Astronomy 352K

STELLAR ASTRONOMY
Fall 2010 — Unique Number 47725

Meetings:

MWF 9–10, in RLM 15.216B

Instructor:

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TAs:

TBA
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Required Text:

An Introduction to Stellar Astrophysics
author: Francis LeBlanc
2010, Wiley, paperback edition

Grading:

Homework Sets: 40% of grade
Hour tests (3 of them): 40%
Independent topic report 20%
Final Exam: 0%
(last Hour Test probably will be during the final exam period)
Students with special needs may request appropriate accommodation;
call UT's office of Services for Students with Disabilities, 471-6259.

Subject Matter, Goals, and Miscellaneous Comments

What is it? To whom am I speaking? Astronomy 352K is a junior/senior-level introduction to stellar astronomy and astrophysics, with emphasis on observational and empirical methods for studying stars via the light they emit. It is designed with upper-division astronomy majors in mind, but it is also suitable for students majoring in closely related fields such as physics, mathematics, or engineering. See an additional remark in the textbook paragraph below.

Prerequisites? I expect you to have taken Physics 316 (Electricity & Magnetism) and its associated lab course Physics 116L, which have as their prerequisites Physics 301 (Mechanics) and 101L, and relevant math courses. It is acceptable to have taken instead the Engineering Physics courses 303K and 303L, with their lab courses. Astronomy draws on such a wide variety of areas in physics that we cannot expect you to have prior preparation in all of them, and so we will introduce physical ideas and laws as needed. (Examples include the theory of radiation, atomic structure, and statistical mechanics.) We will usually be interested mainly in *applying* physical principles, rather than in deep and lengthy derivations. In general the mathematical manipulations expected of you (*e.g.*, on homework sets) will be pretty straightforward.

Background? We do not assume that you have strong (indeed, any!) previous background in astronomy, although many of the students already will have taken other upper-division astronomy courses or at least had an introductory astronomy course such as AST 307 or 301. If you find that there are gaps in your basic astronomical knowledge, please ask me or the TA to explain or elaborate (either in class or during office hours). You might also find it helpful to consult one of the many fine introductory textbooks that are widely available (I can lend you one of them). It should take you only a few evenings to master all of the relevant material that is contained in these books.

Overlap with other courses? There is a small amount of overlap between AST 352K and AST 358 (Galaxies and the Universe), AST 353 (Astrophysics), and AST 352L (Positional, Kinematical, and Dynamical Astronomy). We will try to avoid excessive redundancy, but that is inevitable in some subject areas, since not all members of the present class will have taken these other courses.

Textbook? For the first time in my recent teaching of this course, we will have a textbook: Francis LeBlanc's *An Introduction to Stellar Astrophysics*. This book is so new that we have had struggles in getting copies. The University Co-op says that it will come in on August 28. Until then, the author and publisher have kindly given us access to pdf files of the first two chapters. I have put these files on the class web site in our password-restricted area. The book covers material appropriate to both this course and the AST 353 course that includes discussion of stellar interiors and nuclear energy generation. This is a nice single source for basic information about stars, and I like its presumption that many readers will have had no prior introduction to astronomy in any detail.

Class notes? I also am posting copies of my notes notes on the class web site. I have alternated teaching this course with Prof. Harriet Dinerstein, and between us we have pretty much settled on the topics and presentation order that we like. Harriet made a major upgrade in the class notes a few years ago, and the current version has a lot of her ideas in it.

Independent topic report? Students generally benefit from the experience of researching a specific topic in some depth. To accomplish this here, about mid semester you will divided into groups and asked to give a short group presentation on a topic that deals with some interesting aspect of stellar astronomy. The presentations will occur the last 2-3 class days of the semester. They will consist of an oral exposition of a poster or slide set on the subject that you have prepared for the occasion. Your grade will be determined from a combination of astronomical content, presentation style and overall effort. The members of the group will work together to decide how to divide up the larger topic into individual sections. Groups that work together well and give uniformly high-quality presentations will get "bonus" points added to their grade, giving students an incentive to help each other.

My bias in this course? I regard AST 352K as a vital link between the basic, often elegant physics and mathematics that you have ingested at UT for the past two-three years, and the real, often messy world of astronomical research. *Astrophysics* combines elements from all areas of physics to offer coherent theoretical models for how the solar system, galaxy, and universe are constructed and how they have and will evolve. If you are looking for that in this course, forget it. Theoretical astrophysics cannot really derive rational models for an object without appealing to *observational astronomy.* I am not an astrophysicist as the term is sometimes meant (that is, I am not a theorist). I am an observational astronomer, and proud of it. And observational astronomy is what you will find covered in this course. *Not* how is the universe constructed, but how does one practically assemble the basic data about particular astronomical objects (stars) that can be gainfully used in constructing the story of the universe?

So forget cookbook problems? Not entirely, but we will deal as much as possible with real data from the literature that have been obtained at various astronomical facilities over the past decades, and which now are readily available for study. Many of the homework problems will encourage you to seek data from basic astronomical catalogs. These sources can be found on web sites and in our Peridier Library, to which we intend to introduce you if you have not already seen it. *However, a serious word needs to be given here.* The Peridier Library is **NOT** part of the general UT library system, but is instead a part of the department and observatory research facility. It is available to help you by providing materials for this course. It is intended solely for the use of our faculty, staff, and research students. We invite you to begin integrating into our program with privileges to the Peridier Library. Please use this library moderately, quietly and with respect for others. Think of your use of the Peridier Library as a guest membership at a club, and please do not abuse it or overstay your welcome.

Homework, and your approach to it? The homework sets are the keys to what I want to get done in this course. I intend to be deliberately vague in some of the assignments. I admit that this is a sometimes maddening ploy. Real astronomical research usually does not admit cookbook solutions to interesting problems, and I want you to get used to that. Such an approach is also a signal on my part that I encourage interactions with you outside class. Feel free to discuss with me the course material, problem sets, or any other astronomical topic that come to mind. On the first page I give the formal office hours, but you of course may set up appointments with me at other rational times of day. Notice also that I give my work number, email address, and my home phone number. *I greatly prefer* contact in person or a phone call; emails to me can get deeply buried. I would not give out my home phone number if I did not expect calls in the evening whenever you need to. (It is true that we are the only Snedens in the Austin telephone directory.) I want to help you do well in this course, but I need *you* to make contact! Don't be shy: remember that the truly stupid question is the unasked one.

Caveat Emptor! Two warnings must be given, one applicable to all faculty members here and one specific to me. First, in this department you deal with professional astronomers. The good part is that you get very close to current research, and that can be very exciting. The bad part is that we tend to travel a lot (most obviously to observatories in remote and exotic locales), and I will need to excuse myself from class a couple of times during the semester. At present I have a trip for November 2–7 (missing class November 2 maybe & 4 definitely); one or two other trips that are unknown now might occur. A substitute lecturer will pinch-hit for me in class on those occasions. All class meetings will occur as scheduled. Second, I am currently Letters Editor of *The Astrophysical Journal.* This means that inevitably I am pulled in many different teaching/service/research directions simultaneously, and frankly I am very busy. However, this should not become your problem! I expect you to work in this class, and you should expect no less of me. Do not feel the slightest hesitation in pushing me to make time for you outside of class; politely in the beginning, but more firmly if I do not respond. Your interaction in this course can only aid your understanding.

Finally, a Carrot Instead of a Stick: I formally teach only one semester each year (because of my editing duties). In spring 2011 (an "off" semester) I will be offering a guided research position to an interested student who has successfully (A-B grade) completed AST 352K this semester. Usually the student will sign up for some course number that signifies independent study. Real investigation into the chemical composition of stars will occur! Some background buildup will be necessary, but then collaborative research can commence. A grade for that course will be the least interesting outcome, as successful work (often going beyond the spring semester) should lead to a published paper and/or attendance at a professional meeting.

Preliminary Course Outline (subject to revision)

1. Introduction and Vital Observational Statistics of Stars: positions, distances, magnitudes, etc.
2. The Basic Quantities of Radiation: intensity, flux, blackbodies
3. Interpreting Stellar Magnitudes: luminosity & effective temperature; stellar photometry & color indices; effects of the Earth's atmosphere
4. The Heart of Observational Stellar Physics: spectroscopy; stellar spectral types; excitation & ionization equilibria; the Hertzsprung-Russell diagram
5. Further Extractions from Spectroscopy: radial velocity & proper motion; interstellar extinction; binary stars & the measurement of stellar masses; the Mass-Luminosity relation
6. Variable Stars: Cepheids, RR Lyraes, Long-Period Variables; white dwarf pulsators; close binary systems (mass-exchange & contact binaries; cataclysmic variables; novae; etc.)
7. Star Clusters: young clusters/pre-MS evolution; Main Sequence turnoffs & cluster ages; globular clusters; etc.
8. (as time permits) Stellar Atmospheres: radiative transfer; basic principles of model atmospheres; spectral lines & abundance determinations.

Your First Assignment

Please read the first chapter of the text in enough "detail" to be able to come to class on the second day with questions. In particular, note carefully how this chapter matches (haphazardly) with the course material order of presentation in the notes.