Astronomical Technique

AY 433 Section 001

Spring 2016, Lecture

Dr. William Keel

Office Hours and Contact Information

Lectures are 11:00-11:50 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. Course materials are at http://astronomy.ua.edu/keel/techniques.

Prerequisites

UA Course Catalog Prerequisites

No prerequisites or none listed.

Course Description

UA Course Catalog Information

Catalog description not available.

Core Designations:

Writing

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.

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.

Required Texts

UA Supply Store Textbook Information

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

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Outline of Topics

Date	Topics (chapter)
13-Jan	Intro - radiation, Stokes parameters, far-field detection. Atmosphere, telescopes, optics, detection…
15-Jan	Electronic resources to master - literature, catalogs, data. (Electronic access tips) (5.5)
20-Jan	Detectors I: the eye, photomultipliers (1.1)
22-Jan	Detectors II: CCDs. Instrumental signatures, subpixel properties, pixel boxes versus sampling fn (1.1.8)
25-Jan	Detectors III: IR (1.1.15)
27-Jan	Noise and S/N optimization, Poisson processes, model fitting/testing (1.1.17)

29-Jan	No class (physics contest)
1-Feb	Important statistical ideas - parametric/nonparametric. Bayesian/frequentist.
3-Feb	Telescopes I: image formation, diffraction aberrations. Designs.(1.1.18,19)
5-Feb	Telescopes II: optical fundamentals, optical components (1.1.19)
8-Feb	Telescopes III: structures and mountings. Tracking/acquisition, moving targers.
10-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)
15-Feb	Space astronomy - orbital and mission considerations, pointing , attitude control and determination. High-alt balloons.
17-Feb	Brief history of space astronomy
19-Feb	Brief history of space astronomy
22-Feb	Hubble - operation, instruments, data
24-Feb	(Other) current/pending space observatories, archival data introduction
26-Feb	Radio and microwave detection; single-dish antennae (1.2)
29-Feb	X-ray and gamma-ray detection. Modulation collimation, grazing-incidence optics, coded masks.(1.3)

2-Mar	Software for astronomical analysis. IRAF, IDL, Python… Mira, Maxim, Registax.
4-Mar	Theory of imaging - the inverse problem, deconvolution, image display and processing. (2.1) First essay due (case study of obs technique)
7-Mar	Imaging at the telescope. History (esp. photography), drift scanning, stacking. Even the shutter matters. (2.2)
9-Mar	Radio interferometry; deconvolution again. Aperture synthesis, VLBI (2.3)
11-Mar	Optical/IR interferometry, spectral and spatial. Fabry-Perot, Fourier-transform instruments.
21-Mar	Occultation and radar imaging (2.7,2.8)
23-Mar	Photometry. Details, details. Absolute/differential, calibration, single/multiobject. Filter/detector (magnitude) systems. (3.1)
25-Mar	Photometry: atmospheric extinction and dispersion. Time series, period analysis. Exoplanet transits, Doppler beaming, binary properties(3.2)
28-Mar	Spectroscopy/spectrophotometry. Spectrographs - point-source, slit, IFU. Slits, image slicers, fibers, matching the telescope. (4)
30-Mar	Spectroscopic data analysis
1-Apr	Astrometry - coordinate systems,spherical trig and matrix approaches, wide- and narrow-field measurements (5)
4-Apr	Astrometry - precession, nutation, aberration (5.1)
6-Apr	Polarimetry - broadband, single-channel and imaging, spectropolarimetry (5.2)
8-Apr	Particle astrophysics - Cerenkov systems, particle tracking, gravitational waves (1.4-1.6)
11-	Case studies in data analysis. Put the effort where it does the most good.

Apr	
13-Apr	Data assessment and presentation. Graphics principles and standards, interaction with eye and brain
15-Apr	The art of the proposal
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.
22-Apr	Special meta-topics: combining survey data
25-Apr	Special meta-topics: citizen science, handling big data
27-Apr	Special topics/overflow
29-Apr	Special topics/overflow
2-May	Final exam date - final proposal assignment due

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). 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, February 24.

Emergency Contact Information

UA's primary communication tool for sending out information is through its web site at www.ua.edu. In the event of an emergency, students should consult this site for further directions. Additional course information will be posted using Blackboard Learn.

Severe Weather Guidelines

The guiding principle at The University of Alabama is to promote the personal safety of our students, faculty and staff during severe weather events. It is impossible to develop policies which anticipate every weather-related emergency. These guidelines are intended to provide additional assistance for responding to severe weather on campus.

UA is a residential campus with many students living on or near campus. In general classes will remain in session until the National Weather Service issues safety warnings for the city of Tuscaloosa. Clearly, some students and faculty commute from adjacent counties. These counties may experience weather related problems not encountered in Tuscaloosa. Individuals should follow the advice of the National Weather Service for that area taking the necessary precautions to ensure personal safety. Whenever the National Weather Service and the Emergency Management Agency issue a warning, people in the path of the storm (tornado or severe thunderstorm) should take immediate life saving actions.

When West Alabama is under a severe weather advisory, conditions can change rapidly. It is imperative to get to where you can receive information from the National Weather Service and to follow the instructions provided. Personal safety should dictate the actions that faculty, staff and students take.

The Office of University Relations will disseminate the latest information regarding conditions on campus in the following ways:

- Weather advisory posted on the UA homepage
- Weather advisory sent out through UA Alerts to faculty, staff and students
- Weather advisory broadcast over WVUA at 90.7 FM
- Weather advisory broadcast over Alabama Public Radio (WUAL) at 91.5 FM
- Weather advisory broadcast over WVUA-TV/WUOA-TV, and on the website at http://wvuatv.com/content/weather. WVUA-TV Home Team Weather provides a free service you can subscribe to which allows you to receive weather warnings for Tuscaloosa via e-mail or cell phone. Check http://wvuatv.com/content/free-email-weather-alerts for more details and to sign up for weather alerts.

In the case of a tornado warning (tornado has been sighted or detected by radar; sirens activated), all university activities are automatically suspended, including all classes and laboratories. If you are in a building, please move immediately to the lowest level and toward the center of the building away from windows (interior classrooms, offices, or corridors) and remain there until the tornado warning has expired.

Classes in session when the tornado warning is issued can resume immediately after the warning has expired at the discretion of the instructor. Classes that have not yet begun will resume 30 minutes after the tornado warning has expired provided at least half of the class period remains.

Policy on Academic Misconduct

All students in attendance at The University of Alabama are expected to be honorable and to observe standards of conduct appropriate to a community of scholars. The University of Alabama expects from its students a higher standard of conduct than the minimum required to avoid discipline. At the beginning of each semester and on examinations and projects, the professor, department, or division may require that each student sign the following Academic Honor Pledge: “I promise or affirm that I will not at any time be involved with cheating, plagiarism, fabrication, or misrepresentation while enrolled as a student at The University of Alabama. I have read the Academic Honor Code, which explains disciplinary procedure resulting from the aforementioned. I understand that violation of this code will result in penalties as severe as indefinite suspension from the University.”

See the Code of Student Conduct for more information.

Disability Statement

If you are registered with the Office of Disability Services, please make an appointment with me as soon as possible to discuss any course accommodations that may be necessary.

If you have a disability, but have not contacted the Office of Disability Services, please call (205) 348-4285 (Voice) or (205) 348-3081 (TTY) or visit 1000 Houser Hall to register for services. Students who may need course adaptations because of a disability are welcome to make an appointment to see me during office hours. Students with disabilities must be registered with the Office of Disability Services, 1000 Houser Hall, before receiving academic adjustments.

UAct: Ethical Community Statement

The University of Alabama is committed to an ethical, inclusive community defined by respect and civility. The UAct website (http://www.ua.edu/uact) provides a list of reporting channels that can be used to report incidences of illegal discrimination, harassment, sexual assault, sexual violence, retaliation, threat assessment or fraud.