

**Syllabus**  
**Astronomy 418/518**  
**Astronomical Instrumentation & Observation**  
**Fall 2022**

**Class meetings:** Tues-Thurs 11am, Steward Observatory 208. Online depending on circumstances. See attendance policy for details on optional lecture and required requirements (See D2L for zoom link if informed).

**Instructor and Contact Information:**

Assistant Professor Ewan Douglas  
Office: Steward Observatory N402  
<https://www.ewandouglas.space>  
[douglase@arizona.edu](mailto:douglase@arizona.edu) – Include “518/418” in the e-mail title.

Teaching Assistant: Joseph Long, [josephlong@arizona.edu](mailto:josephlong@arizona.edu),  
<https://joseph-long.com/>

**Office Hours:** By Appointment (many week’s Thursday class will serve as TA and instructor office hours.)

**Course Overview:**

Whether theorists, observers, or instrumentalists, science proceeds faster when researchers have a deep understanding of the methods behind the data, they test their hypotheses against. The need for a detailed understanding of systematics spans the field of astronomy: a search of ADS the last week of March 2022 for “calibration” returns 192,452 results, a factor of ~2x greater than supernova (93,905) and ~8x exoplanets (25,184). Astronomical Instrumentation (ASTR 518), seeks to teach students the basics of calibration and measurement:

“Radiant energy; signals and noise; detectors and techniques for imaging, photometry, polarimetry and spectroscopy. Examples from stellar and planetary astronomy in the x-ray, optical, infrared and radio. Graduate-level requirements include an in-depth research paper.”

Astronomy 418/518 is a 2-credit course on astronomical instrumentation given at the advanced undergraduate (418) or graduate (518) level. It is one of the required courses for the graduate astronomy program but has also proven relevant for students in planetary sciences and optical sciences, among other areas. The course is intended for scientists and engineers who will be future users or reviewers of astronomical instrumentation, as well as those interested in building and operating such systems.

**Course Objectives:**

- Students will understand the interplay between radiation, photon detection, and detector design
- Students will gain an advanced understanding of X-Ray, Optical, Infrared, and Radio instrumentation used in astronomy sufficient to:
  1. Plan and execute sophisticated observing programs and data analysis
  2. Understand strengths and limitations of various instruments used in modern astronomy
  3. Understand the design processes involved in creation of a new astronomical instrument
- Students in 518 will develop expertise with communicating fundamental astronomical concepts in a written format.

**Expected Learning Outcomes:**

- Students will apply principles of radiative transfer and physics to draw conclusions about such fundamental concepts as signal to noise, limiting sensitivity, and throughput.
- Students will synthesize learning to develop comprehensive proposals for observing time
- Students will be able to identify and critically evaluate instrument functionality and limits at a range of wavelengths.

**Evaluation, Assignments and Exams:**

- Periodic homework assignments
- An optional midterm
- [https://teams.microsoft.com/l/team/19%3aaT5WVJZZUN6v40W\\_2Vuno2yAv8I5Yc0Mq\\_uLzeiQVYaY1%40thread.tacv2/conversations?groupId=2c6ef569-9588-458a-aea3-2c5e18848a&tenantId=5ee35505-eb8e-4929-937d-645df5013288](https://teams.microsoft.com/l/team/19%3aaT5WVJZZUN6v40W_2Vuno2yAv8I5Yc0Mq_uLzeiQVYaY1%40thread.tacv2/conversations?groupId=2c6ef569-9588-458a-aea3-2c5e18848a&tenantId=5ee35505-eb8e-4929-937d-645df5013288)
- 518-only: A final written report on observing and data analysis written in the form of a scientific manuscript in the AASTeX format is required. 20% of grade

**Final Examination or Project:**

- a detailed lab notebook. submitted via PDF digitally at the middle of the semester (10%, Oct 11<sup>th</sup>.) and in hard-copy and PDF at the end of the semester (20%). (The UA library's document scanner or a special purpose smartphone scanning app, such DropBox or Adobe Scan is recommended). The final lab notebook will serve as cumulative final grade

**Required Textbooks (available on D2L or library.arizona.edu):**

"Measuring the Universe," G. H. Rieke, Cambridge University Press. Available from the UA library and on D2L.

“Electronic Imaging in Astronomy”, 2nd Ed. I. S. McLean, Springer. Available from the UA library and on D2L.

**Course Prerequisites or Co-requisites:**

The course assumes a minimum preparation of Math 122B or 125 (Calculus I), Math 129 (Calculus II), Math 223 (Vector Calculus), Math 254 (Differential Equations), Physics 141/161 (Intro. Mechanics), and Physics 142/162 (Intro Thermal and Optical Phys.) or admission into the astronomy or planetary sciences graduate program. In addition to these, ASTR 300A/B, 302, and PHYS 305 are highly recommended.

Potential students who are unsure of their level of preparation should consult the instructors.

**Grading Scale and Policies:**

The course is normally given for standard (ABCDE) grades, but 418 can be taken as pass/fail.

The grading scale will be A: >85%; B: 70 – 85%; C: 60-70%; D: 50-60%; E: <50%.

This is the scale for both the final grade and all assignments.

Grading for 518 will be based on homework (40%), an in-class midterm (10%), a project (30%); and final lab notebook (20%).

Grading for 418 will be based on homework (50%), in-class midterm (20%), and final lab notebook (30%).

**Graduate Specific Policies:**

Graduate students in 518 will be responsible for a final observation report in the style of a published scientific manuscript.

**Scheduled Topics:**

See evolving course schedule:

<https://docs.google.com/spreadsheets/d/10WB0oB3pZx3dFgtpLEVqC4mztlsz1yISLP4KXICEyLA/>

**A variety of other policies:**

For in-person classes, COVID guidelines as set by the University will be followed.

NO smoking, eating, drinking (except water), or pets are allowed in class. Please **turn off** your cell phones and avoid disrupting the students around you, even if not explicitly described in this section!

**Absence and Class Participation Policy**

Attendance on non-lecture days, as indicated by the schedule, is not required but strongly encouraged to work through problems with the instructors and other students. **Students need to make sure they attend at least 4 lab tours and take detailed notes.** Participating in observing runs (e.g. remotely observing at the LBT) that are not part of your regular research is

an acceptable substitute if you take careful notes and your notebook is signed by the lead observer that night.

**If the opportunity is available, all students are expected to attend in-person at least 2 observing nights at the 90” or 61”, (or 21” if neither is available).**

The UA’s policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <https://deanofstudents.arizona.edu/absences>

### **Classroom Behavior Policy:**

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

### **Threatening Behavior Policy**

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

### **Accessibility and Accommodations**

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit <http://drc.arizona.edu>.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

### **Code of Academic Integrity**

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See:

<http://deanofstudents.arizona.edu/codeofacademicintegrity>

<http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

*Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent.* Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

### **UA Nondiscrimination and Anti-harassment Policy**

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

### **Additional Resources for Students**

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>

Student Assistance and Advocacy information is available at

<http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

### **Confidentiality of Student Records**

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

## **Assistance:**

If you anticipate barriers related to the format or requirements of this course, please meet with me so that we can discuss ways to ensure your full participation in the course. If you determine that disability-related accommodations are necessary, please register with **Disability Resources** (621-3268; [drc.arizona.edu](https://drc.arizona.edu)) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coordinate your accommodations.

The University of Arizona provides a wide variety of resources to help you feel more at home in the UA environment. Examples of student resource/cultural centers include:

**African-American Student Affairs Center** <https://aasa.arizona.edu/>  
**Asian & Pacific American Student Affairs Center** <https://apasa.arizona.edu/>  
**Guerrero Student Center** <https://chsa.arizona.edu/>  
**Immigrant Student Resource Center** <https://eao.arizona.edu/isrc>  
**LGBTQ+ Student Affairs Center** <https://lgbtq.arizona.edu/>  
**Native American Student Affairs Center** <https://nasa.arizona.edu/>  
**Transfer Student Center** <https://transfer.arizona.edu/>  
**Veterans Education and Transition Services Center** <https://vets.arizona.edu/>  
**Women & Gender Resource Center** <https://wrc.arizona.edu/>

We encourage you to take advantage of the community, support, and learning opportunities afforded by these centers, and to encourage your friends and colleagues to do the same.

### Campus Pantry

Any student who has difficulty affording groceries or accessing sufficient food to eat every day, or who lacks a safe and stable place to live and believes this may affect their performance in the course, is urged to contact the Dean of Students for support. In addition, the University of Arizona Campus Pantry is open for students to receive supplemental groceries at no cost. Please see their website at: [campuspantry.arizona.edu](https://campuspantry.arizona.edu) for open times.

Furthermore, please notify me if you are comfortable in doing so. This will enable me to provide any resources that I may possess.

Preferred Gender Pronoun This course affirms people of all gender expressions and gender identities. If you prefer to be called a different name than what is on the class roster, please let me know. Feel free to correct instructors on your preferred gender pronoun. If you have any questions or concerns, please do not hesitate to contact me directly in class or via email (instructor email). If you wish to change your preferred name or pronoun in the UAccess system, please use the following guidelines:

**Preferred name:** University of Arizona students may choose to identify themselves within the University community using a preferred first name that differs from their official/legal name. A student's preferred name will appear instead of the person's official/legal first name in select University-related systems and documents, provided that the name is not being used for the purpose of misrepresentation. Students are able to update their preferred names in UAccess.

**Pronouns:** Students may designate pronouns they use to identify themselves. Instructors and staff are encouraged to use pronouns for people that they use for themselves as a sign of respect and inclusion. Students are able to update and edit their pronouns in UAccess. More information on updating your preferred name and pronouns is available on the Office of the Registrar site at <https://www.registrar.arizona.edu/>.

#### Safety on Campus and in the Classroom(s)

Familiarize yourself with the Steward Safety Manual, Building Evacuation and Active Shooter plans. The UA active shooter video is available at <https://ua-saem-aiss.narrasys.com/#/story/university-of-arizona-cert/active-shooter>

We will likely be visiting working labs and mountain-top observatories and awareness of safety will be paramount. Students must observe all warnings and respond to safety instructions from hosts or the instructor promptly. The Steward safety manual is available from: <https://www.as.arizona.edu/steward-observatory-safety-manual>.

#### **Subject to Change:**

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.