Astronomy 712: Radiative Processes
Spring 2013

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Class Times:
GRS AS712: Mon, Tue: 9:30-11:00 (CAS 500, CAS 606)

Office Hours:
TBD

Textbooks:
Stellar Atmospheres and Radiative Transfer, Alex de Koter
Radiative Processes in Astrophysics, Rybicki & Lightman
Stellar Spectra (IDL exercises - A & B): Rob Rutten

Supplemental Reading: I reserve the right to supplement the reading/texts with other material including (but not limited to) refereed journal articles that make use of radiative processes.

Web site: I will have most of the course information available through the BU Blackboard site (http://blackboard.bu.edu). You will be able to log into the course site by logging into blackboard with your BU username and Kerberos password.

Course Description and Goals: Formally, Astronomy 712 covers the generation, propagation, and transfer of electromagnetic radiation. Spectral energy distributions, continuum radiation, spectral lines. Interaction of radiation with matter, transfer of radiation through astrophysical media. Thermal and nonthermal radiative processes. To completely cover all of that information in a semester is literally impossible. Therefore, I am going to teach this class more as a stellar atmospheres class but also make sure that there are strong ties to how these tools are used in other sub-fields. I will attempt to guide you through the foundations of radiative processes and give you some of the tools and resources necessary to learn the material on your own (in the future) should you need more than this course will cover. In addition, my goal is for us to engage in discussions and collaborative learning that I think will be beneficial to all of us (including me).

First Time Teaching: This is the first time I am teaching AS 712, the first time I have taught a core-level graduate class, and only the 2nd graduate course I have taught in my career. Therefore, I *too* will be learning a lot this semester and will be experimenting with both the style and the content of the course. Some of you may have heard (or experienced) about when I taught my last graduate class (AS 753) and worked everyone WAY too hard – I am really going to try my best to make the work more manageable this semester. I certainly encourage, value and

appreciate any feedback you feel comfortable giving me throughout the course (even if it is not of the positive variety). I also reserve the right to alter the syllabus throughout the semester (it will certainly happen).

Seminar (and other) Styles: My personal belief is that not much learning comes out of lecture-style classes and that doing problems and then discussing them is a much better way of getting the most out of the material. I don't think that classes should be the professor deriving math, and then the students doing problems and synthesizing – in fact, I think it should be exactly the opposite. Therefore, Mondays in AS 712 will be taught in a seminar style format where we will go over problems and content from the reading and I will help pull out important points and it will give you the opportunity to ask questions and build intuition. This format also requires that everyone do their homework beforehand and come prepared for discussion. A portion of your grade will be how well I think you have prepared for class (see below). On most Tuesdays (but not all) we will be in CAS 606 working on computer exercises that will apply some of the material we are learning in class and will give some of you more experience with programming.

Current Science/Astro-ph: Most of you already spend some amount of time every day looking through astro-ph. For those who don't, it's time to start (you can get a daily email, RSS feed, etc.). As new papers that are related to the class content appear throughout the semester, we will add them to our reading or spend some time in class discussing some of the new results. Since I sometimes miss articles, please be ready to alert me (and the rest of the class) to relevant papers.

Daily Order-of-Magnitude problems: We will start many classes with a 5-10 minute order-of-magnitude problem for you to solve both individually and/or in small groups. This is designed to help you hone your skills at thinking on your feet and assessing the validity of results and the feasibility of observations/experiments.

Homework: There will be $\sim$10 homework assignments that will be assigned/due roughly once per week. I will try to keep the assignments to a few problems that will focus on skills or concepts that are important/relevant to the material we are discussing at that time. Is is important that everyone do (or attempt) the homework before the Monday class. I will check everyone's progress each Monday - failure to do so will result in a significant penalty. However, the final homework assignment will be due later in the week (TBD) so that you can correct/finish problems after discussing them in class.

Late Policy: Homework will be not be accepted late. The main point of doing the assignments is to prepare you for class and give you a chance to delve more deeply into a specific topic.

Leading Discussion: Each student (including the auditors) will be responsible for leading discussion for one class during the semester. During his or her class, the "leader" will prepare handouts, write notes and think of questions and problems with which to present the class. I will also prepare my own notes for each class and will supplement the content provided by the student leader. I will be available to meet with each leader prior to the assigned week and will be the "leader" for the first week to give you all an example of what I expect. My hope is that by giving you ownership of your education, it will help contribute to more productive

discussions and more educative class time. Sign up for a time as soon as you wish.

Projects: Each student will be asked to write a short paper based on a project that he or she works on during the semester. I have a number of ideas for projects and will present them during the 3rd or 4th week of the semester. Even though I have a list of my own ideas for projects, I am open to students coming up with different/new suggestions - so start thinking. The projects should use real data (or theory) to explore some problem involving radiative processes. They can also explore areas that we did not have time to cover in class. The projects can be executed in teams of 2-3 people (or individually), but each enrolled student will be responsible for turning in his or her own write-up at the end of the semester. In addition, teams will give brief presentations on their projects in the last week of class. More details about the projects will be presented in February.

Important Dates:

- West in PA: 2/5 (Tuesday) - computer on your own
- West in AZ: 2/11, in 502 - computer on your own
- Meredith Danowski Oral Exam - 2/12, 9AM
- President's Day: 2/18 - no class
- Monday Schedule: 2/20 (Wednesday) - computer
- Midterm: 3/4 (Monday)
- Spring Break: 3/11-12 - no class
- West in HI: 4/2 (Tuesday) - Prof. Withers, 4/8 (Monday) - Prof. Opher
- Patriots Day: 4/15 - no class
- West in OR/WA: 4/16 - computer on your own
- Monday Schedule: 4/18 (Thursday)
- Last Day of Class: 4/30
- Projects Due: 5/2 (Thursday)
- Final Exam: 5/8, 9 AM-11 AM

Grading:
Homework: 15%
Computer assignments: 15%
Project: 15%
Discussion leading 5%
Participation/preparation: 10%
Midterm: 15%
Final: 25%

Course Outline

Week	Mon (Tues) Leader	Topic	Homework/Assignments	Reading
Week 1: 1/22	West	Introductions, syllabus and expectations	HW 1 (due 1/31)	No Reading
Week 2: 1/28, 1/29	West (Comp)	The Spectra of Stars	HW 2 (due 2/6)	dK: Ch. 1, 2
Week 3: 2/4, 2/5	Feldman (Comp)	Characterizing the Radiation Field	No Homework	dK: Ch. 3; R.L.: 1.1-1.3
Week 4: 2/11, 2/12	Comp (Meredith Orals)	No Topic	HW 3 (due 2/21)	No Reading
Week 5: 2/20 (Wed), 2/19	Comp (Theissen)	The Equation of Transfer	HW 4 (due 2/27)	dK: Ch. 4, R.L.: 1.4
Week 6: 2/25, 2/26	Valdez (Comp)	Radiation and Matter	Project Abs. (due 3/6)	dK: Ch 6
Week 7: 3/4, 3/5	Midterm (Comp)	Midterm	HW 5 (due 3/20)	TBA
Week 8: 3/18, 3/19	TBD (Comp)	Discrete Processes	HW 6 (due 3/28)	dK: Ch 7; R.L.: 10.3–10.5
Week 9: 3/25, 26	TBD (Keck)	Continuum Processes & Grey Atmospheres	HW 7 (due 4/3)	dK: Ch 8, 10
Week 10: 4/1, 4/2	TBD (Withers)	LTE & Planetary Atmospheres	HW 8 (due 4/10)	dK: Ch 11
Week 11: 4/8, 4/9	Opher (Young)	Spectral Lines	HW 9 (due 4/19)	dK: Ch 12; R.L.:10.6
Week 12: 4/18 (Thursday), 4/16	TBD (Comp)	Scattering & NLTE Mechanisms	HW 10 (due 4/25)	dK: 13, 14
Week 13: 4/22, 4/23	Morgan (TBD)	Bremsstrahlung, Synchrotron, Compton	No Homework	R.L.: 5, 6, 7
Week 14: 4/29, 4/30	Projects (Projects)	Project Presentations	No Homework	TBA