AST 308
Galaxies & Cosmology
Fall 2009
MWF 3:00–3:50, Room 287 Chem

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 1-2. 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 Monday, Dec 14 at 3PM.

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 2 Sept 4	**Course Introduction: The Big Picture** Curtis-Shapley debate, Hubble classification [25.1]
Mon Sept 7	**Labor Day**
 Sept 9 Sept 11	**The Milky Way Galaxy** MW Morphology (history/dust/components) [24.1, 24.2] *Stellar populations and chemical enrichment*
Sept 14 Sept 16 Sept 18	*Star-forming regions; the Orion Nebula* Kinematics, Oort's constants (but not dark matter) [24.3] (Dr. Smith) Galactic distance scale. [24.3] **SKIP [24.4]**
 Sept 21 Sept 23 Sept 25	**The Nature of Galaxies** Spiral & Irr galaxies; rotation curves ➔ dark matter; Tully-Fisher Relation [25.2] Spiral structure, density waves [25.3] Spiral structure, density waves [25.3]
Sept 28 Sept 30	E galaxies; types, triaxial structures & orbits; Faber-Jackson; Fundamental plane [25.4] *Distribution of galaxy types, Schecter luminosity function, L* galaxies.*
Fri Oct 2	**Midterm 1**
 Oct 5,7,9	**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 12,14,16	[17] General Relativity and Black Holes
Oct 19,21,23	[29.3] Relativistic Cosmology
Oct 26,28,30	[29.4] Observational Cosmology
Nov 2,4	[30.1] The very early universe and inflation
Fri Nov 6	**Midterm 2**
Week 11: Nov 9,11,13	**The Structure of the Universe & Evolution of Galaxies** [27.3] Clusters of galaxies [28.4] Using quasars to probe the universe (grav. lenses) *What is dark matter?*
Nov 16,18,20	[30.2] The origin of structure; WMAP measurements.
Nov 23,25	[26.1] Interaction of galaxies
Fri Nov 27	**Thanksgiving Holiday**
Nov 30, Dec 2,4	[26.2] The formation of galaxies
Dec 7,9,11	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
Mon Dec 14	**Final Exam 3–5PM**

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:

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.

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

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

- 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!*

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.

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

- 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.

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

- 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).