ASTRON 0088: Stonehenge to Hubble
Course Syllabus

Revised August 11, 2020

Basic Course Information

Term: Fall 2020 (2211)
Units: 3
Prerequisites: Basic mathematics. Any MATH Course or MATH PLACEMENT SCORE (61 or Greater) or SAT HIMAT SCORE (620 or Greater) or ACT HIMAT SCORE (27 or Greater)
Meeting Time:
Class #10926, Section 1070: Tuesdays and Thursdays 1:150 to 2:30 PM
Class #18075, Section 1200: Tuesdays 6:30 to 9:00 PM

This course will be 100% remote. Lectures will be pre-recorded and made available on Canvas, and all assignments and exams will be completed on-line. I will be available for questions or consultations on zoom and live chat, as well as email.

Instructor: Prof. Carles Badenes

Office: 309 Allen Hall (3rd floor)
Office Hours: Mondays 1:30-2:30 PM, Thursdays 3:30-4:30 PM (or by appointment)
Email: badenes@pitt.edu (email is generally the best way to contact me)
Website: https://carlesbadenes.github.io/
Office Phone: (412) 624-9039

Background I am an Associate Professor at the Department of Physics and Astronomy at the University of Pittsburgh. 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 fun. Do not hesitate to contact me with **any** questions or concerns, either by email or by live chat or zoom. 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, despite the strange circumstances!

Logistics I will hold regular office hours on Mondays between 1:30 and 2:30 PM, and on Thursdays between 3:30 and 4:30 PM via zoom. 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.

Graders

Class #10926, Section 1070: Travis Court
Office Hours: TBD.
Email: tac136@pitt.edu

Travis is a PhD student in the Department Physics and Astronomy. His research interest is in binary stars and supernova explosions. He was born and raised in western PA, loves hiking and camping, and is an avid home cook.

Class #18075, Section 1200: Amy Sanderson
Office Hours: TBD.
Email: aes181@pitt.edu

Amy Sanderson is a Ph.D student in the Department of Physics and Astronomy. She has BS's in Physics & Astronomy and Psychology from Northern Arizona University, and currently studies particle decay physics at Pitt. Amy Sanderson is a Ph.D student in the Department of Physics and Astronomy.

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 his course is *Discovering the Cosmos, 2 nd 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. Finally, a basic level astronomy textbook that I like is *21st Century Astronomy* by Kay, Palen, and Blumenthal. This book provides a careful and accurate description of the logic of the scientific method.

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, lecture quizzes, and lecture discussions. The final grade will be computed from these components according to the following percentages:

- **20%** for lecture quizzes and lecture discussions.
- **35%** for assignments and quizzes.
- **45%** for the sum of the grades on the three exams. Each exam is worth 15% 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, or for your GPA, or for any other reason), you should **watch the lectures, complete the assignments on time, and study for the quizzes and exams**.

Lecture Quizzes and Lecture Discussions

The **lectures** for this course will be delivered asynchronously: I will upload videos for each lecture on Canvas that you can watch at your own pace. While you are free to make your own schedule, I strongly recommend that you use the designated class meeting time to watch the lecture videos, otherwise you will find that you have to cram the videos in at the last minute in order to meet the deadlines for quizzes and assignments. This will probably affect your learning negatively and impact your performance on the quizzes and exams.

At the end of each lecture, there will be a short **lecture quiz** (2 to 4 questions). These will be mostly (though not always) easy questions to check that you assimilated the lecture contents, similar to the clicker questions I use in normal lectures. The lecture quizzes for each lecture will be available until the next class meeting time, so make sure you complete them promptly. The lecture quizzes are not meant to be a source of stress - you will get 80% of the points by just answering the questions, even if your answers are incorrect. At the end of the course, if the total of all your lecture quizzes is at least 80% (for example, if you have answered all the questions, even incorrectly), you will get 100% of the credit for the lecture quizzes, which will be 10% of your final grade. So answer the questions - you have nothing to lose!

There will also be on-line **lecture discussions** which you will complete in groups. These discussions will be an opportunity to go beyond the lecture content and examine some interesting implications of the scientific method and general astronomical knowledge. At the end of each discussion, each group will submit a short (less than one page) essay, or complete an on-line assignment. The total grade for the lecture discussions will be 10% of your final grade.

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 35% 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, you may use your average assignment grade to replace two more quiz grades. Because you can have up to four quizz 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. 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. The focus of this course will be on a qualitative understanding of astronomical subjects and sound reasoning in addressing scientific questions. Each exam will constitute 15% of your final course grade. The three exams taken together will constitute 45% 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:

- **First exam: Tuesday, September 15.**
- **Second exam: Tuesday, October 13.**
- **Third exam: Tuesday, November 17.**

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 (two 75 minute lectures for class #10926, Section 1070, days marked in blue; one 2.5 hour lecture for Class #18075, Section 1200, days marked in red).

Unit 1:	Aug 20, 25 Aug 25	Introduction: our place in the Universe, the Scientific Method (the lecture on the Scientific Method will be delivered by John Radzilowicz).
Unit 2:	Aug 27, Sep 1 Sep 1	The first astronomers: Archaeoastronomy. The Greeks. The birth of scientific thought.
Unit 3:	Sep 3, 8 Sep 8	The Middle Ages. The Geocentric model of the Universe. The Renaissance. The Copernican Revolution. *Add/drop period ends Sep 4.*
Unit 4	Sep 10, 15 Sep 15	The first modern astronomers: Tycho Brahe and Johannes Kepler. **First exam: Tuesday, September 15**
Unit 5	Sep 17, 22 Sep 22	Kepler's Laws of Planetary Motion. Galileo Galilei.
Unit 6	Sep 24, 29 Sep 29	Telescopes. The Enlightenment. Isaac Newton.
Unit 7	Oct 1, 6 Oct 6	The Universal Law of Gravity. The Laws of Motion.
Unit 8	Oct 8, 13 Oct 13	The properties of Light. Matter and Radiation. Flux, Luminosity and distance. **Second exam: Tuesday, October 13**
Unit 9	Oct 15, 20 Oct 20	The Quantum Revolution. Nuclear fusion and the age of the Solar System. *Monitored withdrawal deadline is Oct 20.*
Unit 10	Oct 22, 27 Oct 27	How Stars Work. Stellar Evolution.
Unit 11	Oct 29, Nov 3 Nov 3	Albert Einstein and Relativity. White Dwarfs, Neutron Stars, and Black Holes.
Unit 12	Nov 5, 10 Nov 10	Galaxies. Edwin Hubble. The Expanding Universe.
Unit 13	Nov 12, 17 Nov 17	The Big Bang model. The Cosmic Microwave Background. The Large Scale Structure of the Universe. **Third exam: Tuesday, November 17**

Canvas

ASTRON 0088 will be hosted in the new 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. Our class materials will not be available in Blackboard (CourseWeb), only in Canvas.

To aid in your use of Canvas, I suggest familiarizing yourself with the new 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

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 Understanding and Avoiding Plagiarism tutorial. A minimum sanction of a zero score for the quiz or exam will be imposed on students violating this policy.

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.

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 as described in the University policy for medical absences:
https://www.studentaffairs.pitt.edu/shs/medical/medical-excuses/

Health and Safety Statements under COVID-19

In the midst of this pandemic, it is extremely important that you abide by public health regulations and University of Pittsburgh health standards and guidelines. While in class, at a minimum, this means you must wear a face covering and comply with physical distancing requirements; other requirements may be added by the University during the semester. These rules have been developed to protect the health and safety of all community members. Failure to comply with these requirements will result in you not being permitted to attend class in person and could result in a Student Conduct violation. For the most up-to-date information and guidance, please visit https://www coronavirus.pitt.edu and check your Pitt email for updates before each class.

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.

Take Care of Yourself

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking time to relax. Despite what you might hear, using your time to take care of yourself will actually help you achieve your academic goals more than spending too much time studying. All of us benefit from support and guidance during times of struggle. There are many helpful resources available at Pitt. An important part of the college experience is learning how to ask for help. Take the time to learn about all that is available and take advantage of it. Ask for support sooner rather than later – this always helps. If you or anyone you know experiences any academic stress, difficult life events, or difficult feelings like anxiety or depression, we strongly encourage you to seek support. Consider reaching out to a friend, faculty or family member you trust for assistance connecting to the support that can help.

The University Counseling Center is here for you: call 412-648-7930 and visit their website. If you or someone you know is feeling suicidal, call someone immediately, day or night:

- University Counseling Center (UCC): 412 648-7930
- University Counseling Center Mental Health Crisis Response: 412-648-7930 x1
- Resolve Crisis Network: 888-796-8226 (888-7-YOU-CAN)

If the situation is life threatening, call the Police: On-campus: Pitt Police: 412-268-2121. Off-campus: 911