AST 308
Galaxies & Cosmology
Fall 2011
Tu-Th 12:40-2:00 Room 1420 BPS

SOME MAJOR RESEARCH THEMES IN GALACTIC & EXTRAGALACTIC ASTRONOMY

- **Cosmology and dark energy.**
- **Nature of dark matter.**
- **Formation of structure.**
- **Evolution of galaxies.**
- **Production of the chemical elements.**

Instructor: Jack Baldwin
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Office Hours: Regular office hours are Mo 11-12, Th 2-3. Or catch me in my office whenever you can… I'm usually there from 9AM – 5 PM, except Wed 11:30-3:00.

Textbook: Carroll & Ostlie, *An Introduction to Modern Astrophysics, 2nd edition.*

Some Websites to bookmark:

Course website: www.pa.msu.edu/courses/ast308
Most lecture slides will be posted here, either just before or just after the lecture.

Some other important web sites (you can copy these links from course website)
ADS abstract service: http://adsabs.harvard.edu/abstract_service.html
ArXiv astro-ph eprint archive: http://xxx.lanl.gov/form/astro-ph?MULTI=form+interface
SIMBAD database: http://simbad.u-strasbg.fr/simbad
NED database: http://nedwww.ipac.caltech.edu/index.html
HST Digitized Sky Survey: http://archive.stsci.edu/cgi-bin/dss_form
Ned Wright's Javascript Cosmology Calculator: http://www.astro.ucla.edu/~wright/CosmoCalc.html

Grading:
Homework: 20% 2 midterms: 25% each Final: 30%

The final is over the whole course, but it will be strongly weighted to the material after Midterm 2. It will be on Tuesday, Dec 13 at 12:45PM.

AST308 COURSE OUTLINE

Subject to change at any moment

- Numbers in square brackets [25.1], etc. refer to sections in Carroll & Ostlie, 2nd ed., which you are always responsible for reading.
- *Italicized* topics are mostly add-ons not covered in the textbook. I'll hand out notes.

Week	Topic
Sept 1	**Course Introduction: The Big Picture** Curtis-Shapley debate, Hubble classification [25.1]
Mon Sept 7	**Labor Day**
Sept 6,8	**The Milky Way Galaxy** MW Morphology (history/dust/components) [24.1, 24.2]. Skip the star counts equations. *Measuring chemical abundances in stars. Stellar populations and chemical enrichment*
Sept 13,15	*Measuring chemical abundances in ionized gas. Star-forming regions; the Orion Nebula.* Kinematics, Galactic distance scale (but not dark matter) [24.3] **SKIP [24.4]**
Sept 20,22	**The Nature of Galaxies** Spiral & Irr galaxies; rotation curves ➔ dark matter; Tully-Fisher Relation [25.2] Spiral structure, density waves [25.3]
Sept 27,29	E galaxies; types, triaxial structures & orbits; Faber-Jackson; Fundamental plane [25.4] *Distribution of galaxy types, Schecter luminosity function, L* galaxies.*
Tu Oct 4	**Midterm 1**
Oct 6	**Cosmology** [27.1] The extragalactic distance scale [27.2] The Expansion of the Universe [29.1] Newtonian Cosmology [29.2] The Cosmic Microwave Background
Oct 11,13	[17] General Relativity and Black Holes
Oct 18,20	[29.3] Relativistic Cosmology
Oct 25,27	[29.4] Observational Cosmology
Nov 1	[30.1] The very early universe and inflation
Thu Nov 3	**Midterm 2**
Week 11: Nov 8,10	**The Structure of the Universe & Evolution of Galaxies** [27.3] Clusters of galaxies [28.4] Using quasars to probe the universe (gravitational lenses) *What is dark matter?*
Nov 15,17	[30.2] The origin of structure; WMAP measurements.
Nov 22	[26.1] Interaction of galaxies
Thu Nov 24	**Thanksgiving Holiday**
Nov 29, Dec 1	[26.2] The formation of galaxies
Dec 6,8	Quasars & Active galactic Nuclei (AGN) [28.2] Unified model of AGN … *(Skip [28.1], [28.3])* [18.2] Accretion Disk description pp. 661-666 [24.4] The Galactic Center
Tu Dec 13	**Final Exam 12:45-2:45PM**

AST 308 Prerequisites:

AST 208 and PHY 215 (thermo) *and* (PHY 321=class. mech. or concurrently).
Meaning you should also have taken:

AST 207
PHY 183 or similar mechanics course; *and*
PHY 184 or similar E&M course; *and*
Math 132+133+234 or similar calculus + line & surface integrals sequence.

➔ Things I Think You Already Know:

Entries in [square brackets] indicate chapters/sections in the Carroll & Ostlie textbook.

Physics

- Classical mechanics at the level of Newton's laws, energy and angular momentum conservation, and basic problem solving using them.
- Light [3]
  - $E=h\nu= hc/\lambda$
  - $F=L/(4\pi r^2)$
  - Black body radiation [CO 3.4,3.5]
- Basic idea of Special Relativity [CO 4]
  - [CO 4.3] is a useful catalogue of some S.R. effects that are relevant in astronomy.
- Bohr model of the atom [CO 5.3]
  - What atomic energy levels are.

Math

- Calculus, able to solve simple differential equations as used in physics problems.

Astronomy

- Apparent and absolute magnitude scales [3.2]
- What UBV photometry is
- Basic idea of the Hertzprung-Russell diagram
  - Something about age-dating clusters using H-R diagram
- Stellar spectral types OBAFGKM

Thumb through CO chapters [3], [4], [5] and make sure that it all looks familiar. If not, take the time to read it carefully.

Senior Thesis

- 2 options
  - Review paper to satisfy capstone writing requirement, based on reading many scientific papers.
  - Or… research project, plus paper about it to satisfy capstone writing requirement.
- Most students should *NOT* undertake a research project.
  - Concentrating on getting better grades will help you more.
- Doing a research project requires you to find a professor who can supervise you.
- To do either type of senior thesis this year:
  - Prof. Smith must sign off on topic/supervisor choice. *TALK TO HIM NOW!*

www.pa.msu.edu/astro

AST OBSERVATIONAL FACULTY
Baldwin: H II regions; QSOs.
Donahue: Clusters of galaxies
Loh: Instrumentation; cosmology
Smith: Variable stars, MW structure
Zepf: Galaxy formation; globular clusters.

AST THEORY FACULTY
Brown: SN explosions, compact objects.
O'Shea: Star & galaxy formation.
Voit: Galaxy clusters; cosmology.

NSF POSTDOCS
Heather Jacobsen (2173 BPS): stellar pops.
Nick Sterling: emission line regions

PHYSICS FACULTY
Linneman: γ ray, cosmic ray observations
Schatz: Nuclear astro.

Getting into Grad School

- Grad school does not *have* to immediately follow your B.S. degree.
  - Going off and working for a while is sometimes a good idea.
- You should receive full financial support, if they actually want you.
  - Think twice before taking out that 5th student loan.
- Many grad schools start evaluating applications in January, despite having later deadlines.
- You usually can *NOT* start in January, or at least get any funding at that point.

- Get advice early, from at least two astro profs.
- Bring your transcript.

- Admissions committees consider:
  - Overall GPA
  - GPA in upper division Physics & Astro courses.
  - GRE scores
  - GRE Physics subject exam
  - Letters of recommendation
  - Research experience

- You can take these more than once and use the highest score.
- So take them early, just in case.

- What does it take to get admitted (my best guess):
  - To get into a top-10 astronomy program:
    - 4.0 GPA or close
    - Strong GRE scores
    - Great letters
  - To squeak into a reputable PhD program
    - 3.2 GPA
    - No more than 1-2 grades below 3.0 in upper division Physics & Astro courses.
    - GRE
      - Verbal: 60th %tile is pretty average.
      - Math: most applicants have at least 75-80th %tile.
      - Physics subject exam: at least in 500's; 600+ much better

Probably will get you admitted to 1 program, if you apply to 6 of top-10. But also apply to a couple of fallback schools.

Apply to a wide range of schools (6 or more).

Random Info: Spring semester

AST 860
Gravitational Astro.
Prof. Loh

GLG 440
Planetary Geology
Prof.Velbel