Instructor: Prof. John F. C. Wardle  
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Office: Abelson 329

Class hours: M, W, Th 1:00 – 1:50 (block F)  
Classroom: to be determined.

Office hours: M, W, Th 11-12, or by appointment, or drop by – I am here nearly all the time. I expect you all to make use of my office hours. They are not just for people having difficulties with the course; they are for everyone interested in learning astrophysics.

Goals: the first goal is to give physics majors a taste of modern astrophysics, so that you can choose to participate in undergraduate research or eventually apply to graduate school in astrophysics. The second goal is to apply physical ideas learned in first and second year courses on a cosmic scale to explore the physics of stars and galaxies, and the mechanisms by which they emit the radiation we see.

Outcomes: students will understand the basic physical processes underlying the structure and evolution of objects in the universe, and how different objects emit radiation in all parts of the EM spectrum. Students will have sufficient preparation and background knowledge to carry out undergraduate research in the astrophysics group, including taking PHYS 99 (senior research) leading to an honors degree. Students will have enough understanding of basic astrophysical processes that they will be able to get the gist of many papers published in the Astrophysical Journal and other mainline journals.

Text: “Astrophysics Processes” by Hale Bradt (Cambridge University Press). This is by an x-ray astronomer from MIT. It is up to date and just the right level. We will work through nearly all of it, and use its problems.

Format: With a small class, we have the luxury of conducting it partly as a seminar. This requires that everyone participates. I expect you to attend every class and to have read the assigned reading beforehand.

Work: There will be weekly, relatively short problem sets, a midterm and a final exam. There will also be individual projects, where each student will research a different topic, write a paper and make a power-point presentation in class. Both the papers and the power-points will be posted on LATTE, and a small number of final exam questions may draw on those materials.

Evaluation: Your grade will be earned from the following components.
Weekly homework …………………30%
Midterm exam…………………………20%
Final exam (not cumulative)………..20%
Research paper and presentation ………20%
Overall participation………………10%
These percentages are approximate (+/- 5%).

Success in this 4 credit hour course is based on the expectation that students will spend a minimum of 9 hours of study time per week in preparation for class (readings, papers, discussion sections, preparation for exams, etc.).

Disabilities: If any student has a documented disability that requires accommodation, please see me immediately.

Collaboration and independent work: If you wish to collaborate on the homework problems, that is OK. But what you hand in MUST be your own work and reflect your own understanding of each problem. Homework should be typed, and it is HIGHLY RECOMMENDED that you use LaTeX. (If you do not know LaTeX, it is time to learn it and I can give you excellent introductory materials.) The research project must also be your own work, but you can certainly talk to me and other students about it (and there may be some overlap between topics).

Phys 108b – Introduction to Astrophysics ---- Syllabus

Chapter 1: Gravity and Orbits
1.3 – Kepler and Newton
1.4 – 2 body problem with M>>m
(1.5 – Generalization to arbitrary masses)
1.6 – Determining masses
1.7 – Exoplanets and the Galactic Center

Chapter 2: Equilibria in Stars and fundamental processes
2.2 – The Jeans’ length
2.3 – Hydrostatic equilibrium
(2.4 – Virial theorem)
(2.5 – Timescales)
2.6 – Nuclear burning
2.7 – Eddington luminosity

Chapter 3: Equations of state
3.2 – Maxwell-Boltzmann distribution
(3.3 – Phase space)
3.4 – Ideal gas
3.5 – Photon gas
3.6 – Degenerate electron gas

Chapter 4: Stellar structure and evolution
4.2 – The equations of stellar structure
4.4 – White dwarfs, neutron stars and black holes
Chapter 5: Thermal bremsstrahlung radiation
5.1 – Introduction
5.2 – Hot plasma
Summary of useful formulas

Chapter 6: Blackbody radiation
6.2 – Characteristics of the radiation
6.3 – Cosmological expansion

Chapter 7: Special relativity in astronomy
7.4 – Doppler shift
7.5 – Aberration
7.6 – Astrophysical jets
7.7 – Magnetic force and collisions

Chapter 8: Synchrotron radiation
8.1 – Introduction
8.2 – Celestial synchrotron radiation
Summary of useful formulas

Chapter 9: Compton scattering
9.2 – Normal Compton scattering
9.3 – Inverse Compton scattering

Chapter 12: Gravitational lensing
12.2 – Discovery
12.3 – Point-mass lens

You are expected to read the introductory section(s) of every chapter.

Items in parentheses will be covered only briefly. This is to make room for more examples and applications to real objects.

Those who have taken a class with me previously will know that I am easily drawn into long digressions. The list of topics above is not set in stone. Rather, it should be considered a list of good intentions.