

# AST309N: "LIVES & DEATHS OF THE STARS: ELEMENTS OF THE COSMOS"

Web Site: <http://www.as.utexas.edu/astronomy/education/fall16/dinerstein/309n.html>  
(There will be a portal with a username and password, to be set up soon.)

Course Unique No. & Semester: 47540, Fall 2016

Class Meetings: Tues. & Thurs., 12:30 – 1:45 PM, Welch 3.502

Instructor: Prof. Dinerstein, [harriet@astro.as.utexas.edu](mailto:harriet@astro.as.utexas.edu) (512) 471-3449

Office Hours: Wed. 2:30 – 3:30 PM or by appointment, in RLM 16.324

Teaching Assistants:

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Office Hours: M 1-2, Tu 4-5, W 11-12, Th 10-11, in RLM 15.202, "Peridier Library"  
Help Sessions: Some weeks, Wed., 4:30 – 5:30 PM in RLM 15.216B

## PREREQUISITES AND CREDIT:

**Ast 309N has a prerequisite of AST 301** or an equivalent college-level introductory astronomy course (if taken at UT, this would be either Ast 301 or 307). *We strongly advise against taking Ast 309N without a previous introductory class.* We will begin the semester on topics that are usually not covered until the end of the semester in introductory courses. However, we recognize that you may have forgotten some of that content and will reviews the relevant background material as we go along.

This course is intended and designed for students who are **not** majoring in Natural Sciences or Engineering. Science majors are permitted to take Ast309N, but it will not count towards their major. Ast 309N does not carry a quantitative reasoning (QR) flag, but can count for the Natural Science & Technology Part I core requirement.

## WHAT THIS COURSE IS ABOUT:

The "stars" of astronomy are ... well, the stars! They provide the light and heat that makes life-bearing planets like Earth possible. They are the building blocks of galaxies, as atoms are to matter. Yet, despite their huge masses, sizes, and energy output, stars are deeply connected to the tiny scales of atoms and nuclei. Nearly every atom of all elements heavier than helium was created deep inside a star that existed long ago. This is what Carl Sagan meant when he said "We are star stuff," and what Neil deGrasse Tyson calls "the most astounding fact" about our Universe.

Your introductory astronomy course probably started by talking about the night sky and continued with our Solar System, stars, galaxies, and cosmology. We will tell this story in the opposite direction: we start at the beginning, with a universe of hydrogen and helium only, and trace the increasing chemical complexity that results from stars "cooking" up other elements and releasing them to space. This eventually creates the conditions that enabled rocky planets to form around stars, as we see in our universe today. This course is about cosmic chemistry in a very broad sense.

## RECOMMENDED BOOK AND CLASS RESOURCES:

There is no textbook available that fully matches the content of this course. If you still have the book from your introductory astronomy course, you may benefit from looking up specific topics in it. However, to provide everyone with an alternate source of information, I highly recommend the brief but well-written book “**Stars: A Very Short Introduction,**” by Andrew King. You can buy it as a paperback from the Coop (about \$12 new or \$9 used) or download the eBook from Amazon for \$6.15. It discusses many of the basic ideas underlying the course material, although for some topics it includes more math than we will use or less detail than we will present.

Other resources will be available at or through the class website. These will include selected (not all) slides shown in class. Slides will be posted **after** class (*not before*), in order to accurately reflect what was actually covered in class. Other postings will include links to websites; feedback (but not answer keys) for quizzes, exams, and in-class exercises; and an archive of all current and previous announcements. The video segments shown in class will **not** be posted, but in some cases I may post transcripts of the videos. You should **bookmark** the class site and visit it often!

## COURSEWORK AND GRADING:

My grading philosophy is that all students should have the opportunity to earn a grade based on their own work; there are no quotas for A’s and B’s. After the first exam I will post a table of numerical score to letter grade equivalents, to be used for the rest of the semester (barring extraordinary circumstances). I do use +, – grades.

Your course grade will be based on a combination of **in-class exams (“midterms”), short answer quizzes, and participation activities**. The latter two categories work on a cumulative credit basis: you earn points up to a pre-set maximum, and then they are capped. Some out-of-class activities may be used to earn a small amount of **extra credit** (see below). Because there will be more quizzes and activities than needed to reach the maximum, there is no need and will be no opportunities to make up that *specific* quiz or activity. Instead, you are expected to earn equivalent credit through a later activity or quiz, or extra credit point. A similar policy applies to exams: no custom make-up exams will be given, but all students will have the opportunity to drop one low exam score (two exams, if you also take the final exam). All students (including SSD-approved) must take exams *at the same time*. **No one may take an exam earlier or later than the rest of the class; there will be no exceptions to this policy.**

**In-class Exams:** The four midterms will be “unit exams” in multiple-choice format, focusing on material covered the few weeks before the exam. With certain restrictions, the highest three exam scores count towards your course grade. The rules are as follows: if you take all four exams, we will count (a) the higher score of Exam 1 or 2; (b) the higher of Exam 3 or 4; and (c) the next highest exam score. These will be equally weighted, **25%** each, for a total of **75%**. If you miss an exam for any reason, *no matter how legitimate*, that becomes the score that is dropped. However, everyone has the option of taking the comprehensive final exam during Exam Week, and if (but *only* if) you do better on it than on the previous lowest exam, the final exam score replaces it.

The preliminary dates for the midterms – these are subject to revision, except for the one on Dec. 1 – are **Sep. 22, Oct. 20, Nov. 10, Dec. 1**. These are Thursdays, and there will be a help session the Wednesday before each exam (perhaps other weeks). The **final exam** during Exams Week will be on **Thursday, Dec. 8, 9:00 AM – noon**.

**Quizzes:** We will have about 7 or 8 “pop” quizzes consisting of 2 short-answer essay questions. The purpose of these quizzes is to test your ability to quickly respond to and answer the questions, so (unlike the exams) they are not subject to SSD-approved accommodations for extra time on assignments. Quizzes may be given at any point during the class period. Credits earned on quizzes will accumulate up to the maximum allowed total of 10 points and count up to **10% of the course grade**. You can earn this maximum through higher scores on a few quizzes or lower scores on more quizzes. There are no quiz make-ups; missed points can be earned only on later quizzes.

**Participation Credit:** The remaining **15%** of the grade will come from credits earned over the semester through in-class activities and a few take-home activities. Most in-class activities will be carried out in small groups and collected on index cards or worksheets. Credit will be given for any *honest effort* on these (need not be correct).

**Extra Credit:** A few extra points (each point = **1%** of the course grade) can be earned through pre-approved out-of-class activities. These include *documented* attendance at up to three UT Star Parties, 1 point for each. It is also possible to earn credit by attending an approved public lecture and turning in a short write-up. For example, there will be two suitable public talks in September, on Sep. 16 and Sep. 21. If any additional opportunities become available, I will announce these in advance.

## **CLASSROOM EXPECTATIONS AND POLICIES:**

I expect everyone to be respectful of the instructor and their classmates. Talking to your neighbor or using a cell or smart phone is highly distracting to others. **Turn off the volume on your phone before the beginning of class, and do not use it for texting or internet access during class.** I also strongly discourage the use of tablets or laptops in class. There is documented evidence not only that students using the internet for unrelated purposes during class receive lower grades (by half a letter grade on average), but that this also *lowers the grades of students sitting near them*. If you are using a laptop, please sit in the back two rows of the auditorium. Also, if your use becomes too distracting or disruptive, I reserve the right to ban it entirely. Students are also expected to refrain from other activities that may disturb the instructor and other students such as entering or exiting the auditorium loudly, *conversing with neighbors* except during assigned activities, listening to something via earbuds, snoring, etc.

It is expected that you will attend and participate regularly in class. This is the best way to keep up with the class and be prepared for quizzes and exams. Also, the dates and times of the quizzes and activities will not be announced in advance, so if you skip a class you may miss one of these. If you are looking for a class to take by just showing up for major exams, this is **not** it! Please take this warning seriously; every semester there are students who enroll but fail to attend regularly. This is guaranteed to be a losing strategy in this course, and absence/failing reports will be filed with your Dean.

**Academic Integrity and Academic Dishonesty:** The University of Texas at Austin holds its students and community to high standards of academic integrity. Details can be found at [http://deanofstudents.utexas.edu/sjs/acint\\_student.php](http://deanofstudents.utexas.edu/sjs/acint_student.php). We take these rules seriously. *We will not tolerate copying or cheating on exams, quizzes, or other classwork.* If we find duplicated work or other evidence of cheating, neither student will receive credit. We may also impose more severe academic penalties depending on circumstances, not excluding an F for the course and a report to the Dean of Students.

**Students with Disabilities:** The University of Texas at Austin provides selected adjustments for students with certified disabilities. To be assessed for certification and accommodations, contact the SSD (Services for Students with Disabilities) office: [ssd@austin.utexas.edu](mailto:ssd@austin.utexas.edu), or visit <http://diversity.utexas.edu/disability/>. It is necessary to reapply for accommodations at the beginning of each semester, so do this as soon as possible. In particular, in order to make arrangements for special exam accommodations such as extra time or alternate settings it is *essential* that you provide the instructor with a letter and test scheduling form **as soon as possible** at the start of the semester. All such parallel exam-taking for this course must be proctored by SSD. This applies to exams only, not quizzes (as explained above). Your exam times *must fully overlap with the exam period for the rest of the class*, but you may start early or end late for more time.

## GETTING HELP IN THIS CLASS:

There will be several opportunities each week to ask questions and get help. At least on weeks when exams are given (and possibly more often if there is sufficient student demand), there will be help sessions on Wednesdays from 4:30 – 5:30 PM in RLM 15.216B. We will also hold office hours. We prefer that you come during the regular office hours of the professor or Teaching Assistants if at all possible, but we can also set up individual appointments in advance if none of those times work for you (email us!). You may also send questions through Conversation on Canvas, to both T.A.s and instructor. If you have questions about procedures, please check the website first.

## ADDITIONAL OPPORTUNITIES:

The Astronomy Department offers Star Parties most Wed., Fri., and Sat. evenings. Details are posted at <http://outreach.as.utexas.edu/public/viewing.html>. You can earn credits by attending star parties, if you obtain a signed slip from the person in charge.

## KEY DATES FOR SPRING 2016: (from UT's academic calendar)

First class meeting: **Thurs., Aug. 26**

Last day of online adds/drops: **Mon., Aug. 29**

Last day to drop a course or switch between letter grade and pass/fail: **Tues., Nov. 1.**

After Nov. 1, drops require dean's approval and are *only* for non-academic reasons (the instructor no longer has the authority to allow these). Note that we will have had two midterm exams before then and you will know your scores on them.

Last class meeting and date of last "midterm" exam: **Thurs., Dec. 1**

Optional Final Exam: **Thurs., Dec. 8, 9:00 AM – noon**

## LEARNING OBJECTIVES FOR THIS COURSE:

Be able to identify the major (nuclear) element groups of the Period Table and the basic nuclear reactions that create them. [The nuclear physics of the elements]

Identify the astronomical sites where each of these reactions happens (e.g. type of stars, interior or surface, early Universe, etc.) [The astrophysics of the elements]

Summarize the composition of the Sun and present-day stars; explain why this differs from the past composition of the universe. [Cosmology: the history of the universe]

Explain why some elements are much more common than others. [The story of stellar aging and “element cooking” = Lives and Deaths of the Stars]

Describe the composition of the Earth and other planets, and why it differs from that of the Sun and stars. [Star and planet formation; history of the Earth]

Increase skills in interpreting diagrams, making powers of 10 (order of magnitude) comparisons, and concepts of proportionality. [General quantitative skills]

## PRELIMINARY SCHEDULE OF TOPICS: (subject to change)

(Weeks 1 and 14 each have only one class meeting. Topics in italics are mostly review from your intro course, but some reminding is helpful to many.)

Week 1: Introduction, Background Survey, Syllabus (first class meeting)

Week 2: *Atoms, energy*, the Sun in depth

Week 3: *Light, the Big Bang*, nuclear reactions in the early universe

Week 4: *Gravity*, gravitational lenses & waves, dark matter

Week 5: Dark matter halos, first stars and galaxies Exam 1 (9/22)

Week 6: *Stellar Properties*, Nucleosynthesis in Supernovae

Week 7: Metal-Poor Stars, stellar “archeology” (Guest lecturer: Prof. Sneden)

Week 8: *Evolution* and nucleosynthesis in low-mass stars (and the origin of dust)

Week 9: *White dwarfs*, interacting binary stars Exam 2 (10/20)

Week 10: Neutron stars, *pulsars*, in binary systems

Week 11: Black holes, gamma-ray bursts, X-ray binaries

Week 12: Interstellar matter and “real” chemistry (molecules) Exam 3 (11/10)

Week 13: Star Formation, protostars & protoplanetary disks

Week 14: Formation and evolution of planets

Week 15: Wrap-up, Course-Instructor survey Exam 4 (12/1)

Finals Week: Optional, comprehensive final exam Final (12/8)

## General Memo for Undergraduate Astronomy Students

Welcome to this undergraduate Astronomy course. We wish to clarify the ground rules for Astronomy Department courses. These courses operate with mutual responsibilities between faculty and students. For each of our classes:

- A written syllabus will be handed out at the first class meeting containing a description of the course, the material that the course will cover, all requirements in the course, and an explanation of what fraction of your grade is derived from each activity. These requirements or percentages are not to be changed during the semester.
- This course, although designed for non-science majors, is nevertheless a **science** course. You will be exposed to scientific reasoning in the course, which you will be required to use on tests, quizzes, and activities. Only simple mathematics is used; the level varies from instructor to instructor.
- Students in the College of Natural Sciences should note that AST 301 and AST 309 courses do NOT count towards your degree requirements. We encourage you to consider taking AST 307 instead.
- There will normally be help available outside of class at least once a week. If you have trouble understanding the material, or other problems, such as illness, arise, *let your instructor know as soon as possible*. Don't wait until the end of the semester, for it may then be too late to find a solution.
- You should not need to pay for any outside tutoring. The outside help that is provided with the courses should be adequate. If you need extra help, please see your instructor or T.A. during office hours. Should you still feel the need of a tutor, be aware that astronomy graduate students generally cannot tutor for money. The Learning Skills Center runs sessions on general study techniques and math review. Many of their services are free. Go to JES A332A or phone 471- 3614.

Note that our undergraduate courses are taught by faculty members who are professional astronomers. In addition to their obligations to you and other students in this and other courses, faculty members have responsibilities to their graduate students and to remain professionally competent through research. As a consequence, your instructor may occasionally be away conducting research or attending a scientific meeting. Usually another faculty member will conduct the class when the regular instructor is absent.

We expect, and usually find, honesty in our students. Your instructor will explain any special rules, such as the encouragement of genuine collaboration on assignments. However, submission of another's work or cheating on exams are grounds for failure in the course and reporting to the Dean of Students.

If you have any complaints or problems, please try to work out a solution with your instructor first. If you and your instructor cannot find an amicable solution, then please see either:

Milos Milosavljevic  
Chair, Astronomy Undergrad Studies Committee  
(Office: RLM 17.220, Phone: 471-3397)

or

Shardha Jogee  
Chair, Astronomy Department  
(Office: RLM 15.218, Phone: 471-3302)

If you are in crisis and need immediate assistance, please telephone the Office of the Dean of Students Emergency Staff: 512-471-5017. They can help you with a number of services, and may be able to contact your professors for you if you have an emergency that prevents you from attending class.

(<http://deanofstudents.utexas.edu/emergency/>)

For general questions about undergraduate courses, please consult Sandra Catlett in the Astronomy Student Office, RLM 15.204, [scatlett@astro.as.utexas.edu](mailto:scatlett@astro.as.utexas.edu). This office handles many student matters.

Students are encouraged to attend our free Astronomy events, such as Star Parties at the 9-inch telescope on the roof of Painter Hall or the 16-inch on the roof of RLM. More information is available through links from our class home page. You can also call our Skywatchers' Report at 471-5007.