

Physics 308 – Observational Astronomy – Fall 2020

Instructor

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Video Conference: Zoom, Team, or Blackboard Collaborate

Information

This is a basic course in observational astronomy with an emphasis on optical astronomy. The prerequisite is a course in introductory physics. Familiarity with elementary astronomy or astrophysics will be very helpful but is not required. Necessary materials will be provided, usually through the class website.

The class meets by video conference weekly from 2:00 to 2:50 PM on Mondays when we will discuss a topic relevant to optical astronomy from the ground or from space. We will also have observational sessions on some nights where you can join by video conference as we operate a telescope and acquire data in real time using our facilities in Kentucky, Arizona, and Australia.

The first scheduled class day this semester is Monday, August 17. With Labor Day holiday also on a class day and with Fall Break, we lose two of our class days this semester, making the days we have important for learning opportunities. If you are unable to join we should have recordings of the class time available, but of course those will not have an opportunity for two-way discussion so attendance is really essential. Typically, observing weather in the fall is good in September, October, and early November here and at Mt. Lemmon and we may be able to invite you to join remotely when you can on several occasions. Within a few weeks we will organize small teams among those in the class and have projects for you to complete this semester using telescope data or data available from an archive of space-based research.

Objectives

This course in observational astronomy builds on experiences with hands-on, live remote, and robotic astronomy for students to

- develop skills enabling research in observational astronomy
- learn how to explore large sets of data for new discoveries
- reinforce studies of fundamental astrophysics
- connect basic knowledge to contemporary astrophysics research

- understand the relationship of technology and engineering to scientific discovery
- propose critically reasoned tests of new ideas
- prepare reports on scientific work
- present results of scientific work to peers

We will use mentored creative research on a team project of your own choosing to meet these goals.

During the course you will

- plan observing the night sky based on the time of year, phase of the moon, and capabilities of instrumentation
- use computer-controlled telescopes with state of the art instrumentation
- obtain image data through telescopes using CCD cameras and broadband filters
- obtain image and other data from on-line archives from TESS and the Hubble Space Telescope
- apply image processing and analysis software tools for astrometry and photometry to image data
- use analytical tools to study examples of planets and satellites, asteroids, and comets in our solar system; planets around stars in the solar neighborhood; binary and variable stars, clusters of stars, and nebulae in the Milky Way; and nearby galaxies and supernovae.

Depending on your project and interests you also may have opportunities to

- examine the spectra of stars to determine their age, composition, and velocity in space
- confirm or discover an extra-solar planet, a new binary or variable star, or an asteroid
- experiment with high speed imaging to minimize effects of atmospheric turbulence for planetary and stellar imaging
- make measurements of asteroids or comets

Websites

The course will operate through Blackboard which will provide links to other resources that may change during the semester. Two other sites which will have content for you are.

The homepage for course resources is

<http://prancer.physics.louisville.edu/classes/308>

The U of L astronomy homepage with links to the observatories and weather information is

<http://www.astro.louisville.edu>

Requirements

Since we will be entirely remote this semester with virtual presence in our class meetings and the observatories, you will need a way to join into these sessions, receive routine email, and to do some computer-based work at home. A laptop with a camera and microphone suitable for video conferencing is recommended, but for that purpose a cell phone or a tablet should work. For computing and data analysis, most software requires a laptop or desktop with Windows, MacOS, or Linux. If you have a difficulty with this please let us know. There will be emails about how we will run the class with video conferencing for our Monday meetings, and how to connect for remote observing during the semester.

Class meetings

Our Monday class is an essential opportunity to ask questions and discuss ideas together as a preparation for accessing data from an archive, time at the observatory, or operating a telescope remotely for something unique. Please plan to attend these classes. Keep in mind that we miss two – Labor Day and Fall Break both fall on Monday.

Live online at an observatory

We will have remotely operating observing sessions offered from Moore Observatory here near Louisville, from our telescope on Mt. Lemmon near Tucson, Arizona, and from Mt. Kent Observatory of the University of Southern Queensland west of Brisbane, Australia.

There are more opportunities to participate in observational astronomy than the 1 hour course credit can reward, but consider the possibilities and take advantage of what you are interested in and able to do. At a minimum, come to the Monday class online and participate in a few remote observing sessions, especially any to obtain data for your team project.

Homework

There will not be much, but to help you prepare for projects and to learn by hands-on experience we will have 3 assignments for you with the goal to help you complete them successfully. The homework assignments will allow 2 weeks, with due dates September 14, October 19, and November 9.

Team project

The conclusion of the class requires a team research project report and presentation. Usually these projects would have 2 or 3 members who collaborate with defined roles. After our first class, you should identify others to work with, settle on something to do, and we will discuss the progress in Monday classes. Projects can involve acquiring new data with our telescopes, or using data we have acquired for you, already have in our archives, or that are retrieved from NASA databases of space-based telescopic data. For the latter, use of TESS data is emphasized this semester because it will be part of the class.

In the last weeks of the semester, your team prepares both a written paper in the style of a professional publication, and an oral presentation such as you would make as a talk at a scientific meeting. These should describe why the work was done, its outcome, and your individual contributions. During the final class sessions of the term each team will present its work for review and discussion by everyone. The papers should be written using L^AT_EX

through cloud-based [Overleaf](#) service because this will show you how collaborative science is communicated. The presentation would be based on any format such as a Google Slides from Google Docs on line, a pdf that could be displayed during your talk, or a Powerpoint, or Keynote file as you prefer. Presentations would usually take 15 minutes with 5 additional minutes for questions and will be organized for the last two class days, Monday, November 23 (Monday of Thanksgiving week), and November 30 (Monday of finals week).

Grading

Formally for grading, the work required comprises individual online class participation, the remote observing, homework, and the team project. Completion of all 4 categories would be an **A**, while not completing a category could lower the grade a letter. Here “completion” means attending most of the Monday classes (some misses are normal, but not systematic ones without an agreement for reviewing the recorded classes). It means attending one or more remote observing sessions. It means returning the homework on time, and if asked, correcting your work. Lastly, it means contributing to a team project’s work, its written paper, and its presentaion.

Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other non-consensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain confidential support from the PEACC Program (502.852.2663), Counseling Center (502.852.6585), and Campus Health Services (502.852.6479). To report sexual misconduct or sex discrimination, contact the Dean of Students (502-852-5787) or University of Louisville Police (502.852.6111).

Disclosure to University faculty or instructors of sexual misconduct, domestic violence, dating violence, or sex discrimination occurring on campus, in a University-sponsored program, or involving a campus visitor or University student or employee (whether current or former) is not confidential under Title IX. Faculty and instructors must forward such reports, including names and circumstances, to the University's Title IX officer.

For more information, see the Sexual Misconduct Guide.

<http://louisville.edu/hr/employeerelations/sexual-misconduct-brochure>

Weekly topics for class

August 17 Discussion of course. How to work remotely. Observatories and other resources. TESS.

August 24 Accessing and understanding existing data. Simbad, MAST, TESS, Gaia, and HST

August 31 Telescopes.

September 7 No class. Labor Day Holiday.

September 14* Roundtable: research project choices.

September 21 AstroImageJ, our tool for almost everything. Python and Julia for everything else.

September 28 Observing stars: magnitudes and variability, colors, proper motion, parallax

October 5 No class. Fall break.

October 12 Exploring the TESS full frame images: highlights of the mission.

October 19* Measuring and analysing the transits of extrasolar planets.

October 26 Stellar spectra: composition, temperature, rotation, activity, velocity.

November 2 From observing to understanding planets detected orbiting distant stars.

November 9* High spatial resolution imaging from the ground. Jupiter, speckles, adaptive optics.

November 16 Extended objects: faint gaseous nebulae, the Magellanic Clouds, distant galaxies.

November 23 Presentations

November 30 Presentations

* Homework due