (5% each), and a short oral 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 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 LaTeX, must include all relevant images and plots, and must be turned in by midnight on the due date posted on the course website. Your reports 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 Material
THE TOOLS OF THE ASTRONOMER			
Tu	Aug 30	Introduction, optical telescopes	
Th	Sept 1	CCD operation & digital imaging	
Tu	Sept 6	Celestial sphere and coordinate systems	Meet in UM Planetarium
Th	Sept 8	Charts and catalogs, planetarium programs	Unix tutorial
Tu	Sept 13	Basics of scientific programming	Python tutorial, sect. 1-2
STATISTICAL ANALYSIS			
Th	Sept 15	Errors and uncertainties, significant figures	Python tutorial, sect. 3
Tu	Sept 20	Mean, standard deviation, SDOM	Python tutorial, sect. 4-5
Th	Sept 22	Distribution functions & histograms	Python tutorial, sect. 6-7
Tu	Sept 27	Optical telescopes	
Th	Sept 29	Basics of scientific writing	LaTeX tutorial
CCD PHOTOMETRY			
Tu	Oct 4	CCD calibration	
Th	Oct 6	Error propagation	
Tu	Oct 11	Least squares fitting	
Th	Oct 13	Flux and the magnitude scale	
Tu	Oct 18	<i>Student work day</i>	
Th	Oct 20	Stellar photometry, PSF	
Tu	Oct 25	Effects of the atmosphere	
BROADBAND CCD IMAGING			
Th	Oct 27	Filters and colors	
Tu	Nov 1	Thermal (“blackbody”) emission	
Th	Nov 3	Astrometry	
Tu	Nov 8	<i>Election Day – No Class</i>	
Th	Nov 10	Image mosaicking	
TIME DOMAIN ASTRONOMY			
Tu	Nov 15	Eclipsing binaries	
Th	Nov 17	Transiting exoplanets	
Tu	Nov 22	<i>Student work day</i>	
Th	Nov 24	<i>Thanksgiving Day – No Classes</i>	
Tu	Nov 29	Curve fitting	
Th	Dec 1	<i>Student work day</i>	
Tu	Dec 6	<i>Student work day</i>	
Th	Dec 8	<i>Student work day</i>	