Physics 308 – Observational Astronomy – Fall 2022

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 websites.

It is scheduled to meet on Mondays in the Natural Science 312 astronomy conference room. The space should be safe for use by a small class such as this one when the COVID incidence rate is moderate, and we will keep all the windows open and urge that you wear a mask following the University's current policy. If you think you may have been exposed to infection, are testing positive, or have symptoms, please do not come to class. The content is available online.

Also this semester we will have opportunities to use telescopes visually or remotely through software. Since the class meets on Mondays, we lose two days to holidays – Labor Day on September 5, and Fall Break on October 3. If the weather cooperates those weeks may be ones we will plan for observing on a suitable evening that you could optionally attend. Also, weather permitting, class meetings may be set at the Planetarium to use their garden area in the daytime, or on the roof of the Natural Science Building where we have a student observatory. There will be optional opportunities to come to Moore Observatory, the University's research facility in Oldham County, some evening before the colder weather sets in, or during the daytime to see the telescopes and possibly observe the Sun. Lastly, we have remotely operable telescopes and there will be some sessions scheduled when you can join a conference where we will use one as a class so that you can see how remote or robotic operation is done. Our intent is to offer in-person use of telescopes on campus for observing the Sun, Moon, and bright planets (Jupiter and Saturn will be visible this fall), and visits to Moore Observatory nearby in Oldham County for those who want to see and use research telescopes in person. The fact is though, that except for a few technicians, engineers, and specialist observers, most contemporary observational astronomy is based on remote operation of instruments, and the analysis of astronomical data.

We will emphasize optical astronomy from the ground and from space with the goal of developing your understanding of how the data are acquired, how to access data, and the use of physics and computing to understand its meaning. The course is organized to cover a new topic each week, and to have practical examples to review in class or with online supplements.

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 and present reports on scientific work

We will use simple assignments and mentored creative projects to meet these goals.

Websites

The course will operate through Blackboard which will provide links to other resources our our servers

https://prancer.physics.louisville.edu/classes/308

https://prancer.physics.louisville.edu/moodle

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

https//www.astro.louisville.edu

Requirements

The ideas we discuss in our class meetings are supported by online content with astronomical data and tools for analysis that will require a laptop or desktop computer with network access. Assignments will be submitted through the University's Blackboard system.

Live online at an observatory

We will have remotely operating observing sessions from Moore Observatory near Louisville, from our telescope on Mt. Lemmon near Tucson, Arizona, and perhaps from our facility at Mt. Kent Observatory of the University of Southern Queensland west of Brisbane, Australia. These sessions would use Zoom conferencing in which we would share the control screens for the telescopes. Astronomical data acquired in remote sessions is available for download to your own computer.

Observing with a telescope in person

Outdoor possibilities include observing the Sun in the daytime on campus, and using the telescope on the roof of the Natural Science Building to observe or record images of the Moon, Jupiter, Saturn and the brightest of star clusters and nebulae. Visiting Moore Observatory during early evening hours when the weather is favorable would be partly indoors (the telescopes are remotely operated) and with a small telescope that you can view through. Since typically September and October have a favorable probability of clear sky, and the bright planets this fall are visible soon after sunset, there should be opportunities of some kind available. We will assess the safety of in-person activities based on COVID monitoring and the availability of improved vaccines in the fall.

Assignments

The class will have bi-weekly (fortnightly) assignments intended to help you keep up with the content, and to stimulate questions during our classes. There should be about 6 assignments this semester.

Project

After the first few weeks of the class, we will help you to choose your own topic that uses data you may acquire with our facilities, or retrieve from ground- or space-based astronomy archives. While your work will use the ideas and skills you develop in the class, we will help you with what is needed in the research, the preparation of a report, and a presentation to the class. Start thinking about this early. After Labor Day you'll be asked to decide what to do so that we can help you with it over most of the term, and discuss it in our class meetings as needed.

Grading

Your course grade will be 60% from the assignments and 40% from the research project components. If you participate in the weekly classes, complete the assignments by the due dates, and develop and report on your project then letter grades will be assigned based approximately on A (90 to 100); B (80 to 89); C (70 to 79); and D (60 to 69) without the $\pm$ option. Late work or lack of class participation could affect the course grade.

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

Observational examples covered over the term

These are examples that will be included in the weekly class meetings and in supplementary online material for you to use. They may suggest further projects you could pursue.

Earth What does the Earth look like from space?

Sun Multiwavelength monitoring

Jupiter's satellites Galileo's measurements, their orbits, Jupiter's mass

Jupiter's atmosphere Image the planet and measuring its rotation

Exoplanet transit event Analyze the transit of an planet of another star

Color-magnitudes Work with Gaia data

Stellar composition and temperature Analyze the spectrum of a star

Image processing Color images from filter data

Proxima Centauri Measure proper motion and determine distance from parallax

Supernova Detect and measure a supernova

Proposed weekly topics for class

August 22 The sky and celestial coordinates: Stellarium

August 29 Observables in astrophysics

September 5 Labor Day holiday Monday. Observatories on Earth and in space (online)

September 12 Accessing existing data: Simbad, MAST, Gaia

September 19 Optical astronomical telescopes

September 26 Sensing and imaging light: detectors and photon statistics

October 3 Mid-term break Monday. Observing the solar system and others (online)

October 10 AstroImageJ, our tool for almost everything with Python and Julia for everything else.

October 17 Observing stars: magnitudes, colors, proper motion, parallax

October 24 Stellar spectra: composition, temperature, rotation, activity, velocity

October 31 Observing variable and binary stars

November 7 Detecting and characterizing planets of other stars

November 10 James Webb Space Telescope

November 21 Thanksgiving week. No new content or assignments

November 28 Project presentations

December 5 Project presentations continued on thelast day of classes

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