Physics 308 – Observational Astronomy – Fall 2018

Instructor

John Kielkopf
Department of Physics and Astronomy
Natural Science LL01 or LL06, and Moore Observatory
University of Louisville
Louisville, KY 40292, USA

University Email: kielkopf@louisville.edu
Google Mail (preferred): jkielkopf@gmail.com
Telephone: 502.852.5990 (forwards to cell at night)
Video Conference: Zoom Meeting 5116430632

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.

The first scheduled class day this semester is Monday, August 20. Unlike other Physics & Astronomy lab classes that 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 for a few students at time 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 the class during our first class meeting.

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
- confirm or discover an extra-solar planets
- 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 once we have passed the first weeks of work.

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 from a workstation in the departmental computer room, or an operator may be present while we meet during video conferencing with him. A similar arrangement with Moore Observatory is available if needed. For example, on any clear night we are working you can call in with Zoom and talk with us, and share the telescope control screen.

- Queue-scheduled observing is available on telescopes at Moore and Mt. Kent observatory, and possibly also at our facility at Mt. Lemmon in Arizona. These instruments are in use full time for research on extra-solar planets supporting the NASA TESS mission, and when possible we will share data from them with you. Those data include the most recent exciting discoveries in exoplanet science. Online 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 for viewing Mars (at opposition) and Jupiter. 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 expectation is that you will work with one other person but if more than two want to make team you may propose that plan when everyone has a defined role. 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 in class. A written proposal is required from every team so that with all proposals everyone in the class is represented in one of them.

After the research is finished, 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 proposals and papers will be written using LaTeX through cloud-based Sharelatex, also known as Overleaf. We will provide templated for the proposal and the paper into which you can add the actual content online. The team also will submit an electronic version of their presentation in a format of their choice such as as a Google Doc Presentation, LibreOffice Presentation, Microsoft Powerpoint, or pdf file with supplements if needed.

Grading

In summary, the work required comprises individual class participation (20%) which may include a few 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 joint 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 $\pm$ grading when needed close to these divisions.

Provisional topics for discussion in class

August 20 Discussion of course. University resources and the observatory schedules.

August 27 Celestial coordinates. Celestial catalogs. Accessing existing data.

September 3 No class. Labor Day Holiday.

September 10 Optical imaging sensors, filters, and photometry. What ground-based optical telescopes can measure.

September 17 Research choices and class discussion of ideas.

September 24 Optical telescope design and performance.

October 1 Photometry: star magnitudes and colors, exoplanet transits, binary stars, and variable stars.

October 8 No class. Fall Break.

October 15 Measuring extrasolar planets: high precision methods.

October 22 Spectroscopy: composition, temperature, and velocity.

October 29 Within our solar system: asteroids and comets.

November 5 Limitations of seeing and diffraction: lucky images.

November 12 Analysis of data and your work.

November 19 No class. Thanksgiving week.

November 26 Presentations.

December 3 More presentations if time needed.

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 in class.

Ephemeris and properties of the transits of known exoplanets.

Validation of exoplanet transit candidates (may be limited to non-TESS targets).

Satellites of solar system planets (Jupiter and Saturn early in the semester, Uranus and Neptune later.)

Dynamic planetary atmospheres (Venus, Jupiter and Saturn early in the semester)

A current comet.

Orbit of a near-Earth asteroid.

Asteriod recovery or discovery in exoplanet data images.

Measurement and analysis of an eclipsing binary star system.

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

Photometry of globular star cluster to find its distance.

Photometry of an open star cluster to find its age and distance.

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

Stellar spectra.

Version of August 18, 2018

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