Physics 308 – Observational Astronomy – Fall 2019

Instructor

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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 weekly from 2:00 to 2:50 PM on Mondays in the astronomy conference room Natural Science 312. It offers hands-on opportunities with telescopes at Moore Observatory, and use of Internet technology for remote operation and data acquisition at Moore Observatory, Mt. Lemmon in Arizona, and Mt. Kent Observatory in Australia. We will also use data acquired with NASA's space-based telescopes, especially the Transiting Exoplanet Survey Satellite (TESS) now in operation.

The first scheduled class day this semester is Monday, August 19. Unlike other Physics & Astronomy lab classes that often skip the first week, we will meet as planned. With Labor Day holiday also on a class day and with Fall Break, we lose two of our class days this semester, so attendance is really essential. However, if you must miss a class I will try to provide some of the content online for you to review. We will also try to organize nights at the observatory during these first weeks after Labor Day. Typically, observing weather in the fall is good in September, October, and early November. Once the winter cloud pattern settles in, weather in late November and December here is often poor for astronomy. However, we have remotely accessible resources that may have good skies, and a very large database of prior data to draw on. Of course the entire Space Telescope archive is available too.

Observing sessions will be scheduled throughout the semester when weather permits at Moore Observatory in nearby Oldham County, and sometimes remotely at Mt. Kent Observatory in Queensland, Australia. We will discuss what days or nights work best for a few students at time. we'll have to see if the weather cooperates.

If you are interested, there are opportunities to get involved more often with the research routine now focusing on observing extrasolar planets and following up on TESS discoveries.

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

- use narrowband filters to study atomic species in nebulae
- 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
- examine the spectra of stars to determine their age, composition, and velocity in space

Websites

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

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.

We will have sessions offered at Moore Observatory in Oldham County at night when the weather, the Moon, and our schedules align. Other events could include observing by eye and taking snapshots of the Moon and planets with the telescope on the roof of the Natural Science Building, and remote operation of our telescopes at Moore, on Mt. Lemmon in Arizona, and in Queensland, Australia, from facilities on campus or even from your own home.

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, visit the observatory, and perhaps drop in a remote observing session some evening either by video conference from home, or by being present on Belknap Campus when we are operating.

The conclusion of the class requires a research project report and a presentation. Usually these would projects be a team effort with 2 or even 3 members. Begin soon to identify someone to work with, settle on something to do, and discuss it in a Monday class. 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 and will be discussed in 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 LaTeX 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 made on the last two days of class, Monday, November 25 (Thanksgiving week), or December 2 (finals week). The written papers and a copy of the presentation file are sent by email or web link and are due by Monday, December 2.

Grading

Formally for grading, the work required comprises individual class participation and observatory visits (40%), and the team's data acquisition (20%), presentation to the class with a presentation file (20%), and paper explaining and summarizing your work (20%). Letter grades will be assigned with a scale of **A** (90 or more); **B** (80 to 89); **C** (70 to 79); and **D** (60 to 69).

Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other nonconsensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain confidential support fromthe 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 Resource Guid

Weekly topics for class

August 19 Discussion of course. Observatory and other resources. TESS.

August 26 Accessing and understanading existing data. Simbad, MAST, TESS, Gaia, and HST

September 2 No class. Labor Day Holiday.

September 9 Optical telescopes.

September 16 Roundtable: research project choices.

September 23 AstroImageJ, our tool for almost everything. Python and Julia for everything else.

September 30 Star magnitudes, colors, pulsations, and eclipses.

October 7 No class. Fall break.

October 14 Exploring the TESS full frame images: highlights of the southern sky.

October 21 Measuring and analysing the transits of extrasolar planets.

October 28 Stellar spectra: composition, temperature, rotation, activity, velocity.

November 4 From observing to understanding planets detected orbiting distant stars

November 11 High spatial resolution imaging from the ground. Jupiter, speckles, adaptive optics.

November 18 Extended objects: faint gaseous nebulae, the Magellanic Clouds, distant galaxies.

November 25 Presentations.

December 2 More presentations if time needed.

Night Sky Highlights

You should install Stellarium on your favorite device. See https://stellarium.org/
What you might see if it is not cloudy on Monday nights this semester:

August 19 Jupiter and Saturn past the meridian in a dark sky at 10 PM.

August 26 Crescent Moon in the dawn sky. Orion in the east before sunrise.

September 2 Crescent Moon at dusk. Jupiter on the meridian. Andromeda rising at sunset.

September 9 Gibbous waxing Moon low in the east when the Sun sets at 8 PM local time.

September 16 Nearly full Moon rises at 9:24 PM.

September 23 At sunset a dark sky with Summer Triangle overhead, M13, M57, Sagittarius, Milky Way.

September 30 Thin crescent Moon at sunset. Dark all night. Andromeda galaxy overhead at 1 AM.

October 14 Full Moon. Sirius rises at 2 AM.

October 21 Last quarter Moon rises at 30 minutes after midnight.

October 28 New Moon and dark sky all night again. Jupiter low in the southwest at sunset.

November 4 Back on EST yesterday, sunset at 5:40 PM with first quarter Moon. Orion rises at 10 PM.

November 11 Full Moon, bright sky, cloudy winter weather eminent.

November 18 Pegasus crosses overhead soon after sunset. The northern Milky Way at its best.

November 25 New Moon, dark sky, Sirius rises at 10 PM. Orion visible most of the night.

December 2 Approaching summer in the southern hemisphere. The Small Magellanic Cloud is over the south celestial pole at sunset. Alpha Centauri rises at 10:41 PM Australian time.

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