

Astronomy 680: High Energy Astrophysics

Professor:

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PSC 1114

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Class web page: <http://www.astro.umd.edu/~miller/teaching/astr680>

Schedule:

Lectures on Tuesdays and Thursdays from 2:00 to 3:15, ATL 0201.

Textbooks:

None. We will use my online notes on the website.

Other references:

Gravitation, by Misner, Thorne, and Wheeler, is a good overview of the fundamentals of general relativity, and *Black Holes, White Dwarfs, and Neutron Stars* by Shapiro and Teukolsky is a fine introduction to the astrophysics of compact objects. Both are in the astronomy library.

...and let's not forget that the Web is vast! Wikipedia, for example, has a lot of good descriptions of concepts, and stackexchange often has useful discussions.

Course Grading

I will grade each problem (in the homework and in the exams) on a four-point scale. One point is awarded if you demonstrate understanding of the physical issues associated with the problem. One point is awarded if you use the correct equations (assuming equations are needed). Two points are awarded for correct solution of the equations.

If you come up with an answer that is obviously incorrect (e.g., a velocity 1000 times the speed of light!), but correctly say why it is incorrect and approximately what the right answer is, you will get one of those possible two points. On the other hand, if you get an obviously incorrect answer and say nothing about it, I'll take more points off; I want you to think about your answers. You have to commit one way or another: saying "I might be wrong" gets you nothing and could lead to subtraction of points if you were actually correct.

The midterm and final will both be in-class, and both will be closed-book and closed-notes.

Homework sets will be available on the class webpage, at least two weeks before the due date. Due dates will be Thursdays, typically two weeks apart (except for the week of the midterm). Homework will be due right at the beginning of class, because I want it to be possible for you absorb the content of that lecture instead of worrying about the problems! I will therefore enforce this policy strictly, and will take off points for, e.g., homework turned in at the end of class. I will do my best to return graded homeworks to you, with a solution set, by the next Tuesday. Starting with the second homework, there will be a computational problem per homework. You may use any language you want, and you will send me your code and any instructions needed to compile and run your code (for example, if you use Python you'll need to specify whether you use Python 2 or Python 3). I'm not going to install anything, so your code has to compile and run as is on the astro machines. If you

Table 1. Grade weights

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Homework	30%
Midterm Exam	25%
Final Exam	30%
Individual Project	10%
Class Participation	5%

send me your code enough in advance of the beginning of the class, I can give it a try to see whether it works (although I won't tell you whether you have the right answer).

The individual project will be a report on one current topic in high energy astrophysics. This will typically be represented by a single short paper in the literature, but it can be more extensive if you want. I'll want you to have selected the topic you'll discuss by the beginning of November, so that we can talk about it and make sure it's a good project. The report will be both a written report (4-5 pages in double-spaced 12pt format) and an oral report, which will be given in class at the end of the semester. For this project you will be graded on both content and presentation in the oral and written reports.

The "class participation" portion involves two components. For the first, I will require that you read the lecture notes for a given class before the class, and by midnight of the day before you need to send me (1) a topic from that lecture that you feel you understand, and (2) a topic from that lecture that you would like elaborated. This will allow me to customize the lectures to some degree. The second component of class participation involves both your questions to me and answers to my questions during class; I don't expect you to get the "right" answer every time (and indeed in many cases the question I pose will be open) but I do want you to try. As part of this, I will also typically have a group discussion during each class, in which I will ask you to form groups of 3-4 to discuss a question that I will pose. When you finish your discussions, I will ask you to report on your findings.

Letter Grades

I will guarantee that you will receive no worse than the following letter grades for a given percentage of the total available points: A- for 85% to 100% of the points; B- for 70% to 85% of the points; C- for 55% to 70% of the points, and D- for 40% to 55% of the points. I may grade on a curve if the class average is significantly lower than suggested by the table. There will be no extra credit.

Late Policy and Make-Up Policy

Partial credit for late homework assignments may be given if you give me a valid reason before the assignment is due. No credit will be given for homework turned in after the beginning of the class after the homework is due (i.e., after the beginning of class the Tuesday after a homework Thursday), because I will hand out solution sets then. If you cannot make the midterm or the final exam, then we can arrange a different time if you tell me at least a week before the exam (to be fair to other students, the alternate time should be before the scheduled time). For adjustments to homework

turn-in times please document your reason as much as you can; for the “major grading events” (i.e., exams) university policy dictates that you must document your valid reason.

Academic Integrity

This has never been a problem in graduate classes, but I need to have a syllabus item anyway. If you have any questions, please talk with me and/or look at the University page <http://www.studentconduct.umd.edu/>

Some general guidelines;

1. I encourage you to work together, but you need to write things up separately. Copied materials, from each other, from previous students, from websites, etc., are a violation of our honor code. If for some reason you feel that it is essential to quote a particular source (this might come up in your term project), put quotes around the quoted part and cite the source there. For example: “If you don’t make mistakes, you’re not working on hard enough problems. And that’s a mistake.” (Frank Wilczek) My general advice is to do as much as you can yourself before talking with others or looking up references; that maximizes your learning and won’t give you a reputation with others as a freeloader :)
2. If you work in group chats, feel free to discuss general approaches, but do not post detailed solutions or numerical answers to problems.
3. No bullying, please! Grad school is tough enough as it is. You’ll all do better if you cooperate constructively. Now, that doesn’t have to mean that you agree with each other all the time; a major part of the cooperative aspect of science is the push and pull of robust discussion to get to better answers. But this can be done in a fun and civil way.

Tentative Course Outline

August 30: Overview and administrative matters.

September 1–8: The interactions and detection of photons, particles, and gravitational waves.

September 13–22: General relativity.

September 15: First homework due.

September 27–October 6: Black holes.

September 29: Second homework due.

October 11: Gravitational lensing

October 13: Midterm.

October 18: Frontiers: observational signatures of strong gravity.

October 20: Third homework due.

October 20–25: Clusters of galaxies.

October 27: Frontiers: the Sunyaev-Zeldovich effect.

November 1–10: Neutron stars.

November 3: Fourth homework due.

November 15: Frontiers: measurements of neutron star masses and radii.

November 17: Fifth homework due.

November 17: Frontiers: ultra-high energy cosmic rays.

November 22: Frontiers: gamma-ray bursts.

November 24: Thanksgiving.

November 29: Binary sources of gravitational radiation.

December 1: The LIGO/Virgo detections.

December 1: Sixth homework due.

December 6-8: Presentation of projects.

December 17: Final exam, 10:30 AM-12:30 PM