

Observational Techniques

Astronomy 5150, 4 credits

Spring 2024 v 1.0

The purpose of this course is to train advanced students in astronomy/astrophysics in the observational tools of the professional astronomer. The idea is that by the end of this semester you will be able to perform every step needed to acquire and interpret astronomical data: planning the observation, deciding the telescope and instrument combination to be used, performing the observations and collecting calibration data, calculating the signal-to-noise ratios expected, reducing the data to eliminate instrumental artifacts, and extracting photometric and spectroscopic measurements in the units astronomers use.

The class will consist of bi-weekly homework assignments which include traditional analytical written homework assignments, data analysis assignments with IRAF utilizing photometric and spectroscopic datasets, and some programming using the/python language. My intent is to teach you the things that I've found most useful as an observational astronomer. Of course, this cannot be done in one semester, but we'll start with the basics and I expect you'll pick up the rest after this course ends when you do research for real.

The high-level overview of this course is to lean to plan observations and carefully reduce one imaging and one spectroscopic dataset.

- Telescope operation and observing planning (5 weeks)
- CCD photometry (6 weeks)
- CCD spectroscopy (3 weeks)

We will only briefly touch on observations and data at infrared, X-ray, and radio wavelengths. Many of the analysis techniques that we'll learn from optical data will carryover to these other wavelength regimes, but any specialized methods you'll have to pick up on your own.

Instructor: Prof. Chip Kobulnicky — email: chipk@uwyo.edu

Office Hours: MWF 10:00 - 11:00 and by appointment or happenstance; just drop by, I'm nearly always around

Class Meetings: MWF 9:00 – 9:50 in PS227

Web Page: physics.uwyo.edu/~chip/Classes/ASTR5150

Text: *To Measure the Sky*, by F. Chromey (recommended)

Text: *Data Reduction and Error Analysis* by Bevington
or *Error Analysis* by Taylor or similar (recommended)

Text: *Handbook of CCD Astronomy* by S. Howell (recommended)

Text: *Astronomical Optics*, 2nd edition, by Schroeder (recommended)

Class Requirements

homework assignments	35%
midterm exam	30%
final exam	35%

Grading:

>85%=A 75-85%=B 60-75%=C 50-60%=D <50%=F

Expectations, Collaborations, and Ethical Conduct

I adhere to the University of Wyoming's policy on academic integrity. If you are unclear about issues of academic integrity, see siswww.uwyo.edu/reg/bulletin/contents.html. Work presented as your own should reflect your own effort. Nevertheless, I encourage you to work together, study together, and teach each other on homework assignments. You'll get more out of the course that way, and avoid getting frustrated on difficult problems. Because I do not grade on a curve, it is to your advantage to study together and learn from one another. Late homework policy: declines 10% for each 12-hour period late to a minimum of 50%.

Course Outline

(subject to revision)

Week 1: The Celestial Sphere, Time, Catalogs

Text: Chromey Ch. 1, 3, 4

Goals: observing seasons, celestial motions, coordinates, time, precession, proper motion

Week 2 Telescopes

Text: Chromey Ch. 5, 6

Goals: Telescope types, optics, resolution, seeing, plate scales

Week 3 Atmospheric Effects, Light, magnitudes

Text: Chromey Ch. 1, lecture supplements

Goals: EM spectrum, atmospheric effects, common, bandpasses

Week 4 Fluxes, astronomical units, detectors

Text: Chromey Ch. 1, 8, Howell Ch 1-3, + supplements

Goals: magnitudes and conversions to other units, detector types and operation

Week 5 Statistics and Signal-to-noise

Text: Chromey Ch. 2, Bevington Ch. 1-4; Howell Ch. 4

Goals: photon statistics, source noise, background noise, read noise, flatfielding noise, dark current, error propagation

Week 6 CCD Photometry 1

Text: Chromey Ch. 9, 10, Howell Ch. 4-5

Goals: IDL/IRAF, image displays, image combination, flatfielding, bias correction

Week 7 CCD Photometry 2: Photometry and Fitting

Text: Chromey Ch. 9, 10, Howell Ch. 4-5

Goals: apertures, aperture photometry, aperture corrections, psf fitting photometry

Week 8 CCD Photometry 3

Text: Bevington Ch. 5-7

Goals: linear fits, error estimate, chi-squared, propagation of errors, centroid analysis

Mid-Term exam TBD

Week 9 CCD Photometry 4

Text: Chromey Ch. 9–10, Howell Ch. 4–5

Goals: Extinction corections, color corrections

Week 10 PSF Fitting Photometry

Text: supplements

Goals: deconvolution, PSF fitting

Week 11 Spectroscopy Instrumentation

Text: Howell Ch. 6, Chromey Ch. 11, Schroeder Ch. 12–15

Goals: grating equation, collimator, camera, dispersion, reimaging optics

Week 12 Spectroscopy Data 1

Text: Howell Ch. 6, Chromey Ch. 11, Schroeder Ch. 12–15

Goals: calibrations, standards, flat fielding, illumination corrections

Week 13 Spectroscopy Data 2

Text: supplements

Goals: spectral extractions, flux calibration, wavelength calibration

Week 14 Spectroscopy Data 3, Final Projects

Text: supplements

Goals: velocity corrections and line measurements

Week 15 Review & Final

Final exam: TBD

Classroom Behavior Policy: Include a statement of policies to foster a positive learning environment (civility and respectful discussion, for example), including use of cell phones, mobile devices, etc. Electronic devices such as mobile phones should be (left at home, set to silent, turned off). Laptops (are, are not) allowed for note-taking purposes. No video or audio recording during class is allowed to protect the privacy of your fellow students.

Classroom Statement on Diversity: The University of Wyoming values an educational environment that is diverse, equitable, and inclusive. The diversity that students and faculty bring to class, including age, country of origin, culture, disability, economic class, ethnicity, gender identity, immigration status, linguistic, political affiliation, race, religion, sexual orientation, veteran status, worldview, and other social and cultural diversity is valued, respected, and considered a resource for learning.

Disability Support: Insert a statement referring to reasonable accommodations provided by University Disability Support Services. Example: The University of Wyoming is committed to providing equitable access to learning opportunities for all students. If you have a disability, including but not limited to physical, learning, sensory or psychological disabilities, and would like to request accommodations in this course due to your disability, please register with and provide documentation of your disability as soon as possible to Disability Support Services (DSS), Room 128 Knight Hall. You may also contact DSS at (307) 766-3073 or udssuwyo.edu. It is in the student's best interest to request accommodations within the first week of classes, understanding that accommodations are not retroactive. Visit the DSS website for more information at www.uwyo.edu/udss