ASTROPHYSICS 440

Spring 2004 [class # **11528**] **Tentative Schedule** Dr. Däppen

Texts: **compulsory**: Prialnik *Stellar Structure and Evolution* (PR), Phillips *Physics of Stars, 2nd Edition* (PH), Schwarzschild *Structure and Evolution of Stars* (S); **optional**: Böhm-Vitense *Stellar Astrophysics: Vol. 2 stellar atmospheres* (BV)

Date	Topic	Reading
Jan. 13+15	Introduction and overview	PH 1.1; PR 1.1-4
20+22	Stars: elementary considerations	S II.5;PR 2.8;PH 1.2-3
27+29	Equilibrium in stars: hydrostatic	PR 2.1-5
Feb. 3+ 5	Equilibrium in stars: energy transport	PH 3.1-3;PR Ap.1;S II.6
Feb. 10+12	Properties of stellar matter: equation of state, thermodynamics	S II.8;PH 2.1-5; PR 3.1-3.6
	FIRST MIDTERM EXAM: THURSDAY, FEBRUARY 19, 4 p.m.	
17+19	Properties of stellar matter: opacity	PR 3.7;S II.9
24+26	Properties of stellar matter: nuclear reactions; convection	PR 5.5,6.5-6;4.1-7; S II.7;PH 4.1-2[1]
Mar. 2+ 4	Modeling techniques; polytropes, homology	PR 2.6-7;5.1-3;7.1-4; PH 5.1-2;S III.12
Mar. 9+11	Stellar evolution: pre- and main sequence	PR 8.1-2;PH 4.3
	Spring Recess: March 15-19	
Mar. 23+25	Stellar graveyard: white dwarfs, neutron stars, black holes; accretion	PR 5.4,8.8,9.4-6;PH 6.1-4
	SECOND MIDTERM EXAM: THURSDAY, APRIL 1 (no joke!!), 4 p.m.	
Mar. 30+4/1	Advanced stages; Supernovae	PR 4.8;7.5;8.4-7;8.9;9.1-3
Apr. 6+ 8	Stellar atmospheres	BV[2] 4;5;6;9; **make notes**
Apr. 13+15	Star formation; Stellar life cycle	PR 10.1-5
20+22	The Sun: neutrinos; helioseismology	PH 1.4;PH pages 123-127; PH 7.1-4;PR 8.3
Apr. 27+29	REVIEW; Practice Final Exam	

[1] with the exception of pages 123-127 (solar neutrinos), assigned for week of Apr. 20+22
[2] the BV reading is optional. the mandatory material is given in class.

FINAL EXAM: TUESDAY, MAY 4, 4:30-6:30 p.m.

Classes meet:	TTh 4-5:20, GFS 217
Office/Contact:	SHS 370, 740-1316, e-mail: `dappen@usc.edu`
Office hours:	Monday 11-12 (SHS 370), Tuesday 3-4 (SHS 370) *and by appointment* (arranged in person, by phone, or e-mail)
Departmental Office:	SGM 407, 740-1140

The scope of this course is an introduction to *stellar* astrophysics, that is essentially the theory of stellar structure and evolution. Basic knowledge from stellar astronomy (such as the observational origin of stellar parameters) is required. I will emphasize PHYSICS in astrophysics, showing how many branches of physics come together in our understanding of stars. We will see that a star is a relatively simple physical machine, for which a surprisingly large number of properties can be estimated even with limited effort. The most important mathematical and physical techniques of the theory of stellar structure and evolution will be presented. The theory of stellar structure and evolution is immensely successful, because it explains a large body of astronomical facts (e.g. distribution of stellar parameters; abundance of chemical elements) from a small, well defined set of assumptions. The theory of stellar structure and evolution is also immensely important, because it has led to a large number of fundamental discoveries in astrophysics (e.g. the distance determination in the universe, with applications such as Hubble's Law and therefore the idea of a Big Bang!).

Not surprisingly, there is a wealth of books on the subject. A sequence of classical books illustrates the path of progress of the field (among them: Emden, *Gaskugeln*, 1907; Eddington, *The internal constitution of stars*, 1926; Chandrasekhar, *An introduction to the study of stellar structure*, 1939; Schwarzschild (1958, one of our textbooks); Clayton, *Principles of stellar evolution and nucleosynthesis*, 1968). A typical modern textbook (slightly beyond the scope of this course...) is the one by Kippenhahn & Weigert, *Stellar structure and evolution* (1990).

In my opinion, Schwarzschild is still the most beautiful book on the subject, despite the fact that it was written before the computer revolution spawned a wealth of numerical results of stellar evolution. In no other text are the basic principles so clearly and economically explained. For our purposes, the progress made since 1958 is well covered in the textbook by Prialnik.

There will be **two mid-term examinations** and one **final exam**. The overall **course grade** will be based upon examinations and homework as follows: the mid-term exams are **each** worth 25% of the total score of the course, the final exam is worth 35% the total score of the course. The remaining 15% of the total score are for homework.

Broadly speaking, **grading** is done by the distribution **curve** of the combined scores of exams and homeworks. I use a grade distribution that is customary for this type of class in the Department of Physics and Astronomy. **There are no rigid percentage marks**. My grading policy also contains the following **two mitigating factors**: (1) occasional bad results, inconsistent with the overall record, are given less weight than their numerical score would imply; (2) overall improvement during the course of the semester is given consideration in the determination of the course grade.