

Observational Techniques

AY 433-001 | Spring 2018 | 3 Credit Hours

Lecture

Dr. William Keel

Contact Information

UA Campus Directory:

- Dr. William Keel (<https://www.ua.edu/directory/?i=wkeel#listing>)

Lectures are 9:00-19:50 am MWF in 310 Gallalee. Office hours are 1:15-3:00 Wednesday, 1:00-3:00 Tuesday, or by appointment. My office is in 316 Gallalee, 348-1641, wkeel@ua.edu (<mailto:wkeel@ua.edu>). Course materials are at <http://astronomy.ua.edu/keel/techniques> (<http://astronomy.ua.edu/keel/techniques>).

Prerequisites

UA Course Catalog Prerequisites:

AY 204 or AY 206 PH 253 or permission of instructor

Course Description

Course Description and Credit Hours

Students will learn to perform astronomical observations with eye, telescope, and modern detectors, using techniques of digital imaging, photometry, and spectroscopy. Wavelength ranges from radio to gamma-ray will be addressed. Students will gain familiarity with current software tools for data analysis, model fitting, and error analysis. Students will carry out and report on all components of observational research, from concept and data collection to analysis and presentation of conclusions. Writing proficiency within this discipline is required for a passing grade in this course.

Required Texts

Required Texts from UA Supply Store:

- KITCHIN / ASTROPHYSICAL TECHNIQUES (Required)

- KITCHIN (RENTAL) / (RENTAL) ASTROPHYSICAL TECHNIQUES (RENTAL)

Course Objectives

Students will learn to perform astronomical observations with eye, telescope, and modern detectors, using techniques of digital imaging, photometry, and spectroscopy. Students will gain familiarity with current software tools for data analysis, model fitting, and error analysis. Students will carry out and report on all components of observational research, from concept and data collection to analysis and presentation of conclusions.

Student Learning Outcomes

On successful completion of this course, students will:

- be able to perform astronomical observations with eye, telescope, and modern detectors.
- understanding principles of data analysis, model fitting, and error analysis.
- be familiar with current software tools for these tasks.
- be able to carry out and report a complete research project, from concept and data collection to analysis and conclusions.

Other Course Materials

Web material at <http://astronomy.ua.edu/keel/techniques>

Outline of Topics

Date	Topics (chapter)
10-Jan	Intro - radiation, Stokes parameters, far-field detection. Atmosphere, telescopes, optics, detection...
12-Jan	Electronic resources to master - literature, catalogs, data. (Electronic access tips) (5.5)
17-Jan	Detectors I: the eye, photomultipliers (1.1)
19-Jan	Detectors II: CCDs. Instrumental signatures, subpixel properties, pixel boxes versus sampling fn (1.1.8)
22-Jan	Detectors III: IR (1.1.15)
24-	

Jan	Noise and S/N optimization, Poisson processes, model fitting/testing (1.1.17)
26-Jan	Important statistical ideas - parametric/nonparametric. Bayesian/frequentist.
29-Jan	Telescopes I: image formation, diffraction aberrations. Designs.(1.1.18,19)
31-Jan	Telescopes II: optical fundamentals, optical components (1.1.19)
2-Feb	Telescopes III: structures and mountings. Tracking/acquisition, moving targets.
5-Feb	Atmospheric effects: seeing, high-speed imaging, adaptive optics. Refraction, dispersion. (1.1.22)
12-Feb	Observatory enclosures and sites - dome/thermal effects. Weather and climate, atmospheric windows. Robotic ops, light pollution/RFI.(1.1.24)
7-Feb	Space astronomy - orbital and mission considerations, pointing , attitude control and determination. High-alt balloons.
9-Feb	Brief history of space astronomy
12-Feb	Brief history of space astronomy
14-Feb	Hubble - operation, instruments, data
16-Feb	No class (UA high-school physics contest)
19-Feb	(Other) current/pending space observatories, archival data introduction
21-Feb	Radio and microwave detection; single-dish antennae (1.2)
23-Feb	X-ray and gamma-ray detection. Modulation collimation, grazing-incidence optics, coded masks.(1.3)
26-Feb	Software for astronomical analysis. IRAF, IDL, Python... Mira, Maxim, Registax.
28-Feb	Theory of imaging - the inverse problem, deconvolution, image display and processing. (2.1) First essay due (case study of obs technique)
2-	Imaging at the telescope. History (esp. photography), drift scanning, stacking. Even the

Mar	shutter matters. (2.2)
5- Mar	Radio interferometry; deconvolution again. Aperture synthesis, VLBI (2.3)
7- Mar	Optical/IR interferometry, spectral and spatial. Fabry-Perot, Fourier-transform instruments.
9- Mar	Occultation and radar imaging (2.7,2.8)
19- Mar	Photometry. Details, details. Absolute/differential, calibration, single/multiobject. Filter/detector (magnitude) systems. (3.1)
21- Mar	Photometry: atmospheric extinction and dispersion. Time series, period analysis. Exoplanet transits, Doppler beaming, binary properties(3.2)
23- Mar	Spectroscopy/spectrophotometry. Spectrographs - point-source, slit, IFU. Slits, image slicers, fibers, matching the telescope. (4)
26- Mar	Spectroscopic data analysis
28- Mar	Astrometry - coordinate systems,spherical trig and matrix approaches, wide- and narrow-field measurements (5)
30- Mar	Astrometry - precession, nutation, aberration (5.1)
2- Apr	Polarimetry - broadband, single-channel and imaging, spectropolarimetry (5.2)
4- Apr	Particle astrophysics - Cerenkov systems, particle tracking, gravitational waves (1.4-1.6)
9- Apr	Case studies in data analysis. Put the effort where it does the most good.
11- Apr	Data assessment and presentation. Graphics principles and standards, interaction with eye and brain
13- Apr	The art of the proposal
16- Apr	Ethics in astronomy - research practice, credit,fairness in and out, bias conscious and unconscious, acting like a human being.
18- Apr	Ethics in astronomy - research practice, credit,fairness in and out, bias conscious and unconscious, acting like a human being.
20- Apr	Special meta-topics: multiwavelength astrophysics. Source and resolution matching.

23- Apr	Special meta-topics: combining survey data
25- Apr	Special meta-topics: citizen science, handling big data
27- Apr	Special topics/overflow

Exams and Assignments

There will be regular homework assignments, both paper and digital. In addition, there will be several observing projects for students enrolled in AY533 (these will be extra credit for 433 students). The final exam will be a mock observing proposal in take-home format, adhering to formats used by national observatories or space facilities (typically 4 pages, single spaced), due on the scheduled exam date for the class (Friday, May 4). There will be hands-on observing sessions using our campus observatory and the remote SARA observatories. Scheduling of these always depends on the weather as well as telescope allocations; opportunities will be announced a few days in advance.

Writing assignments: AY433 carries a W designation. As such, writing proficiency is required for a passing grade in this course; a major essay assignment (detailing the application of a selected astronomical technique to a current problem; 5 pages double-space) early in the term, and the final proposal, will be graded both on technical content and the quality of the writing. The first paper will be graded and returned by the midterm grade date, March 2.

Grading Policy

There will be regular homework assignments, both paper and digital. In addition, there will be several observing projects for students enrolled in AY533 (these will be extra credit for 433 students). The final exam will be a mock observing proposal in take-home format, adhering to formats used by national observatories or space facilities (typically 4 pages, single spaced), due on the scheduled exam date for the class (Friday, May 4). There will be hands-on observing sessions using our campus observatory and the remote SARA observatories. Scheduling of these always depends on the weather as well as telescope allocations; opportunities will be announced a few days in advance.

Policy on Missed Exams and Coursework

Late or missed work will be handled on a case-by-case basis, with the primary aim to ensure that each student demonstrates all the knowledge and skills being evaluated.

Attendance Policy

Students are responsible for any lecture material they may miss. There is substantial online material to

assist in this.

Notification of Changes

The instructor will make every effort to follow the guidelines of this syllabus as listed; however, the instructor reserves the right to amend this document as the need arises. In such instances, the instructor will notify students in class and/or via email and will endeavor to provide reasonable time for students to adjust to any changes.

Statement on Academic Misconduct

Students are expected to be familiar with and adhere to the official Code of Academic Conduct (<http://catalog.ua.edu/undergraduate/about/academic-regulations/student-expectations/code-academic-conduct/>) provided in the Online Catalog.

Statement On Disability Accommodations

Contact the Office of Disability Services (ODS) (<http://catalog.ua.edu/undergraduate/about/support-programs/disability-services/>) as detailed in the Online Catalog.

Severe Weather Protocol

Please see the latest Severe Weather Guidelines (<http://catalog.ua.edu/undergraduate/about/support-programs/severe-weather-guidelines/>) in the Online Catalog.

Pregnant Student Accommodations

Title IX protects against discrimination related to pregnancy or parental status. If you are pregnant and will need accommodations for this class, please review the University's FAQs on the UAct website (<https://www.ua.edu/campuslife/uact/information/pregnancy>).

Religious Observances

Under the Guidelines for Religious Holiday Observances, students should notify the instructor in writing or via email during the first two weeks of the semester of their intention to be absent from class for religious observance. The instructor will work to provide reasonable opportunity to complete academic responsibilities as long as that does not interfere with the academic integrity of the course. See full guidelines at Religious Holiday Observances Guidelines (http://provost.ua.edu/uploads/3/9/7/6/39760652/oaa_guidelines_for_religious_holiday_observance.pdf).

UAct Statement

The UAct website (<https://www.ua.edu/campuslife/uact/>) provides an overview of The University's expectations regarding respect and civility.