Astron 400: Astrophysics I
Physics 903: Stellar Astrophysics

Fall 2016, David Kaplan

Syllabus

Course Description: First semester introductory astrophysics for students with junior-/senior-level background in mathematics and physics. Light and matter; stars and the sun; extrasolar planets; compact objects. Basic familiarity with quantum mechanics, thermodynamics, and differential equations is required. Some knowledge of astronomy phenomenology (e.g., Astron 103 or 211) is required. Topics covered include:

- Hydrostatic equilibrium, pressure support, gravitational collapse
- Virial theorem
- Nuclear fusion, energy generation in the Sun
- Radiation, interaction of radiation and matter
- Stellar evolution, on and off the main sequence
- Stellar remnants
- Explosions
- Star formation

Overarching Course Goal: Students will gain an understanding of the physical basis of modern astronomy, with application to stars and objects within our Galaxy.

Seminar Learning Objectives: The students who take this course will learn the underpinnings of modern astrophysics covering a wide range of areas. They will be able to quantitatively apply the physics knowledge that they are in the process of acquiring to a range of phenomena, pulling together pieces from disparate areas of physics.

Lectures: Tues/Thur 8:00am-9:15am (Kenwood 1130)

- Attendance and participation at lectures is required.

Lecturer: Prof. David Kaplan

- Office: KIRC 4075
- Office hours: Tues 10am-11am; Wed 10am-11am or by appointment
- Email: kaplan@uwm.edu
- Phone: 414-229-4971

Office Hours: All undergraduates are required to attend office hours at least twice per semester (once before and once after the midterm).

Course Website: http://www.gravity.phys.uwm.edu/~kaplan/astron400.html
Lecture notes, reading assignments, and problem sets will be posted there.

Course Textbook:

The Physics of Stars (second edition). by A. C. Phillips (Wiley; 1999)
ISBN 978-0471987987
$54.60

Evaluation:

- •Problem sets (weekly): 50%; grade will be best 10 of 11 problem sets
- •Midterm exam: 20%
- •Final exam: 30%

The mid-term will be an in-class, closed-book exam of 1 hour duration and the final exam will be a closed-book exam of 2 hours duration (only calculator allowed). For both, *formula/constant sheets will be provided.*

The final will be at 7:30am on Thursday, Dec. 22 (the official UWM final time for classes meeting at 8am on Tues/Thur).

Time Investment:

- Lectures: 3 hours/week
- Readings:
- Midterm exam preparation: 10 hours
- Final exam preparation: 15 hours
- Weekly problem set: 4 hours/week
- Reading and preparation for lectures: 1.5 hours/week

Assignments: Weekly assignments will be posted on the course website and handed out in class. Each assignment will consist of a number of single- or multiple-part problems that are homework (private study) exercises for you, the student. Students are encouraged to discuss the problem sets with each other but are not allowed to copy each other.

Graduate Component: Students registered for Physics 903 will have an extra numerical problem on each problem set. This is required for graduate students. The result will need to be emailed separate to kaplan@uwm.edu, with the email containing the source code (C, Matlab, or python) and the resulting plot(s). For undergraduates this problem will be extra credit.

Prerequisites: Physics 309(P), Physics 317 is preferred. Astron 103, 211 or permission of instructor.

Calculator: Please bring a simple scientific calculator to each lecture, discussion, and test. (N.B. You do **NOT** need a fancy and expensive programmable calculator such for basic calculations). You may use a calculator during tests, but note that you will lose a substantial number of points for clumsy and inaccurate work with a calculator (example: if you forget to switch your calculator from degree to radian mode when you should do so, expect a substantial loss of points; your answer(s) will be hopelessly inaccurate).

Makeups: Students will be able to turn in one problem set late, provided there is a reasonable excuse. The instructor must be notified in advance of the intent to not turn in the problem set, and it will be due before the class following the one in which it was originally due. Note that at least one assignment will be dropped for each student before final grades are calculated. Students who are not present during lecture for a quiz without prior permission will receive a 0 for that quiz; with prior permission that quiz will not be counted toward the average. Tests will be rearranged for

students who have conflicts with religious observance (see note 3, page 4 for official UW policy). No make up tests will be allowed except in cases of: illness resulting in hospitalization or an emergency/urgent care visit to a physician; family emergencies/bereavement; and verifiable traveling difficulties (such as snow emergencies). All such absences must be supported by appropriate documents. It is the responsibility of each student to attend the tests. Oversleeping, lapses of memory, and similar excuses will not be considered grounds for a make-up. If a student misses any test, including the final, for medical reasons, a physicians's note (clearly showing the signature and letterhead of the physician) must be produced before a make-up can be allowed or (if the final has been missed) an incomplete awarded. The note must state clearly that, in the physician's opinion, the student was not fit to take the test. A note stating only that a student visited (for example) the Norris Health Center is not sufficient. Notes from family members/relations are not acceptable; if the parent/family member is a physician, such notes could constitute a reportable breach of medical ethics.

University Policies: For information on university policies such as religious observances, incompletes, discriminatory conduct, and so forth, see: http://www.uwm.edu/Dept/SecU/SyllabusLinks.pdf

Detailed Syllabus (roughly 2 weeks per topic):

Topic	Contents
General Astrophysics	Big Bang Nucleosynthesis; Gravitational contraction; Basics of star formation; The Sun: astrophysical scales; Stellar life cycles
Matter & Radiation	Ideal gases; Electrons in stars; Photons in stars; the Saha equation and ionization equilibrium
Heat Transfer in Stars	Heat transfer by random motion; Heat transfer by convection; Cooling of White Dwarfs
Thermonuclear fusion	Physics of fusion; H burning; He burning; Advanced burning
Stellar Structure	Simple stellar models; Minimum and maximum masses for stars
Endpoints of Evolution	White Dwarfs; Core collapse; Neutron stars