Physics 308 – Observational Astronomy – Fall 2016

Instructor

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Natural Science LL01 or LL06, and Moore Observatory

Information

This is a basic course in observational astronomy with an emphasis on optical astronomy. The prerequisite is a course in introductory physics, preferably Physics 298-299 (Elementary Physics for majors). Familiarity with elementary astronomy or astrophysics will be very helpful. 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.

Observing sessions will be scheduled throughout the semester when weather permits, both at Moore Observatory in nearby Oldham County and remotely at Mt. Kent Observatory in Queensland, Australia.

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
- 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 sessions based on the time of year, phase of the moon, and capabilities of instrumentation

- operate computer-controlled telescopes with state of the art instrumentation
- obtain images through telescopes using CCD cameras and broadband filters
- apply image processing and analysis software tools for astrometry and photometry to image data
- use analytical tools to study 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
- acquire and analyze the spectra of stars and nebulae
- experiment with high speed imaging to minimize effects of atmospheric turbulence for planetary and stellar imaging

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

Because we meet as a class only once a week, participation in all Monday class meetings is mandatory. At each of these classes we will introduce a new topic that will be needed to meet the course objectives. The class meeting is an essential opportunity to ask questions and discuss ideas together as a preparation for time at the observatory or operating a telescope remotely. Since this is a 1-credit hour class and you also participate in observing activities, we may substitute those for class meetings if the weather is favorable.

We will offer hands-on research experiences with the telescopes:

- Moore Observatory, in Oldham County, will be open when weather and the phase of the Moon makes it worthwhile. Opportunities will be announced by email and on the class website with as much lead time as the weather forecasts permit. When you are on-site you will actively participate in the operation of a telescope.

- Remote observing at Mt. Kent Observatory in Queensland, Australia, will be offered on a few weekday mornings (night time in Australia) during the term, most likely in October. The telescope and instrumentation may be operated from the conference room in Natural Science 312, or an operator may be present while we meet during video conferencing with them. A similar arrangement with Moore Observatory is available if needed.

- Queue-scheduled observing is available on telescopes at Moore and Mt. Kent observatory, and possibly also at our new facility at Mt. Lemmon in Arizona. On-line software accepts requests for specific data that are acquired robotically (or by telescope operators) when weather and other conditions permit. Data are returned as image files that may be downloaded from the servers. This is the most efficient way to acquire data once you know what you need.

We also have visual and educational activities for you:

- We are developing tools for web-based observing remotely with your own devices, and may request your participation in testing the technology. This may be observing the Moon, or taking images of clusters and nebulae with your cell phone, for example.

- Visual observing with the telescope on the roof of the Natural Science Building will be offered occasionally during the term. This fall we expect to open the telescope on a few evenings Monday through Thursday for 1 to 2 hours after sunset, and a few mornings during twilight before sunrise. Mars, Jupiter, and Saturn are visible at sunset at the beginning of the semester. A few brighter star clusters and nebulae can be seen either in the evening or morning, but visual observing from campus is limited by the bright urban sky, late sunsets in August and September, and colder often cloudy weather at the end of the semester.

A team research project proposal, report, and presentation are required. The first step is for you to identify someone to work with, and together to write a proposal for your project. The proposal identifies the subject, the roles you will take, and requests time on the telescopes. It provides specifics about which object or objects are to be observed, estimated exposures and filters needed, and justifies the request with a brief explanation of the science you want to do. The format of the proposal will be described for you.

After the research is finished, your team prepares both a written report and an oral presentation. The report 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.

Grading

In summary, the work required comprises individual class participation (20%) which may include written assignments, and observatory or telescope use (30%) through one or more of the modes we offer. Teams of two students prepare a proposal (10%), acquire data, develop a written research report(20%) and make a presentation (20%). The assessments of the proposal, and research projects will be based on completeness and accuracy in response

to the questions raised, on originality and creativity, and on the degree of understanding expressed by your work. Letter grades will be assigned from a weighted average with a scale of **A** (90 or more); **B** (80 to 89); **C** (70 to 79); and **D** (60 to 69), with ± grading when needed close to these divisions.

Provisional topics for discussion in class

August 22 What can we see? Discussion of ideas for research with small telescopes.

August 29 Celestial coordinates. Accessing existing data.

September 5 No class. Labor Day Holiday.

September 12 Optical imaging sensors, filters, and photometry.

September 19 Research choices and class discussion of proposal ideas.

September 26 Optical telescope concepts, design and performance.

October 3 No class. Fall Break.

October 10 Photometry of variable stars.

October 17 Measuring extrasolar planets: high precision methods.

October 24 Data analysis: turning raw data into understanding.

October 31 Within our solar system: asteroids and comets.

November 7 Limitations of seeing and diffraction: lucky images.

November 14 Spectroscopy.

November 23 Thanksgiving week.

November 28 Presentations.

December 5 Presentations.

Suggested general categories for student research

Consider choosing a project from one of these categories. You will need to narrow the topic and be specific about your work. These are to give you a broad sense of what subjects are possible. We will discuss these the first day in class.

Moon - features, colors, polarization, libration, earthshine.

Satellites of Jupiter, Saturn, Uranus, or Neptune.

Dynamic planetary atmospheres.

A current comet.

Rotation and color of an asteroid.

Timing and analysis of transit light curves of known exoplanets.

Transit light curves of a exoplanet candidates.

The light curves of a known eclipsing binary star system.

Variable star: pulsation, rotation, star spots and flares.

Photometry of star cluster.

The rise and decay of light from a supernova.

A planetary nebula's structure, images in narrowband filters, or spectrum.

A stellar spectrum.

Gas and dust in a star-forming region of the Milky Way.

An object in the Magellanic Clouds.

Version of August 17, 2016

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 Guide here `http://louisville.edu/hr/employeerelations/sexual-misconduct-brochure`.