Physics 308 – Observational Astronomy – Fall 2015

Instructor

Email: kielkopf@louisville.edu
Telephone: 502.852.5990 (forwards to cell at night)
Skype: john.kielkopf
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 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 a scaffold of scripted exercises and mentored creative research on a group 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 see demonstrations first hand. If needed, we are able to offer remote video conferencing to these classes, or we may substitute a class meeting for other opportunities.

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. 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 handheld (Android and Iphone) 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. Morning sessions allow observing the Moon, Jupiter, Mars, and Venus this semester; evening sessions would allow observing the Moon, Saturn, and perhaps Uranus. A few brighter star clusters and nebulae can be seen either in the evening or morning, but visual observing for faint objects from campus is limited by the bright urban sky (and stadium lighting).

In addition to using telescopes and instruments, there will be 2 homework assignments this semester. They will be scripted analyses to help you develop skills to measure and interpret astronomical data, and to prepare for more independent work toward the end of the semester. The homework will be explained during the class sessions, and require work over a few weeks each on- and off-line to complete.

A group research project proposal, report, and presentation are required. The first step is for you to identify your group (2 or 3 members is a good choice), and together to write a proposal for your project. The proposal identifies the subject, the participants and their roles, 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 group prepares both a written report and an oral presentation. The report should describe why the work was done and its outcome. It should also describe which part of the work was done by each member of the group since all members are expected to contribute. During the final class session of the term the class will hear presentations from each group about their work.

Grading

In summary, the work required comprises individual class participation (20%), observatory or telescope use (20%) through one or more of the modes we offer, and homework (10%). The groups each prepare a proposal (10%), a research report(20%) and a presentation (20%). The assessments of the homework, 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 discussion in class

August 24 What can we see? Discussion of ideas for research with small telescopes.

August 31 How to access existing astronomical data.

September 7 No class. Labor Day Holiday.

September 14 Optical telescope concepts, design and performance.

September 21 Research choices and class discussion of proposal ideas.

September 28 Charge coupled device (CCD) cameras and other sensors.

October 5 No class. Fall Break.

October 12 Remote class session from Mt. Kent in Queensland, Australia.

October 19 Image processing and analysis.

October 26 Principles of photometry for measuring variable stars and exoplanet transits.

November 2 Principles of astrometry for measuring positions and parallax.

November 9 Stellar and nebular spectroscopy.

November 16 High resolution imaging with fast lucky exposures, adaptive optics, and interferometry.

November 23 No class. Thanksgiving Week

December 7 Group 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 (Jupiter is not well-placed this semester).

A current comet.

Rotation and color of an asteroid.

The transit light curves of a known exoplanet.

The light curves of a known eclipsing binary star system.

A variable star: pulsation, rotation, star spots.

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 19, 2015

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`.