SYLLABUS: ASTRONOMY 8100

STELLAR STRUCTURE AND EVOLUTION

SPRING 2008

Prof. Paul J. Wiita

Timings: Mondays and Wednesdays, 10:30 AM – 12:10 PM

Room: Nominally NSC 272, but we should be shifting to 732 One Park Place

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Office Hours: Mondays 4:00 – 5:00 PM, Tuesdays 11:00 AM – noon, **by appointment.** I have an Astr 1020 class MW 5:30 to 6:45 but am usually available at other times; however, if my office door is closed I'm out or do not want to be disturbed.

Required Text: R. Kippenhahn & A. Weigert, **Stellar Structure and Evolution**

Supplementary texts: Martin Schwarzschild, **The Structure and Evolution of the Stars**; Stuart Shapiro & Saul Teukolsky, **Black Holes, White Dwarfs & Neutron Stars**

Other Useful Books: Chandrasekhar, S., **Stellar Structure**; Clayton, Donald D., **Principles of Stellar Evolution and Nucleosynthesis**

Course Objectives: We will study what makes stars work and change. To do so we will use many branches of physics: fluid mechanics, thermodynamics, electromagnetism and quantum mechanics are all necessary to understand stellar structure, and some aspects of nuclear physics and general relativity are also neeeded. However, all of this material will be introduced at a rather basic level and developed to the minimum extent necessary to obtain a fundamental understanding of the structure and evolution of stars. We will stress how mass, composition and angular momentum determine the basic features of stars and determine how they are born and die. While our understanding of stars is far more advanced than our understanding of galaxies and cosmology, there are many open questions, and we shall note some of these as we go along.

The main text by Kippenhahn and Weigert is quite nice, and rather comprehensive, despite being relatively thin. Its major drawback is a lack of problems. While Schwarzschild's book is not absolutely required, it is a classic which all astronomers should have in their libraries; it has the added attraction of being quite inexpensive. The lectures will not usually follow the main text, nor will we be able to cover all of the material in the text. You are expected to read the relevant portions of the text in conjunction with the lectures. Some specific readings of material that will not be covered in class will be given as parts of your assignments.

Note that this is a 4 Credit Hour course and combines what had previously been taught as two separate quarter courses on Stellar Structure (Astr 800) and Stellar Evolution (Astr 815). You should therefore expect to work somewhat harder in this course than you would in a 3 CH 8000-level Astronomy course.

Images of the overhead transparencies used in class will be posted to my web-site shortly after the relevant lecture. So don't worry about copying everything that appears on them; instead, concentrate on understanding the material and writing down what does not appear on the overheads.

TOPIC	$\approx$ **# of Lectures**
Review of Stellar Classification & Binary Stars	1
Review of Thermodynamics & Equations of State	2
Basic Equations and Numerical Techniques	2
Review of Hydrostatic Equilibrium & Polytropic Models	1
Nuclear Energy Generation	2
Energy Transport	2
Homology Relations and the Main Sequences	1
Pulsating Stars	1
Midterm Examination	**Feb 25th**
NO CLASSES, 3 & 5 March	SPRING BREAK
During qualifying exams — the week of 10 March — a class may be cancelled or postponed.	
Rotating Stars	1
Pre-Main Sequence Evolution	2
Main-Sequence Evolution & Hyashi tracks	2
Post-MS Evolution to Red Giants	2
Physics of White Dwarfs	1
Basic General Relativity	1
Dense Nuclear Matter	1
Neutron Stars and Pulsars	2
Student Reports; **Term Papers due, April 16th**	2
Black Holes	2
Take Home Final Exam Due	**Monday, April 28th, at 10:30 AM**

March 3rd is the last day to withdraw and still receive a grade of W.

Of course, **the above syllabus may be modified if necessary.**

GRADES will be based on performance on examinations, assignments, and projects.

The take-home comprehensive final will count for 30% of your grade, while the in-class midterm (closed book and closed-notes) will comprise 20% of it. Several assignments will together account for 30%.

A talk (if we have time) and a paper (definitely required, and due on April 16th) on a special topic will contribute the remaining 20%. Assuming no more than 8 people finally register (currently there are only 3, but I expect 4 or 5 more) there will be one $\sim$12 page observational paper (and, we hope, $\sim$20 minute talk) on each of the four following topics, and one theoretical paper (& talk) on most of them: 1) rotating stars; 2) pulsating starts; 3) the upper mass limit for main sequence stars; 4) the lower mass limit for the MS and brown dwarfs. If more than 8 people register, [an] additional topic(s) will be added. Class participation will be taken into (marginal) consideration. Note that the penultimate week of class has been reserved for these student presentations, but if we fall too far behind schedule we may have to shorten or even eliminate them.

Students are expected to understand and abide by the Policy on Academic Honesty. In particular, this means no collaboration on assignments is allowed with current or former students unless specifically authorized in a specific situation. Questions should be addressed to me in the first instance. Obviously, collaboration is never allowed on exams.