Ast9610: Fundamentals of Modern Astrophysics

Fall Term, 2012

Content: This course is an intensive introduction to modern astrophysics. It is expected that all entering Astronomy MSc students without an undergraduate degree in Astronomy will take this course in their first term of study. Topics include: astronomical terminology; spectra and radiative processes; stars, and stellar evolution; the Milky Way and external galaxies; the high-redshift universe and cosmology.

This course, or its equivalent, is a pre-requisite for all other astronomy graduate courses with the exception of Astronomy 9601 (Solar System and Planetary Astronomy) and Astronomy 9620 (Classical Electrodynamics).

Instructors: Prof. Els Peeters (first half), Prof. Pauline Barmby (second half)

Office: Physics & Astronomy Building, Room 206 (EP); 204 (PB)

Phone: (519) 661–2111 ext. 80973 (EP); 81557 (PB)

E-mail: `epeeters` / `pbarmby` [at] uwo [dot] ca

Office hours:

EP: Tue 2:00-3:00 or after class. I can also be reached during the week through e-mail for simple inquiries, or to make an appointment. I will try to reply to e-mails within two working days of reception.
PB: Wed 3:00-4:30, or drop by.

Course Goals:

- give students experience with applying physics to astrophysics
- develop students' problem-solving skills
- familiarize students with astronomical jargon and modes of research

Please see the separate document "Learning Outcomes for Astronomy 9610" for detailed expectations for each topic.

Time and Location: Tuesday and Friday 9:00–10:30 in PAB Room 22 (Tue) and Room 150 (Fri). Class time will be used for cooperative problem-solving and discussions. The course material will not be presented in lectures; students are expected to read the text in advance and come prepared for discussion.

Textbook: *Astrophysics for Physicists*, A.R. Choudhuri, 2010, Cambridge University Press. A copy of the text is on reserve in Taylor Library (call number QB461.C535x). However, as the quizzes and exam are open-book, students without their own copies will be at a disadvantage. Please see one of the instructors if this is a problem for you.

Website: `http://owl.uwo.ca`. Course notes, problem sets, and course marks will be distributed through the course site on Sakai OWL.

Evaluation: The grade assigned for this course will be based on:

- reading memos (best 10 of 12), 10%
- problem sets (best 4 of 5), 25%
- in-class quizzes (best 3 of 4), 25%
- final exam, 40%

The pass standard for this course is at least 60% overall on all course components and at least 50% on the weighted average of the in-class quizzes and final exam.

Reading Memos (RM): are to be submitted in the astronomy dropbox and are due on **Monday mornings at 10:00am.** Please write down the course number on your reading memo. The idea of a reading memo is to record your *initial* reactions to the text. These reading memos are intended to encourage students to keep up with the reading and inform the instructors on difficult portion of the text; an honest effort rather than detailed understanding is the criterion for full marks. We expect that the length of a reading memo is between 1 and 4 pages. Please see the section "Reading Memos" attached for detailed information on reading memos, instructions for composing reading memos and a guide to the grading scheme.

Problem Sets (PS): are to be submitted *in class* on **the due dates given in the schedule** on the following page. Please write down the course number on your submission. To help the TA grading the assignments avoid any conflict of interest, we ask that you identify your work with a numeric code that we will assign, rather than with your name or student number. Because only the best 4 of 5 problem sets are used to compute the final mark, late assignments will not be accepted. While you are encouraged to discuss your approaches to the assigned problems with your classmates, your solutions should represent your own original work. Please see the section "Problem Sets" attached for a guide to the grading scheme.

In-Class Quizzes (Q): are 80 min. tests scheduled approximately every third week. Because only the best 3 of 4 quizzes are used to compute the final mark, there are no make-ups for quizzes missed for any reason. The quizzes will be non-cumulative, with the material covered on each quiz given in the schedule. Use of the course textbook, supplementary material, and hand-written notes **only** will be permitted.

Final exam: The final exam covers all of the course material and will be scheduled for early in the December exam period. Use of the course textbook, supplementary material, and hand-written notes **only** will be permitted.

Scholastic Offences: Scholastic Offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:
`http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf`).

Astronomy 9610: Weekly Schedule, 2012

Week starting	Topic	Text sections* for RM and Q	Notes
Sep. 3	Welcome to A9610 & intro	Ch. 1	*Organizational info*
Sep. 10	radiative transfer	RM1: 2.1–2.4	
Sep. 17	energy transport, stellar structure	RM2: 2.5–2.7,3.1–3.3	Sep. 21: PS1 due
Sep. 24	stars	RM3: 3.5–3.6, SM[a]	
		Q1: Ch. 1, 2	Sep. 28: Q1
Oct. 1	nucleosynthesis & stellar evolution	RM4: 4.1–4.4, SM[b]	
Oct. 8	stellar evolution & remnants	RM5: 4.5, SM[c]	Oct. 9: PS2 due
Oct. 15	stellar remnants	RM6: 5.1–5.6	
		Q2: Ch. 3, 4, SM[a,b,c]	Oct. 16: Q2
Oct. 22	the Milky Way	RM7: 6.1–6.4	Oct. 26: PS3 due
Oct. 29	galaxies	RM8: 9.1–9.3	
		Q3: Ch 5, 6	Nov. 2: Q3
Nov. 5	active galaxies & large-scale structure	RM9: 9.4–9.6	
Nov. 12	intro to cosmology	RM10: 10.1–10.7	Nov. 16: PS4 due
Nov. 19	relativistic cosmology	RM11: 14.1–14.5	
		Q4: Ch 9,10	Nov. 23: Q4
Nov. 26	the early universe	RM12: 11.1–11.9	
Dec. 3	Catch-up/review		Dec. 3: PS5 due
Dec. 5	(or later) **Final Exam**		

* For details on sections covered, see Learning Goals & Outcomes

[a] Supplementary material on binary stars

[b] Supplementary material on star formation

[c] Supplementary material on stellar evolution

Changes to this schedule will be discussed in class and posted on Sakai OWL. The date of the final exam is subject to change based on consultation with class members.

Additional information: The following textbooks are available in Taylor Library (not on reserve) and may provide additional background. The first two are more general while the latter books cover more specific topics.

1. *An Introduction to Modern Astrophysics,*, 2nd ed., 2007, B.W. Carroll & D.A. Ostlie (QB461.C35x)
2. *Astrophysical Concepts*, 4th ed., 2006, M. Harwit (QB461.H37)
3. *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, 1989, D.G. Osterbrock (QB855.55.O88)
4. *The Physics & Chemistry of the Interstellar Medium*, 2010, A.G.G.M. Tielens (QB790.T54)
5. *The Physics of the Interstellar Medium*, 2010, J.E. Dyson & D.A. Williams (QB790.D97)

6. *Stellar Structure and Evolution*, 1990, R. Kippenhahn & A. Weigert (QB808.K57)
7. *Galactic Astronomy*, 1998, J. Binney & M. Merrifield (QB857.B522)
8. *Galaxies in the Universe*, 2000, L. Sparke & J. Gallagher (QB857.S63)
9. *Introduction to Cosmology*, 2003, B.S. Ryden (QB981.R93x)

Reading Memos

These instructions are taken from C.P. Price, U of Alaska Fairbanks.

The idea for Reading Memos seems to have originated with Taylor at MIT (Am. J. Phys., 60, 201-202, 1992). His goal was to ask students to serve as experts at the task of evaluating a textbook covering material that was new to them, and thereby to improve the text he was writing. In doing so, he discovered that the students self-reported that the process of composing Reading Memos according to his instructions also benefited their learning, and so he resolved to continue to use Reading Memos in all of his classes. Our goal for using Reading Memos is similar: to help us use class time more profitably. Rather than spending time regurgitating all of the topics discussed in the text, we can focus on those items which were not effectively explicated by the text.

Composing Reading Memos: The following instructions apply:

1. The only ironclad rule is that you can never revise. When you write something, it stays on the paper and is turned in. **NEVER** recopy or back-edit your memo - your remarks lose their value when they are no longer 'fresh'
2. Before beginning reading, set a pad of paper or several pieces of paper and a pencil to the side of the text, on the same side that you write.
3. When you begin, note the date and time, your name, the course number and the reading you will be doing (chapters, sections).
4. Note down difficulties as they appear, with the page number.
5. If you cannot figure out what is wrong, note that as well. If the point in question is later cleared up, **DON'T** revise or erase your previous note(s) - just add the second comment noting the resolution for you.
6. At the end of a section or chapter, summarize your general difficulties and list the questions which you would like to have resolved.
7. Your frame of mine in composing a Reading Memo should be 'If I don't understand something, it is the AUTHOR's fault.' However, keep in mind that your questions and comments should be present and intended constructively.

Rubric for Reading Memos: Grades for reading memos will be based on the rubric given below (taken from C.P. Price, U of Alaska Fairbanks) as follows. A reading memo is marked out of 2. Full marks are earned when the majority of criteria are to "full mastery" standard; half marks are earned when majority of criteria are to "developing mastery" standard and quarter marks are earned when it does not meet the half mark standard, but something is turned in.

Stage	Criteria/Standard	Not to expectations	Developing Mastery	Full Mastery
Set-up and preparation	date & time	Absent	Incomplete	Complete
	reading citation (chapter, sections)	Absent	Incomplete	Complete
Commentary	spontaneity	Revisions or strike-outs; insincere; unforthcoming	Somewhat guarded and hesitant about comments	Open and honest stream of consciousness
	comments	Irrelevant	Somewhat focused	On point; highly relevant
	Immediate questions or disconnects	Perfunctory or obfuscatory	Some thought applied	Thoughtfully and constructively posed
Summary of reading	Summary of outstanding issues	Absent	Incomplete or cursory	Clear summary in plain English
	Questions needing resolution	Absent; unnecessarily hostile; not constructive	Incomplete or cursory list; somewhat constructive	Questions are clearly posed and constructive

Problem Sets

These instructions are taken from C.P. Price, U of Alaska Fairbanks.

Grades for problem sets will be based on the rubric/comments given below as follows. A given problem is marked out of 10: 3 marks for setup, 4 marks for solution, and 3 marks for analysis of results. For each stage individually, full marks are earned when the majority of criteria are to "full mastery" standard; half marks are earned when majority of criteria are to "developing mastery" standard and one mark is earned when it does not meet the half mark standard, but something is turned in.

Stage	Criteria/Standard	Not to expectations	Developing Mastery	Full Mastery
Set-up and preparation	Explicit statement of problem[1]	Absent	Incomplete	Complete
	Problem interpretation, placement into context[2,7]	No discussion of problem context	Partial discussion of problem context	Thorough interpretation of problem, noting general area and specific points
"Solution"	Outline of attack[3]	No preview to solution	Partial preview of method to solution	Clear preview of method to solution
	Commented analysis[4]	Sloppy, sketchy development; no commentary on methods	Analysis is directed properly but not always correct; some comments on methods	Precise and correct analysis, with explicit notes on methods at each step
	Explicit citation for non-derived material (equations, methods) [5]	External material introduced *inter alia*	Partial citation of non-derived material	All non-derived materials are completely cited
Analysis of result[6,7]	Summary statement of result	No recapitulation of result	Partial summary of result	Complete summary of result in plain English
	Physical interpretation of result	No interpretation of result	Partial interpretation of result	Thorough interpretation of result in context
	Critical examination of result	No examination of result	Partial examination of result	Full critical examination of result

Comments:

1. The value of an explicit statement of the problem cannot be overstated! Not only does the student avoid doing the wrong problem, but the problem statement is the key part of the context of the answer. This can be copied and pasted.
2. Placing the problem into context can help motivate it, and promotes connections to other results.
3. One is always well-served by knowing what you are trying to do before you start doing it. Not only does it help guide your steps, it can help you pinpoint where you have run into difficulties.
4. Similarly, a running commentary during the analysis is also very illuminating, both to the student and to the grader.
5. If you use material which is not immediately recognizable (e.g. solution to the quadratic equation) or if you emily a result or a method which is also not immediately obvious, you must cite your source. Every time. Whether you found something in a book or using the internet, give the source, and cite it completely. Failure to do so could constitute plagiarism. It should be clear that a graph or a results counts for nothing if we don't know how it was made.

6. When you *finally* wrestle a problem into place, you want to be done with it immediately. Go take a break, but come back, because that answer is incomplete. You need to test and check it. It needs to be interpreted and to be critically examined. What does it tell us? Does it make physical sense? Is there a way of testing it - perhaps by taking a limiting case, or by making a comparison to another known result? Don't forget to finalize the documentation.
7. A few well chose sentences will be sufficient in providing an interpretation, discussion or analysis.

v2.0, 27 August 2012