AST 352K – STELLAR ASTRONOMY

FALL 2014, UNIQUE NO. 48590

Main course website: www.as.utexas.edu/astronomy/education/fall14/dinerstein/352k.html

Class meetings: Tu, Th 12:30-1:45 PM, in RLM 15.216B (the Astronomy Classroom)
Instructor: Prof. Harriet Dinerstein, 512-471-3449, harriet@astro.as.utexas.edu
Prof. Office Hours: M,W 2-3 PM in RLM 16.324 (subject to change)
Help Sessions (before exams and HW due dates): W 4-5 PM, RLM 13.132
Final Exam: **Tues., Dec. 16, 9 AM – 12** [some students may be excused from this; see below]

Teaching Assistants:

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COURSE LEVEL & CONTENT:

Astronomy 352K is an upper-division course on stellar astronomy that approaches the subject from the perspective of how we obtain and interpret astronomical measurements. It is designed for students majoring in astronomy or physics or similar fields such as engineering, although those in other science majors should be fine as long as they have the prerequisites (see below).

Stars are obviously fundamental to the field of astronomy: after all, the very name *means* "study of the stars." They are the ruling bodies of planetary systems, the building blocks of galaxies, and the nuclear ovens in which elements heavier than helium were created. We will approach the subject in the way professional astronomers do, by examining so-called "observable" properties of stars. These are characteristics that can be measured from great distances, through detailed analysis of the light they emit. By applying relevant physical principles, we will learn how to deduce temperatures, radii, luminosities, composition, masses, etc. of stars from such measurements. Appreciating the power and limitations of these methods is one of the main goals of this course, as well as understanding the properties and life histories of stars and their role in the universe at large.

PREREQUISITES & BACKGROUND:

The prerequisites are Physics 301 and 316 or the equivalent: two semesters of college-level, calculus-based physics. Previous astronomy courses are not required but may be helpful. Since astronomy draws on many specialized topics in physics which a student may not encounter until taking upper-division physics classes, we will introduce these as needed. The purpose of the prerequisite is to ensure familiarity with basic physical principles and practice in solving problems. Our main interest lies in *applying* physical principles rather than in carrying out derivations from scratch, and the math we will use will mostly be at the level of algebra, trigonometry, and simple calculus. We also love to make rough estimates of things – hence the term "astronomical accuracy" (which refers to knowing some quantity approximately, maybe only to an order of magnitude).

If you have not previously taken an introductory astronomy course, you may encounter a large number of unfamiliar terms. If this happens, please ask us for clarification! You may also wish to consult an (any) introductory astronomy textbook or (authoritative) web-based resource. Some recommendations for these will be provided by the instructor.

TEXT & RESOURCES:

The primary text for Ast 352K is a set of Course Notes developed collaboratively by Professors Harriet Dinerstein and Chris Sneden over many years. You will be able to download the notes by sections from the course website or Canvas. To comply with "fair use" policies and copyright laws, these notes are for your personal use ***only***; they may not be distributed (or sold!) to other parties. **Note:** The notes and other content-rich materials for the course will be password-protected.

There are few textbooks that provide a good match to the content of Ast 352K. Most books at the advanced undergraduate level are either heavily weighted towards theory or are primarily about observing methods, instruments, and detectors. An exception is Ostlie & Carroll's comprehensive book, "An Introduction to Modern Astrophysics" ("the big orange book"), as well as the smaller (blue or gray) volume entitled "An Introduction to Modern Stellar Astrophysics," which includes "only" half (!) the material in the orange book, Both include a lot of extra material that we will *not* cover, and are very expensive. However, if you plan to continue in astronomy, they are handy for reference, and you might find a bargain on a used copy. Copies of these and a few other useful books will be on reserve in the Physical-Math-Astronomy Library on the ground floor of RLM.

TOPICS:

The following is a list of topics I hope to cover in Ast 352K in Fall 2014: essentially an outline of the Course Notes. The order of some topics has been revised from Fall 2013 to improve coordination with the lab, Ast 152M, and the timeline for term papers (see below).

I. Introductory Remarks & Positional Astronomy (locating and tracking objects on the sky)
II. Properties of Electromagnetic Radiation (radiation quantities, blackbody radiation)
III. Photometry: Measuring Stellar Brightness (definitions, uses, photometric systems)
IV. Effects of the Earth's Atmosphere (image distortion & dimming, sky emissions)
V. Observational Tools and Techniques (more than just telescopes!)
VI. Spectroscopy and Stellar Spectra (spectral types, spectral lines)
VII. The Hertzsprung-Russell Diagram (the Rosetta Stone of astronomy, star clusters)
VIII. Interpreting Stellar Spectra (quantitative stellar spectroscopy, element abundances)
IX. Interpreting Nebular Spectra (emission lines, physical processes & conditions)
X. Stellar Motions and Orbits
XI. Binary Stars (the key to stellar masses)
XII. Stellar Life Histories (star formation, aging, modes & remnants of end stages)

COURSEWORK & GRADING BASIS:

The required coursework consists of three in-class hour exams, about 7 homeworks, and regular attendance and participation. I **do not give make-ups** for hour exams *for any reason, even a well justified one*. If you miss an exam, you can make up the credit in one of two ways. Option 1: the "all-exams" track. You take a comprehensive final exam at the official time, **Tues., Dec. 16, 9 AM**, to replace the missed exam; you can also take the final to try to improve your course grade (best 3 out of 4 exam scores count). Option 2: the "term paper plus exams" track. Instead of taking the optional final exam, you will research and write a substantive term paper on a topic approved by the instructor. The paper is due **Thurs., Nov. 13;** there will also be an opportunity to submit a revised paper after feedback for a potentially improved grade. You will choose between these options early in the semester, and your decision ***will be binding.***

Grading Basis: We will use the plus-minus (A^-, B^+, etc.) scale. The correspondence between scores and letter grades will be set after the first hour exam and will *not* be made tougher later on.

Hour Exams: 3 in-class exams, 25% each; total = 75% of the course grade
Tentative Exam Dates: **Oct. 2**, **Oct. 30**, **Dec. 4** (the last date is unlikely to change)
Format: Essays, numerical problems, & combinations. Calculators but not smartphones are to be used. Closed-book & notes, but a list of constants & equations will be provided.

Final Exam: For those who elect the "exams-only" track and must take the final in order to make up for an earlier missed exam – or just wish to try to improve their grade – the exam is (unfortunately) on **Tuesday, December 16, 9:00 AM – noon.** Please note that instructors have no control over the final exam time, and it will ***not*** be possible to take it early. Therefore, if there is any chance that you may need to take this exam, you should schedule your winter travel so that you will be available to take the exam. It will cover the entire semester's material, since it serves as the make-up for any of the earlier exams.

Term Paper: Research paper, on a topic related to the course material, 25%.
If you choose the "exams plus term paper" option, you will investigate, in depth and at a high level, a topic that interests you and is approved by the instructor as being sufficiently relevant to the course. The completed term paper is due **Thurs., Nov. 13.** You will also have the opportunity to make revisions following feedback from the instructor, which may improve your grade (however, this is not automatic). If you choose the term paper track, a series of shorter assignments with earlier deadlines: choice of topic, rough outline, a partial list of references used, etc.; *you must meet **all** of these deadlines in order to remain on the term paper track,* and they will count towards the term paper grade. The paper should be about 6 – 8 double-spaced pages (< 2000 words) plus figures, and be based at least partly on sources from the professional literature. More details will be provided later.

Homework: About 6 or 7 problem sets, (one) lowest score to be dropped = 15%
Due dates: Homeworks will usually be **due Thursdays at the beginning of class.** We will help sessions on Wed. afternoons as needed, and several office hours during Mon - Wed.

Participation: Regular attendance plus some group activities = 10%
Attendance will be taken via sign-in sheets. Missing an excessive number of classes will result in the loss of participation credit and the filing of an "absence/failing" report.

STELLAR ASTRONOMY LAB, AST 152M:

Simultaneously with Ast 352K, the Astronomy Department offers a 1-credit-hour laboratory course, Ast 152M. This lab class is optional, and typically has a smaller enrollment than 352K. While we will ("book") learn about observational methods in Ast 352K, if you want real, hands-on experience in taking and processing astronomical data, you should enroll in Ast 152M. You will use the 16-inch telescope on the roof of RLM with a CCD detector to take data and learn to analyze it with standard astronomical software packages such as IRAF. The lab has a separate syllabus, and all activities will be directed by Brian Mulligan, one of the T.A.s for Ast 352K. Students enrolled in or interested in adding Ast 152M should stay after Ast 352K is dismissed on Thurs., Aug. 28, at which time arrangements will be made for upcoming meetings of Ast 152M.

IMPORTANT DATES FOR FALL 2014: (some of these apply to any UT class)

First class meeting: **Thurs., Aug. 28**
Last day to add the class (end of free adds/drops period): **Tues., Sep. 2**
Last day to add any class, or to drop with a possible refund: **Fri., Sep. 12**
Last day to drop a class for academic reasons or to change grading basis between letter grade and credit/no-credit: **Tues., Nov. 4** (After this date, to drop the course you will need a dean-approved *non*-academic reason, or to use your limited student-selected Q-drops if eligible.)
Last class meeting: **Thurs., Dec. 4**
Final Comprehensive Exam: **Tues., Dec. 16, 9:00 AM – noon.** This exam will be required for some students, while other students will be exempt (if they chose the term paper track).

COURSE POLICIES, GOALS, & EXPECTATIONS:

Classroom Behavior: Class meetings are a communal activity: we expect that you will treat your classmates and instructor with consideration and courtesy at all times. **Please try to arrive on time** (yes, we know about the slow elevators in RLM) and sign in before taking your seat. **Turn off the volume on your phone** before class begins. I prefer that you avoid using laptops, tablets, and smartphones during class. Their displays are distracting to the people around you, as well as diverting your attention away from class. If you do wish to use such a device for class-related purposes, please sit in the back couple of rows. You must be using it for legitimate purposes, and *we will monitor usage.* Furthermore, I reserve the right to disallow such use if it becomes disruptive to the instructor or classmates (this judgment lies with the instructor). In addition, please do not talk to your neighbors during class unless it is part of a class activity. Personal conversations belong outside of class, and if you have a question or comment about what is being discussed in class, share it with everyone!

In-Class Activities: You are encouraged to bring a calculator to most classes, and will be allowed to use laptops etc., for in-class group activities involving calculations. (Usually only one member of the group will need a calculator.) These are essentially "practice" exercises to introduce you to new equations or problem-solving approaches. You should expect to find similar questions on future homework and exams; direct practice working problems is one of the most effective ways to learn.

Homework Goals: The homework is intended to make you engage with the course material and discover points that are unclear to you. Some homework questions may require you to seek out additional information, and others may have multiple correct approaches. Since I do not want to encourage rigid "packaging" of answers, I will *not* be posting solution sets for the homework.

Getting Help: If you are confused or stuck on the homework, we encourage you to attend the office hours provided each week by the instructor and T.A.s, or to attend the Wednesday help sessions. If none of these times work for you, please contact one of us to make an alternate appointment.

Academic Integrity: Many students like to work on assignments in groups. It is fine for you to discuss general ideas and problem solving strategies with other students, but also essential for you to work through the problems yourself. The paper you turn in must be your own work. Copying of detailed answers from other students will be treated as academic dishonesty and credit will be withheld for *both* (or all) parties involved. See additional discussion of academic integrity below, under General University Policies.

Lateness Policies: Homework in hard copy format (= on paper) will be collected at the beginning of class on Thursdays, but will be accepted up to 4:00 PM the same day *if delivered as hard copy to the T.A.s.* Papers that meet this schedule will be considered for full-credit grading (no late penalty). Homework turned in to the T.A.s by 4:00 PM the next day (Friday) will be accepted, but will have up to 20% of the credit deducted for lateness. These partial-credit homeworks may be submitted as pdf files via Canvas. No credit will be granted after 4:00 PM on the second day. Allowance has been made for emergencies, illness, or having a really bad week, by dropping one homework score.

Out of Class Communications: The University encourages the use of email as a primary form of communication for university business. Using Canvas, it is easy for a student to send email simultaneously to everyone registered in the class. I want to make it clear that I *do not approve* of use of this group email function that has not been approved in advance by the instructor or T.A. For example, I have seen students abuse this resource by using class email lists for personal purposes (taking surveys for another class, subletting an apartment, etc.). I also caution students to be wary of classmates who solicit or share study guides or homework solutions. Sharing homework solutions (or term paper materials) this way is a form of academic dishonesty. When reviewing for exams, you will benefit most if you prepare your own study guide or participate actively in a group effort.

ASTRONOMY DEPARTMENT INFORMATION:

If you have questions or problems regarding this class, please start by consulting the Instructor or Teaching Assistants in order to clarify and try to solve them. However, if this does not lead to resolution of the problems, you may consult the following people. All offices are in RLM.

Student Coordinator: Ms. Rachel Walker, 15.210, rachelw@astro.as.utexas.edu
Chair, Undergraduate Studies: Prof. Milos Milosavljevic, 17.220, milos@astro.as.utexas.edu
Department Chair: Prof. Dan Jaffe, 15.214, chair@astro.as.utexas.edu

Additional information can be found in the *Memo to Undergraduate Astronomy Students*, posted at http://www.as.utexas.edu/astronomy/education/memo.html .

The Astronomy Calendar lists all seminars and colloquia at http://www.as.utexas.edu/calendar . There are talks on a wide variety of topics several days a week by faculty, postdocs, students, and sometimes visitors (mainly Tuesday colloquia). Nearly all talks are held in the Astronomy Classroom and are open to everyone. While these are technical in nature, the further you progress in the semester, the more likely you are to find that you understand some of what you hear!

Finally, if you are not already aware of it, there is a very active undergraduate Astronomy Students Association (ASA) that offers many activities such as special talks, outreach activities, and **free pizza**! For more information, see www.as.utexas.edu/~asa/ or flyers posted in the hall.

GENERAL UNIVERSITY POLICIES AND RESOURCES:

Religious Holidays: It is the University's policy to make reasonable allowance for students who miss a class or assignment due to observance of religious holidays. If there are any holidays that will affect your attendance or participation this semester, please notify the professor no later than Tues., Sep. 2 (the end of the free add-drop period). In most cases, such absences will be covered by flexibility already built into the class policies.

Students with Disabilities: Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, ddce.utexas.edu/disability/. If you are certified for accommodations please bring this to the instructor's attention as soon as possible so that we can make the most convenient arrangements. We rely on SSD's proctoring services to provide extra time or alternative testing environments, and this requires advance notice of a few weeks.

Academic Integrity and the University Code of Conduct: Academic integrity is a fundamental principle for any educational institution, and is highly valued at The University of Texas at Austin. Students at our University are expected to maintain the highest standards of integrity in their scholastic work. The University's Honor Code states: "The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community."

Academic dishonesty may include: cheating, plagiarism, unauthorized collaboration, falsifying academic records, misrepresenting facts, multiple submissions (submitting the same paper for multiple classes without prior approval), and any other acts or attempted acts that violate the basic standards of academic integrity. The consequences of academic dishonesty can be severe. Grade-related penalties are routinely assessed, but students may also be suspended or even permanently expelled from the University for scholastic dishonesty. Other consequences may include establishment of a disciplinary record that can potentially impact future opportunities. Furthermore, scholastic dishonesty diminishes the overall value of scholastic achievements on this campus and reflect poorly on the University. For more details, see:

Office of the Dean of Students, Student Judicial Services: deanofstudents.utexas.edu/sjs/ ; see links to Academic Integrity, Standards of Conduct, the Honor Code, the Discipline Process.

Emergency Procedures: In the event of an evacuation, follow the instructions of your instructor or official personnel. Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Students requiring assistance in evacuation should inform their instructor in writing during the first week of class. Familiarize yourself with all exit doors of each classroom and building you may occupy and remember that the nearest exit door may not be the one you used when entering the building. Do not re-enter a building until given instructions by members of the Austin Fire Department, the University of Texas at Austin Police Department, or the Fire Prevention Services office.

Information regarding emergency evacuation routes and emergency procedures (including weather closures) can be found at: www.utexas.edu/emergency . For more information, contact the Office of Campus Safety and Security, 512-471-5767 or www.utexas.edu/safety/ .

Behavior Concerns Advice Line (BCAL): The Behavior Concerns Advice Line is a service that provides The University of Texas at Austin's faculty, students and staff with opportunities to discuss their concerns about another individual's behavior. This service is a partnership among the Office of the Dean of Students, the Counseling and Mental Health Center (CMHC), the Employee Assistance Program (EAP) and the University of Texas Police Department (UTPD). You may call 512-232-5050 or report online at www.utexas.edu/safety/bcal/ .