Astronomy 0113: Introduction to Astronomy

Course Syllabus

Tu & Th, 1:00-2:15 PM in 104 Thaw Hall

Course Instructor

Instructor: Andrew R. Zentner
Office: 320 Allen Hall
Phone: 412-624-2752
Email: `zentner@pitt.edu`

Office Hours: Mondays at 3PM
Thursdays at 11AM
& By Appointment

I am a member of the Department of Physics and Astronomy at the University of Pittsburgh. My research specialty is theoretical cosmology (cosmology is the study of the Universe).

Please do not hesitate to contact me with **any** questions or concerns about this course. Email is by far the best way to contact me. I want to work with my students to make this course interesting and **fun** and allow my students to learn. All too often, students wait until the end of the semester to express concerns, but by that time I cannot change anything. There is **no** question too insignificant and there is no need to wait until it is too late to express a concern. Of course, I have to abide by University and Department rules and I have to work within the Physics & Astronomy curriculum, so I cannot accommodate all requests, but my intention is to make this course as fun and productive as possible. I am looking forward to a great semester.

The University of Pittsburgh CourseWeb site will be the primary means of communication throughout the class. It is the responsibility of the student to check the CourseWeb site **often** for updates and assignments.

Office Hours

I am happy to use office hours to help in any way I can, including with the preparation of homework sets. If you come to office hours for help with an assignment, please be prepared to demonstrate that you have put some effort into the problem(s). In particular, be prepared to describe your thought process and the point at which you are stuck. I will

not help with homework problems if you cannot first describe to me how you tried to solve the problem.

In general, I also observe an open door policy, so if you see my door open, feel free to stop in.

If you need further help or would prefer to seek help from a tutor, the University of Pittsburgh Department of Physics and Astronomy maintains a Physics Resource Room in 312 Thaw Hall that is staffed by tutors between 9AM and 5PM on weekdays throughout the semester.

Course Description

This course will be an introduction to astronomy and astrophysics at the beginning undergraduate level. This course is intended for students with interest in the sciences. Some familiarity with basic physical concepts such as force, energy, momentum, and temperature will be assumed. Basic mathematical proficiency will also be assumed. Simple algebra will be used throughout the course and will be needed to complete the homework sets and exams. Familiarity with calculus is helpful for understanding the context, but it is *not* required and will *not* be needed to complete any assignments or exams in this course. If your intention is not to study physical systems in detail or if you are uncomfortable applying algebra then you may want to consider taking any of Astronomy 0086, 0087, 0088, or 0089 which are not designed for science majors and do not assume mathematical proficiency.

The word astronomy derives from the Greek and means the "order of the stars"; however, astronomy has come to be a vast field of study encompassing atomic and molecular physics, planetary science, the study of galactic structure, and much more. It would be impossible even to survey the subjects that most practicing astronomers would consider "basic knowledge" in a single semester. Therefore, some choices have to be made. This semester, ASTRON 0113 will cover five basic areas: (1) basic problem solving using approximation techniques; (2) the law of gravity, the process that lead to our contemporary understanding of gravity, and its application to physical problems; (3) basic stellar physics and stellar classification; (4) the structure of galaxies; and (5) the evolution of our entire Universe. The solar system is probably the astronomical system most familiar to beginning students and I will address the solar system only briefly in the first part of the course. This is a course designed for those who plan to continue in the sciences and the emphasis will be on scientific thinking and problem solving. Developing these skills and cultivating a basic familiarity with modern astronomy are the primary goals of this course.

If there is a particular subject related to astronomical science that you find interesting, please let me know and I will try to cover it as part of the course if there is sufficient

interest. In the past, students have requested lectures on black holes, supernovae, planets around stars other than the Sun, searches for extraterrestrial intelligence, space flight, global warming, solar power, nuclear power, and other subjects. Remember, I want to you have fun and be interested in the subject.

Course Grades, Homeworks, and Exams

There will be approximately twelve homework sets due throughout the course of the semester as well as a mid-term exam and a final. Homeworks and exams will be used to determine your final grade in the course. Each exam will account for one quarter of your grade, for a total of 50% of your final grade determined by the two exams. The other 50% of your grade will be based on your performance on the homework sets. Notice that there are only two exams. The reason for this is that the homeworks will be a **very significant** part of the grade (50%). In turn, the reason for this is to focus on problem solving in an environment more like that which practicing scientists are familiar with, rather than regurgitation during timed exams. As a consequence, the homeworks will be challenging. One benefit of this approach is that it will be difficult to do very poorly in this class if you do a good job on the homework assignments. Grading will be done on a curve with approximately half of the grades being B- *or better*.

Exams will be open book exams. The midterm exam will take place in class on **Tuesday, October 18, 2016**. Arrangements for make-up exams must be made well in advance of the exam. Acceptable excuses for missing an exam include being out of town for a verified university-related activity or illness. If you miss an exam due to illness, be prepared to provide a signed letter from your doctor or from the university health service.

In both homeworks and exams, the focus will be on having the correct reasoning. **NO CREDIT** will be given for a correct answer without the reasoning being clearly explained. A great deal of the credit for a problem may be given if the reasoning is correct, but the numerical answer is incorrect for one reason or another. For all problems please give a detailed statement of the problem and give a detailed explanation of your reasoning in order to get full credit for the problem. Occasionally, you may find an answer that is obviously incorrect. For example, say you derived the distance to the sun to be three miles. In such a situation, you can still get partial credit for the problem simply by recognizing that the answer obviously does not make sense *and* explaining why the answer is manifestly incorrect. **NO CREDIT** will be given for an answer that has incorrect units unless you comment on the fact that your answer is wrong and take a guess where you may have gone wrong. For example, if you expect an answer that should have units of length (inches, meters, miles, etc.) but give an answer of 25 seconds you will get no credit unless you comment on this. Finally, your work must be legible. You are not saving the environment

by cramming all of your work onto one sheet of paper. **NO CREDIT** will be given for work that either the course grader or Dr. Zentner find illegible. **NO CREDIT** will be given if either Dr. Zentner or the course grader find it difficult to follow the sequence of steps. Your work must flow sequentially from left to right across the page and from the top to the bottom of the page. It is your responsibility, and yours alone, to make sure that your work is legible and orderly.

You may discuss problems with others on your homework sets, but the solutions you hand in must be your original work. Homework must be turned in at the **beginning** of class (first 5 minutes) on the day that they are due. Late homework will be accepted for 1/2 credit. I will post all solutions to homework sets, usually within a couple of days after the due date and without prior warning. Once I have posted a homework set solution on the CourseWeb, **no credit** may be obtained for handing in the homework.

Course Topics in Detail

Here is a rough outline of what will be covered in the course. This plan may be modified according to student interests and questions that may arise during the course and the pace at which we proceed.

- Week 1: Introduction to the Science of Astronomy
- Week 2: Force, Energy, and the Law of Gravity
- Week 3: Orbits and Applications of the Law of Gravity
- Week 4: Light: Electromagnetic Waves, Emission, and Absorption
- Week 5: Light: Radiation, Thermal Equilibria, Planetary Temperatures, and the basics of Telescopes
- Week 6: Introduction to Stars: Properties and the Hertzsprung-Russell Diagram
- Week 7: The Inner Workings of the Sun and other Stars and **First Exam, Tuesday, October 18**.
- Week 8: The Life Cycles of Stars.
- Week 9: Star Formation and Stellar Life Cycles
- Week 10: Introduction to Galaxies in the Universe: Basic Galactic Structure
- Week 11: The Mystery of Dark Matter in Galaxies
- Week 12: The Milky Way Galaxy and Supermassive Black Holes

- Week 13: Beyond Newtonian Gravity: Gravitational Lensing & Introduction to Cosmology
- Week 14: Introduction to Cosmology and the Large-Scale Structure of the Universe
- FINALS WEEK: **FINAL EXAM**

I intend to hold review sessions before each exam at a time to be determined.

NOTE ON TOPICS: The first ten weeks of the course are roughly the standard content of an introductory course on Astronomy. I like to augment this with lessons on problem solving and advanced topics such as black holes and cosmology. If you find a particular subject interesting and would like to pursue it more, please let me know and I will try to incorporate it into the course.

Textbook

This course is designed to be more detailed than an introductory survey of astronomy for non-science majors such as ASTRON 0087, 0088, or 0089, yet not so advanced that sophisticated mathematical tools (such as calculus) can be brought to bear on astronomical problems. Unfortunately, there is no textbook available that is particularly appropriate for this level. *Universe* by Freedman and Kaufmann is a very popular introductory textbook that makes some use of mathematics. *21st Century Astronomy* by Hester, Burstein, Blumenthal, Greeley, Smith, and Voss (the 2nd edition authors are Hester, Smith, Blumenthal, Kay, and Voss) is a very good introductory book as well. *Astrophysics in a Nutshell* by Maoz is a book that I recommend. This book provides an excellent introduction to most of the topics we will cover in this course including Light, Stellar Physics, Galaxies, and Cosmology. However, this book makes heavy use of calculus and therefore is a bit too advanced to be used for this course. Those of you that refer to this book will likely reap a significant benefit, but this book is not required. Another good text that makes use of calculus is *Astronomy and Astrophysics* by Zeilik and Gregory.

Homework problems will not be taken from any specific textbook and **no specific textbook will be necessary to complete this course**. I recommend *21st Century Astronomy* as a good introductory book and I will make some effort to follow the sequence of subjects discussed in that text. For the more mathematically-inclined students, my recommendation is for *Astrophysics in a Nutshell* by Maoz.

As there is no textbook for the course, attendance in class and taking good notes during lecture will be of critical importance. It will be a good idea to arrange with others in the class to share notes should you miss all or part of any class for some reason. I will **not**

answer questions in office hours about lecture materials if you miss lecture without an acceptable excuse or if you have made no effort to obtain the lecture materials through other means first.

In order to compensate for the fact that we will not follow any specific textbook closely, I will post slides from all of my Lectures on the CourseWeb Blackboard web site for the course at `http://courseweb.pitt.edu`. Please let me know if you have any problems retrieving this material and I will do my best to rectify the problem. I will also try to aid in review for exams by holding an open question and answer period prior to each of the exams. I will arrange the specific dates and times of these review sessions in class.

The Department of Physics and Astronomy

As students at the University of Pittsburgh, you have access to a Physics and Astronomy Department that is highly recognized and is performing world-class research. The Department of Physics and Astronomy wants you to feel welcome. If you are interested in further study of physics or astronomy please talk to your instructor or another faculty member. If you think you may be interested in getting involved in a career in Physics or Astronomy or in research in Physics or Astronomy, please feel free to contact the instructor or other faculty members.

You may make use of the undergraduate lounge off of room 219 in Old Engineering Hall. This is a good place to meet with classmates to discuss problem sets and course material. You might also meet physics majors here that can help you, discuss other classes with you, or inform you about the major program. The Department also hosts a doughnut and coffee hour every Wednesday at 4PM in Allen Hall which is designed to encourage discussion. Please feel welcome. The University of Pittsburgh's Astronomy research group hosts seminars on topics of current interest in astronomy and astrophysics each Friday at Noon in 106 Allen Hall. The talks are typically at an advanced level, but eager students can learn a great deal about contemporary astronomy and astrophysics by attending.

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity without exception. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and pro-

grammable calculators.

Students with Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Accessibility

Blackboard is ADA Compliant and has fully implemented the final accessibility standards for electronic and information technology covered by Section 508 of the Rehabilitation Act Amendments of 1998. Please note that, due to the flexibility provided in this product, it is possible for some material to inadvertently fall outside of these guidelines.

Copyright Notice

Statement on Classroom Recording

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use. The instructor may be more likely to grant permission if the student intends to autotune the lectures.