

ASTRON 0088: From Stonehenge To Hubble

Course Syllabus

Revised January 8, 2024

Basic Course Information

Term: 2244 (Spring 2023-2024)

Units: 3

Meeting Time and Place:

- **Section 1020**: Mondays, Wednesdays, and Fridays 11:00 to 11:50 AM, Room 345 Alumni Hall.
- **Section 1100**: Wednesdays, 6:00 to 8:30 PM, Room 104 Thaw Hall.

Instructor

Prof. Carles Badenes

Office: 309 Allen Hall

Office Hours: Mondays 3:00 to 4:00 PM and Wednesdays 3:00 to 4:00 PM (or by appointment)

Email: badenes@pitt.edu (email is generally the best way to contact me)

Website: <https://carlesbadenes.github.io/>

Background I am a Professor at the Department of Physics and Astronomy. I hold a Ph D in astrophysics, and my research specialty is stellar evolution, in particular supernova explosions.

Goals My main goal is to work with students to make this course engaging, interesting, and enjoyable. Do not hesitate to contact me with **any** questions or concerns, because I need your feedback in order to improve your learning experience! Please let me know if you have issues with the course material, or you would like me to cover some topic that you are particularly interested in. Of course, I have to abide by University and Department rules and I have to work within the Physics and Astronomy curriculum, so I cannot accommodate all requests, but I will do my best. I am looking forward to a great semester!

Logistics I will hold regular office hours on Mondays between 3:00 and 4:00 PM and on Wednesdays between 3:00 and 4:00 PM. If you cannot make these times, please contact me and we can arrange to meet at another time. If you need further help or would prefer to seek help from a tutor, the Department of Physics and Astronomy maintains an online [Resource Room](#) that is staffed by tutors throughout the semester. Please take advantage of this service.

Course Description and Rationale

This course is a self-contained historical introduction to astronomy for students not majoring in the physical sciences. Astronomy is a vast field of study, and it is impossible to even mention all of its major areas in a single course, so ASTRON 0088 is very general and mostly descriptive in nature. Some of the lectures will make use of simple arithmetic and geometry because astronomy is a *quantitative* science. My primary goals are to cultivate an understanding of the scientific method and an appreciation for critical thought that students can apply well beyond this course, to develop an interest in astronomy, and to have fun! The course aims to give an historical

perspective of astronomy, beginning with a discussion of the earliest views of the Universe and the role of astronomy in primitive civilizations. The course proceeds with the development of our current understanding that we live on a planet orbiting a star in one of many similar planetary systems, on the edge of a galaxy that contains billions of stars, and is but one of a hundred billion galaxies in the observable Universe. The underlying theme will be the process of scientific discovery and advancement. Understanding the nature of scientific discovery remains critically important in the world of today, especially because science is often misrepresented or described incorrectly in the media, popular literature, and public debate.

Learning Objectives and Course Outline

The course material will be divided in two major sections. The first section will describe the evolution of humankind's early belief in an Earth-centered Universe to a cosmic view of a Sun-centered Universe developed during the 16th and 17th centuries by Copernicus, Galileo and others. From this, we continue through the time of Isaac Newton, the development of the modern scientific method, and its application to astronomy. This marks the beginning of modern, empirical science and the closely-related fields of physics and astronomy. To reinforce and appreciate the material in this section, we will review some basic practical topics in astronomy, including phenomena that can be readily observed with the unaided eye or a small telescope: seasons, tides, phases of the moon, eclipses, the motions of the planets, other solar system objects, constellations, stars, nebulae, and galaxies. We will briefly discuss the use of small telescopes or binoculars for astronomical observations.

We will then move to a discussion of our modern view of the Universe. This will require a basic understanding of the scales involved in astronomical investigations. For example, the distance between the Earth and the Sun, though vast compared to distances encountered in our everyday lives, is sixty billion times smaller than the distance across our galaxy. From the realization that the Sun is not the center of the Universe, we have successively discovered that the Sun is not at the center of our Milky Way galaxy, that the Milky Way is not at the center of the Universe, and that in fact the Universe has no discernible center. Instead, we live in an expanding Universe of more than one thousand billion galaxies that originated 13.8 billion years ago in an event we refer to as the Big Bang. We will review how we have pieced together the evidence for the Big Bang, and how successive generations of stars formed since then have synthesized the chemical elements that make up our bodies and all living things found on Earth. We will also discuss some topics of active current research by professional astronomers like the evidence for the existence of unfamiliar forms of matter called dark matter and dark energy; black holes at the centers of galaxies; planets around other stars; space exploration; and the search for life elsewhere in the Universe.

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, and many other subjects. Remember, I want you to have fun and be interested in this course.

Course Materials

The official textbook for this course is *Discovering the Cosmos*, 2nd edition by Robert Bless, which captures the philosophy of ASTRON 0088 quite well. However, the book is not required and should be regarded only as a useful reference if you want to have the lecture material reinforced by another source. A book I highly recommend is *Coming of Age in the Milky Way*, by Timothy Ferris. This is a book for popular audiences, not a textbook, but it covers a great deal of the material for the course in a clear and engaging way. A basic level astronomy textbook that I like is *21st Century Astronomy* by Kay, Palen, and Blumenthal, which provides a careful and accurate description of the logic of the scientific method. And finally, there is an excellent open source alternative, *Astronomy* from OpenStax, which you can find [here](#), and should be helpful in clarifying any technical concepts you might need for this or other astronomy courses.

The lecture slides, assignments, and additional materials will cover all of the content you are responsible for in this class, so it will be important to pay attention during lectures, take notes, and work through the additional

materials on your own. I will post all these materials on the Canvas site at <https://canvas.pitt.edu>. Please check it often for updates, and let me know if you have any problems downloading the files.

Assessment and Grading Information

The grading policy for undergraduate classes at the Department of Physics and Astronomy states that the final letter grade should reflect the mastery of the learning objectives demonstrated by each student. In addition to the broad learning objectives listed above, specific learning objectives will be stated for each content unit (roughly equivalent to a week of class). An updated file listing the learning objectives for each unit will be available on Canvas. The largest part of the grade will be tied to direct assessment of these learning objectives through exams, quizzes, and assignments. The remainder of the grade will be tied to indirect assessment of these learning objectives through lecture participation. The final grade will be computed from these components according to the following percentages:

- **5%** for a trip to the Allegheny Observatory.
- **15%** for lecture participation as measured by your answers to interactive questions in Top Hat.
- **20%** for assignments and quizzes.
- **60%** for the sum of the grades on the three exams. Each exam is worth 20% of your final grade.

Each of these items is explained in more detail below. A final letter grade of C or higher will indicate a satisfactory performance in the course, while a grade of C- or lower will indicate an unsatisfactory performance.

I never negotiate grades, and I do not allow students to complete additional assignments for extra credit. In my opinion, this is the only way to ensure that the playing field is level for everyone. If your grade in this course matters to you (because you need it to graduate, for your GPA, to brag to your friends about how much astronomy you know, or for any other reason), you should **attend the lectures, complete the assignments on time, and study for the quizzes and exams.**

Allegheny Observatory Visit

The University of Pittsburgh's own Allegheny Observatory is a facility with a rich history that has been used in a number of important astronomical discoveries. The Allegheny Observatory continues to be used for research today, primarily to observe planets around nearby stars (other than the Sun). As part of ASTRON 0088, you will have the opportunity to visit the observatory on an evening during the course, and, if the weather is clear, to make observations of celestial objects. **At least one trip to the Allegheny Observatory is mandatory, and will be worth 5% of your final grade.** Buses depart from Allen Hall in the evening and return to campus about three hours later. Detailed information about signing up for the trip will be made available soon. The observatory trip schedule can be found in [this website](#).

Lectures

Fifteen percent of your final grade will be based upon your participation in lectures, tracked using [Top Hat](#). You can click on the Top Hat tab on the Canvas course page to get started, or if you prefer to use the Top Hat application directly, you can enter our class code ([367841](#) for Section 1020, [586759](#) for Section 1100). Beginning the second week of class, all lectures will contain interactive Top Hat questions that you should answer using a smart phone, a tablet, or a laptop. Answering these questions correctly should not be a source of stress. You will receive 1 point for each correct answer, and 0.8 points for each incorrect answer. You can earn 15% toward your final grade by getting 80% of the possible Top Hat points. For example, you can earn the full 15% by answering all of the questions incorrectly! Alternatively, you can earn the full 15% by answering 80% of the questions correctly and not

answering the remaining 20% at all. Of course, there are a number of different combinations that get you to 80%. If you earn less than 80% of the total points, credit will be allocated in proportion to the number of points you have earned. It is your responsibility to make sure that the device you use to answer Top Hat questions is functional (i.e., physically present, charged, and accessible)

Assignments and Quizzes

This course has no recitation section. I will provide additional material on Canvas to support each unit. It is your responsibility to work through this material on your own, and use it to address the issues that are unclear from the lectures or need to be expanded or reinforced. I will *expect* you to have worked through the additional material before I answer any questions about assignments, quizzes, or exams.

I will post **assignments** on Canvas, beginning the first week of class. These assignments are designed to emphasize the learning objectives of the lectures and serve as practice for the course exams and quizzes. The assignments are not mandatory. However, if you do not complete the assignments, you will probably not do well on the quizzes or the exams. The solutions for each assignment will be posted on Canvas after the due date. If you submit solutions to the assignments, you may have your cumulative assignment grade (the average of all assignments throughout the semester) replace your two lowest quiz grades. Notice that if you fail to complete an assignment on time, there will be no opportunity for a make-up assignment and you will receive a grade of zero for that assignment. Such a grade will significantly lower your cumulative assignment score.

I will also post between 6 and 10 **quizzes** on Canvas. These quizzes will be administered and graded entirely through Canvas, and you will have a limited time to answer them. Your final quiz grade will constitute 20% of your final grade, and it will be calculated as the average of your quiz grades after dropping the two lowest grades. In addition, if you choose to turn in assignments (see above), you may use your average assignment grade to replace two more quiz grades. Because you can have up to four quiz grades dropped if you are completing assignments, **there will be no make-up quizzes**, except under extremely exceptional circumstances.

Exams

There will be three exams in this course. **Students must bring their Pitt ID card to all exams.** The use of books, notes or other written materials, computers, cellular phones, and all devices that can render documents, graphics, or connect to the internet are absolutely prohibited. Each exam will cover approximately one third of the course material. However, the material covered later in the course will often rely on the material covered earlier in the course, so it is difficult to do well on the later exams if you allow your understanding of the early material to deteriorate significantly. Each exam be comprised of approximately 40 multiple choice or true/false questions. Each exam will constitute 20% of your final course grade. The three exams taken together will constitute 60% of your final grade. Make-up exams will only be given under extremely special circumstances, such as illness or University-approved travel, and will require a written confirmation from, for example, a medical doctor. The exam dates are (Blue for Section 1020, red for section 1100):

- First exam: Friday, February 2/Wednesday, January 31 (in class).
- Second exam: Friday, March 8/Wednesday, March 6 (in class).
- Third exam: Friday, April 19/Wednesday, April 17 (in class).

Course Schedule

Here is a rough outline of what will be covered in ASTRON 0088. This plan may be modified according to student interests, to accomodate questions that may arise during the course, and to adapt to the pace at which we proceed. Each content unit is roughly equivalent to one week of lectures. **Dates shown in blue are for Section 1020, dates shown in red are for section 1100.**

Jan 8, 10, 12; Jan 10	Unit 1: Introduction: our place in the Universe, the Scientific Method.
Jan 17, 19; Jan 17	Unit 2: The first astronomers: Archaeoastronomy. The Greeks. The birth of scientific thought. <i>MLK Day Jan 15 (no class). Add/drop period ends 01/19</i>
Jan 22, 24, 26; Jan 24	Unit 3: The Middle Ages. The Geocentric model of the Universe. The Renaissance. The Copernican Revolution <i>Extended drop period ends 01/26.</i>
Jan 29, 31, Feb 2; Jan 31	Unit 4: The first modern astronomers: Tycho Brahe and Johannes Kepler.
Feb 5, 7, 9; Feb 7	First exam: Friday, February 2/Wednesday, January 31
Feb 12, 14, 16; Feb 14	Unit 5: Kepler's Laws of Planetary Motion. Galileo Galilei.
Feb 19, 21, 23; Feb 19	Unit 6: Telescopes. The Enlightenment. Isaac Newton.
Feb 26, 28, Mar 1; Feb 28	Unit 7: The Universal Law of Gravity. The Laws of Motion.
Mar 4, 6, 8; Mar 6	Unit 8: The properties of Light. Matter and Radiation. Flux, Luminosity and distance.
	Unit 9: The Quantum Revolution. Nuclear fusion and the age of the Solar System. <i>Monitored withdrawal deadline 03/08.</i>
Mar 11-15	Second exam: Friday, March 8/Wednesday, March 6
Mar 18, 20, 22; Mar 20	<i>Spring Break.</i>
Mar 25, 27, 29; Mar 27	Unit 10: How Stars Work. Stellar Evolution.
	Unit 11: Albert Einstein and Relativity. White Dwarfs, Neutron Stars, and Black Holes.
Apr 1, 3, 5; Apr 3	Unit 12: Galactic astronomy: William Herschel, the Milky Way and other galaxies
	Galaxies. Dark Matter.
Apr 8, 10, 12; Apr 10	Unit 13: Modern cosmology: Edwin Hubble and the expanding Universe, the Big Bang model, the Cosmic Microwave Background.
Apr 8	Total solar eclipse, [NASA webpage]
Apr 15, 17, 19; Apr 15	Unit 14: The large scale structure of the Universe, Cosmic evolution in perspective, and back to Earth
	Third exam: Friday, April 19/Wednesday, April 17

Canvas

ASTRON 0088 will be hosted in the Canvas Learning Management System (LMS). To get started with Canvas, go to <https://canvas.pitt.edu>. This link appears on my.pitt.edu but you may wish to bookmark it. Log in with your Pitt User ID and password, and click on the course card for this class.

To aid in your use of Canvas, I suggest familiarizing yourself with the LMS through the short, helpful Canvas Student Tour video series, which you can find [here](#). I also encourage you to try the Canvas mobile app for Android and iOS devices. The full Canvas student guide can be found [here](#).

If you experience any issues using Canvas, you can click the Help button within Canvas, which includes 24/7 chat or telephone support. If you are having issues logging in to Canvas, call the University Help Desk at 412-624-HELP [4357].

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 or research in physics or astronomy please talk to me or any other faculty member.

The Department of Physics and Astronomy provides free assistance for all students. The **Physics Exploration Center** allows students to operate some simple experiments and demonstrations. Within the Exploration Center is the **Physics Resource Room**, staffed with TAs who can answer homework related questions, explain basic concepts and help you with the math. This is a free service and you are encouraged to use it. The Physics Exploration Center and the Physics Help Room are both located in Thaw 312, and a detailed schedule is posted [here](#). In addition,

tutoring is available through the Academic Support Center (WPU 311). You may also make use of the undergraduate lounge off of the mail room on the second floor of the Old Engineering Hall. This is a good place to meet with classmates to discuss problem sets and course material. You might also meet physics and astronomy majors here that can help you, discuss other classes with you, or inform you about the major program. The Department hosts a doughnut and coffee hour every Wednesday at 4PM, which is designed to encourage discussion. The Astrophysics group within the Department hosts seminars on topics of current interest in astronomy and astrophysics every other Friday at noon. The talks are typically at an advanced level, but eager students can learn a great deal about contemporary astronomy and astrophysics by attending. You can find the talk schedule in the Department web site, www.physicsandastronomy.pitt.edu. We also hold bi-weekly coffee discussions on several astronomy-related topics that are regularly attended by faculty, graduate students, and undergraduate students who are completing guided research projects in the astronomy group. Please ask me to provide you with updated information about these events if you want to attend.

Course Policies

Medical Absences

Unless you are going to miss a substantial number of lectures or quizzes, there is no need to let me know about absences for medical or personal reasons or due to athletic events. The one exception is on the exam dates. If you are sick or incapacitated on the day of an exam, and you want to reschedule the exam, make sure you see a doctor and provide me with a note.

Academic Integrity

Students in this course will be expected to comply with the [University of Pittsburgh's Policy on Academic Integrity](#). 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 programmable calculators.

To learn more about Academic Integrity, visit the [Academic Integrity Guide](#) for an overview of the topic. For hands-on practice, complete the [Academic Integrity Modules](#).

Disability Services

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, drs-cep@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.

Equity, Diversity, and Inclusion

The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, visit the <https://www.diversity.pitt.edu/civil-rights-title-ix-compliance> web page.

I ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing titleixcoordinator@pitt.edu. Reports can also be <https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/make-report/report-form>. You may also choose to

report this to a faculty/staff member; they are required to communicate this to the University's Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

Your Well-being Matters

College can be an exciting and challenging time for students. Taking time to maintain your well-being and seek appropriate support can help you achieve your goals and lead a fulfilling life. It can be helpful to remember that we all benefit from assistance and guidance at times, and there are many resources available to support your well-being while you are at Pitt. You are encouraged to visit [Thrive@Pitt](#) to learn more about well-being and the many campus resources available to help you thrive.

If you or anyone you know experiences overwhelming academic stress, persistent difficult feelings and/or challenging life events, you are strongly encouraged to seek support. In addition to reaching out to friends and loved ones, consider connecting with a faculty member you trust for assistance connecting to helpful resources.

The University Counseling Center is also here for you. You can call 412-648-7930 at any time to connect with a clinician. If you or someone you know is feeling suicidal, please call the [University Counseling Center](#) at any time at 412-648-7930. You can also contact Resolve Crisis Network at 888-796-8226. If the situation is life threatening, call Pitt Police at 412-624-2121 or dial 911.

Syllabus Addendum: Natural Science General Education Requirement

This course fulfills one Dietrich School of Arts and Sciences Natural Science General Education Requirement (GER) as described for the GERs starting Fall 2018 (term 2191). That GER reads as follows:

Three Courses in the Natural Sciences:

These will be courses that introduce students to scientific principles and concepts rather than offering a simple codification of facts in a discipline or a history of a discipline. The courses may be interdisciplinary, and no more than two courses may have the same primary departmental sponsor.