Astronomy 123 – Stars and Stellar Structure
Swarthmore College
Spring 2009
Wednesdays, 1:15-4:15
Science Center 113
Prof. David Cohen

We have a very good and quantitative understanding of *stellar* astrophysics, especially compared to other branches of astronomy. Stars are the brightest and most ubiquitous cosmic source of light (even if we exclude the Sun). Stellar astronomy is the most mature subfield of astronomy, with a lot of different basic physics principles applied to its understanding. This understanding is based on stunningly accurate predictions and data-theory agreement (e.g. the Chandrasekhar limit for white dwarfs).

Stars are the engines for processing elements – nucleosynthesis – in the universe; they generate tremendous explosions and put out a prodigious amount of energy; they have a strong influence over the interstellar medium and the galaxies in which they reside. And stars are not static, they are born, live while continually losing mass, and die, with their deaths often triggering the formation of new stars.

The study of stars incorporates and combines a lot of interesting physics: gravity and radiation, atomic physics, nuclear physics, thermodynamics. We will take a quantitative, theoretical approach to understanding the nature of stars and the life cycle of stars. But we will also continually connect this understanding to observational data.

Texts:

Our main text will be *An Introduction to Modern Stellar Astrophysics* by Carroll & Ostlie, 2nd edition.

There will be supplemental texts on the honor reserve shelf in Cornell. These include:

- *The Physical Universe* by Shu (an introductory astro text, but at a pretty advanced level)
- *Principles of Stellar Evolution and Nucleosynthesis* by Clayton (quite advanced, mathematical, and complete text on the physics of the insides of stars)
- *Introduction to Stellar Astrophysics* (vols. 1, 2, 3) by Bohm-Vitense (graduate level, but relatively basic)
- *Allen's Astrophysical Quantities* by A. Cox (lots of data about stars; and theoretical results, trivia, etc.)

- *Introduction to Stellar Winds* by Lamers and Cassinelli

I will be adding other texts to the shelf as the semester progresses.

Topics, syllabus:

1. Introduction, radiation, and stellar properties – Ch. 3
2. Binary stars and stellar masses – Ch. 7; Marcy & Butler, 2000, PASP, 112, 137
3. Interiors and structure, pt. 1 – Ch. 10, secs. 1-3.
4. Interiors and structure, pt. 2 – Ch. 10, rest of chapter
5. Summary of interiors and stellar structure – three papers
6. Radiation transport, pt. I – Ch. 9, first half
7. Radiation transport, pt. II – Ch. 9, second half
8. The Sun – Ch. 11
9. Midterm
10. Star formation and angular momentum evolution – skim Ch. 12
11. Post-main-sequence stellar evolution – Ch. 13; Stancliffe et al. "Why do low-mass stars become red giants."
12. End states of stars – Ch. 15
13. Wind kinematics and phenomenology – Lamers & Cassinelli
14. Wind dynamics: coronal winds, radiation-driven winds – Lamers & Cassinelli plus another article (Owocki, from Ency. of A. & A.)

This is tentative, of course, at this point. We'll flesh out the reading assignments and the specifics of the topics as the weekly assignments are distributed.

Procedures and Policies:

Your grade will depend on your preparation and participation in class, as well as the midterm and final. Many of our assignments will include a list of comments and questions that you should look over before you do the reading, and in response to which you should jot down notes as you read. The purpose of these is to help you figure out what the most important points in the reading are and to prepare you for topics we're likely to discuss in our seminar meetings. You generally will *not* have to hand in your notes written in response to these questions and comments. (Though I may change this practice, depending on how our seminar discussions go.) There will be more standard, generally quantitative problems too. These will be numbered, and you will write up solutions to these problems by the *Monday before our Wednesday seminar* meeting. At the beginning of the semester, the assignments

will consist primarily of traditional, quantitative problems. The more free-form assignments will come later in the semester, with some exceptions.

I will look over your solutions, give you some feedback/comments, and hand them back to you by Tuesday afternoon. This way, you can refresh your memory, see what items you might need to brush up on before our seminar meeting the following Wednesday, and see if you've got any new questions you'd like to see addressed in seminar.

I will grade your solutions, but relatively leniently. You will get an A if you make a decent attempt to thoroughly answer each question and have the right answer or something close for most of them. But I do expect you to hand in work of the quality, neatness, and completeness that you'd demonstrate for a regular problem set. My goal here is to have a system that rewards you for doing a careful job of preparing, with the bulk of the work done well before we meet (so I can give you feedback and to keep you from doing all the work in the last minute, the night before seminar), and to encourage you to plan for our discussions in seminar (which will follow the comments and questions I mentioned above), not just focus on the algebra, etc. that's required to solve the problems. I will *not* be collecting assignments in the seminar or giving you post-seminar assignments. I don't really want students engrossed in copying down algebra/numbers from the board while we're going over problems in class. However, there will be motivation to make sure you can correctly solve all the problems on a given assignment by the time that week's seminar meeting is over, because similar problems will appear on our midterm and final. I will *not* be handing out my own solutions to the problems.

If your assignment is late, but handed in prior to seminar, you will get at most a B. Assignments handed in after seminar (begins) will get no points. These assignments will be worth 30% of your grade, with the midterm also being worth 30% and the final 40%.

If you are sick, have a family or personal emergency, or some similar situation, let me know as soon as possible if you think it will prevent you from getting the week's assignment done. We'll see what we can do, in that case, but it is imperative that you contact me as soon as possible and certainly before the assignment is due.