PHYSICS 108, – Spring 2019
Astronomy Laboratory
1 credit hour
Last modified: January 2, 2019

Instructor: Dr. Benne W. Holwerda

Section	Day	Hours	GTA/UTA
01	Tuesday	10-12	Jacques
02	Wednesday	10-12	Smith
03	Thursday	10-12	Jacques
04	Tuesday	2-4	Jacques
05	Thursday	2-4	Hill
75	Tuesday	7-9	Hill

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Contacting Instructors:
University email is preferable to a phone call, and will provide you with a written response you can save. Please note class and section in the subject.

Each section has a teaching assistant who is in charge of that section and who can answer most questions that come up. These assistants will provide you with their contact information during class, or you can check Blackboard for contact information for all sections. Our assistants are trained to help you with the laboratory experiments and with understanding the fundamental ideas behind them. They grade your work each week, and update the class records.

Objectives
This course offers a "hands-on" opportunity to learn by exploration and discovery how physicists and astronomers have arrived at their current understanding of the universe. There will be guided exercises with class-room and computer-based resources, and use of images and data from the university's telescopes in Kentucky and Australia. Our overall objective is for you to learn how thoughtful reasoning about experiments and observations is the foundation of physics and astronomy. It meets the University's General Education Requirements for a Natural Science laboratory. There is a separate optional Physics 107 Elementary Astronomy course which should be taken concurrently or *before* taking this lab. Both 107 and 108 are also offered online by Professor

Kielkopf.

As with other General Education Natural Science classes, the objective of this course is to incorporate astronomy into your critical thinking skills, and to understand how the methods of science work. We will do that by exploring how physics and astronomy help us unravel the underlying mysteries of the Universe, and to:

1. Help you understand (and cope with) astronomy encountered in everyday life: seasons, solar energy, and the GPS in your cell phone.
2. Provide a basis for understanding the latest developments about astronomy you will hear in the news.
3. Recognize that while physics does not fully explain the universe, it does predict the effects of intangible invisible things, even though nobody knows what they really are ... yet. (That is, not to fret when something seems incomprehensible, since science itself still does not explain everything, and has to rely on predictable behaviors of invisible things such as gravity and the energy and matter in the universe which nobody completely understands.)
4. Present you with mysteries not yet solved, or with contradictory or untested theories, so that you may solve them in the future and win a Nobel Prize. (There is plenty of astronomy that we do not yet know, as mentioned above.)
5. Teach physics and astronomy that you may apply to make life better for yourself and others now, and in the future. (The long term future of our Sun and the near future stability of our planet's atmosphere.)
6. Open your mind to new discovery by knowing that the universe should be understand- able.

Requirements
The lab will offer a scaffold of topics, one each week, for the duration of the semester. Once you have some experience with the lab, many of them will be available on any lab day, and you may choose one you have not done from those. Collaborate with other students in the lab, take your time to understand, ask questions when you need help, and remember the objective is to learn how to observe, reason, and use your growing knowledge and skill to solve problems. We are not expecting you to find an exact "right" answer. We do require active participation during the lab sessions to receive full credit.

You are expected to attend every meeting of your lab class. Your work must be done during the class. *We will not accept, under any circumstances, work that is prepared beforehand and brought to class, or work that is unfinished and returned in a mailbox or at a later class.*

We do not permit doing more than one unit in a single class session. If you miss your regularly scheduled lab you may make it up by attending another lab section. However bear in mind only the top 11 labs are included in your final grade allowing for one or two missed labs (see below).

Websites
The University's Blackboard system is the University's gateway to Distance Education programs:

http://blackboard.louisville.edu/

Use your University User ID and Password to log into Blackboard for announcements. For this Astronomy Laboratory class you have access to the lab materials through the class website given below. A convenient click to link to the site will be provided on Blackboard. This site is open to everyone without a password. It will offer updated information for use in preparing for labs, and links to other sites of interest.

Textbook and Course Content
There is no textbook for this course. The content is provided on-line for free through:

http://prancer.physics.louisville.edu/astrowiki/index.php/Elementary_Astronomy_Laboratory_Activities

You may read the on-line version with any device that displays a web page. Wireless service is available in the labs so if you have your own laptop, tablet, or network enabled phone you may use them in the lab. Files in pdf format are exported from the wiki site from the drop-down "Actions" menu and a click a "Print as PDF". Saved files may be viewed in an e-reader such as a Kindle device, or printed for reference. Since these offerings may change or be edited during the semester, use the on-line version whenever possible.

What You Hand In
Each experiment or investigation has a description of what you are to do, and there is a separate answer sheet that will be supplied in class for you to fill out. The experiments pose a central question which you are to answer by working with others. We encourage you to ask the assistant when you need help, and discuss the issues with those in your group, but you should think through the questions and respond with your own ideas in your own words. What you hand in to us must reflect your own effort. If there is time, we will be glad to advise you on improving your work before we accept it for credit. **All**

work must be done during the two hour lab period, and must be handed in personally to the assistant before you leave. Lab work which is handed in by another student, left on a desk, left later in mailboxes or under doors etc. will not be accepted.

Grading

Each unit should take about 1 to 2 hours to complete properly. Letter grades will be based on an average of the best 11 scores with a scale of A (90 or more); B (80 to 89); C (70 to 79); and D (60 to 69). We do not use ± grading for the lab.

The score for each topic will be based on completeness and accuracy in response to the questions raised, on originality and creativity, the degree of understanding expressed by your work, and your active participation in the group. We may ask that you to reconsider your responses before you leave the lab session and we assign a final score for credit. Remember, our purpose is to help you learn and understand by observation and reason, not to hear an echo of a precisely "correct" textbook answer. This learning process is supported by the group's interaction and your dynamic participation is required.

The final class grade based on the best 11 scores for the labs. This means that with 13 lab opportunities you may miss a lab without a grade penalty unless you miss more than 2. However, you are still expected to participate in all the scheduled lab classes unless you have an excused absence. In the event of a lab canceled due to weather or another university issue, we will reduce the number of scores averaged so there will be no affect on your grade. By fully participating in all labs you will improve your grade and also have an opportunity to do more of the activities that are offered.

Caveats

We reserve the right to make changes in the syllabus when necessary to meet learning objectives, when new astronomical discoveries occur, or when there is a technical or software issue that requires a change in content or methodology. Any changes will be announced by email and posted in the current online syllabus and schedule.

Topics available this semester

Working in small groups of about 3 students each, for the first lab class everyone will learn about identifying constellations and becoming familiar with the night sky. After that, each week you and your group will select for yourselves a topic from those offered. Many of these are available during every lab session.

Early in the semester your lab assistant will advise on how to select and request that one of our telescopes observe an object in the sky for you. These data, usually in the form of digital images, will be made available for you to analyze and discuss later in the semester. It is essential to get these requests submitted soon after becoming familiar

with the sky, so think about what you might like to explore in more detail while you do the first few activities.

1. Identify constellations
2. Watch the sky
3. Under Namibian Skies
4. Night sky using Stellarium
5. Use a remote telescope: requests or live, and analyzing results (a two-part activity)
6. Travel to Mars, Jupiter, Saturn, and Uranus
7. Survey galaxies in the universe
8. Survey galaxies in Virgo
9. The Earth rotates
10. Our dynamic sun (may use the roof top solar telescope)
11. Light and telescopes
12. Experiment with CCD camera images
13. Use a CCD camera
14. Spectra
15. Observing planets and the Moon with a telescope (live remote or with the telescope on the roof)
16. Explore Mars
17. Observe satellites of Jupiter, Saturn, and Uranus
18. Follow Proxima Centauri
19. Colors of stars in Messier 34
20. Variable stars in Messier 3
21. Measure a nearby supernova
22. Track cosmic rays in a cloud chamber (last lab of the term)
23. FLIR near-infrared camera
24. iSPEX spectrometer for mobile phone camera (tryout lab)
25. GalaxyZoo Lab assignment.

Cardinal Core Learning Objectives

1. Demonstrate an understanding of the nature and methods of science inquiry.

2. Apply scientific principles: to interpret evidence, to make predictions, and/or to explain cross-cutting concepts in one or more of the sciences.

3. Explain how scientific principles relate to issues of personal and/or societal importance.

4. Communicate effectively an understanding of scientific concepts and experimental outcomes in speech or writing, using sound scientific terminology and citation.

In this course these outcomes will be assessed through weekly activities that require written responses to questions, and analysis of observations and measurements. A monitored on-line forum for class discussion of topics posed both by students and by the instructor will encourage students to develop their knowledge, deeper understanding of the science, and the skills to communicate effectively with others.

Outcome 1 — Demonstrate an understanding of the nature and methods of science inquiry.

The course covers many interactive examples of how we have come to understand the entire universe and its evolution. From the simplest visual observations of the sky, to working with real scientific data representative of that leading to paradigm shifting discoveries, you will come to understand the contributions of individual scientists and their contemporaries, and the current process of scientific enterprise. Thoughtful questions posed to others in the class are encouraged to engage one another in analysis of the weekly activities of the lab, and to develop communication skills. Each week you complete your work by submitting answers to questions we have asked, and explaining what you understand about the methods and results of that week's study.

Outcome 2 — Apply scientific principles: to interpret evidence, to make predictions, and/or to explain cross-cutting concepts in one or more of the sciences.

While astronomy is based on observation and measurement, the analysis of the observations depends on physics. The emphasis in this course is not as much on fact or measurement of a specific quantity, as it is on understanding what those facts tell us about the universe, how we come to those conclusions, and what the uncertainties are in that process. The requisite simple but essential physics is incorporated into the activities as needed, and the simplifications that leads to allow predictions based on knowledge of the current state and the science responsible for that. Many of the experiments are designed to develop an understanding of how we came to the knowledge we have, and to use that process as a tool. An example would be determining the mass of Jupiter from the motions of its satellites while using those observed motions to predict where the satellites would be in the future. Another would be using measurements of supernova to find the behavior of exploding dying stars, and in turn applying that knowledge to infer the distance to other galaxies in which such supernovae are found. Each week the activity involves gathering data, interpreting it, and explaining it with the foundation science that is incorporated into that work.

Outcome 3 — Explain how scientific principles relate to issues of personal and/or societal importance.

The role of science in modern society is a topic that recurs throughout this class, especially from the relevance of the Sun, Earth and seasonal cycles to our life, and the environment of our planet in the solar system. Our calendar and precision time keeping has been a core component of astronomy since prehistoric times, and in the first activities of this laboratory class you will learn how the daily and annual changes you can see in the sky enable predictions of climate useful for agriculture. You will see how telescopes determine where we are in the universe, the age of the Sun, and ultimately the fate of the Earth. In exploring Mars through robotic spacecraft, you will find how the society's investment in large scale science returns deeper understanding of the origins of life here and potentially elsewhere. Your understanding of these concepts is assessed by questions you answer weekly. While some reflect a measurement or analysis result, many require a written thoughtful response explaining the principles and methods. Additionally, your comments on the class forum will engage others in discussing the relevance of the things your are learning to your life and to society.

Outcome 4 — Communicate effectively an understanding of scientific concepts and experimental outcomes in speech or writing, using sound scientific terminology and citation appropriate to the discipline.

There are required written responses every week to the scheduled work. You are expected to convey your understanding of the concepts underpinning the work, and how the experimental or observational results are interpreted and analyzed. Of course this includes also explaining problems you encountered, and resolving difficulties in the same way that science is done today on the most cutting edge topics. The written responses are assessed and become part of the course grade. There is a mentored discussion forum for the class that invites participation by everyone, so that skills to communicate scientific concepts develop during the course when students explain those concepts to one another, and pose questions to their peers.

A culminating part of this class is to request data from our telescopes on an object that interests you. You will be asked to explain why you make that request, what you expect to learn, and then to use that data to arrive at an explanation that places it in the context of what you knew before.

Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other nonconsen- sual behavior of a sexual nature) and sex discrimination violate University policies. Stu- dents 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 pro- gram, 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.