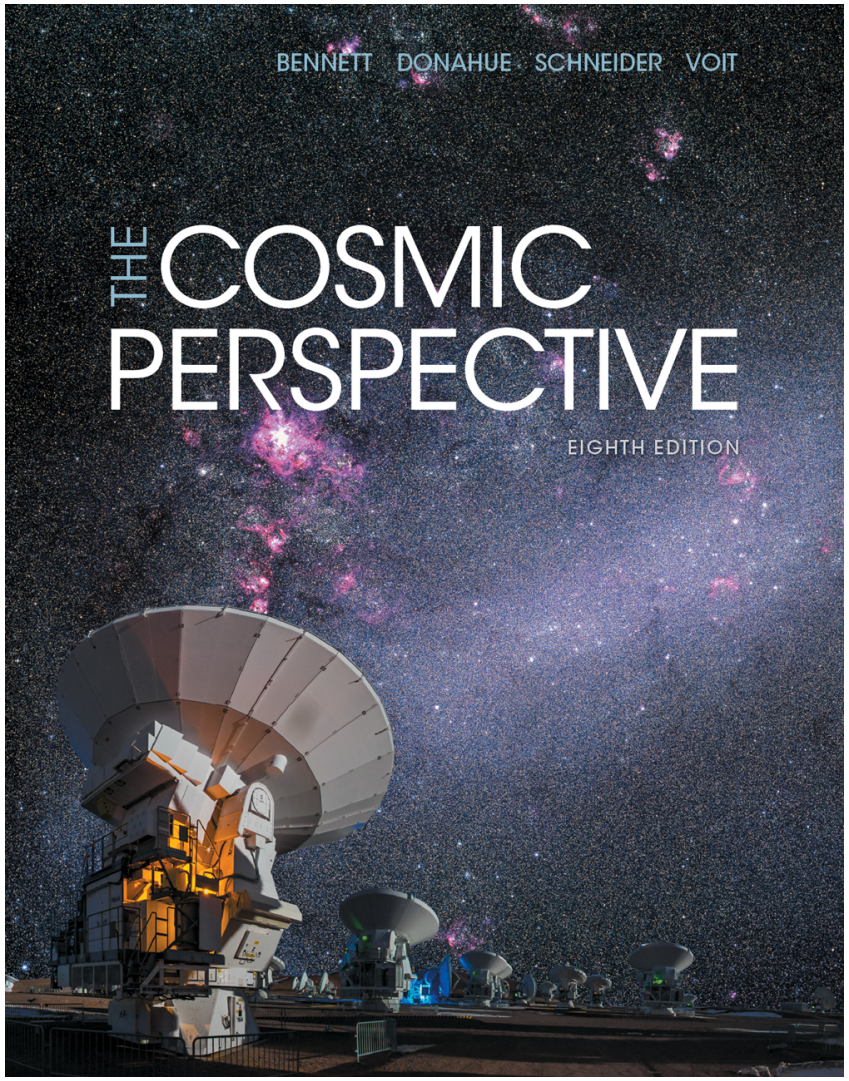
[01] Overview and ASTR120 Review (1/25/18)

ASTR121 Upcoming Items

1. For next class:
   a) Read the syllabus.
   b) Read the learning goals.
   c) Read Ch. 15.1.
2. Discussion tomorrow (Friday) in this room.
3. Lab introduction Monday in ATL 0224.



Can't get enough astronomy? Join AstroTerps!

astroterps
University of Maryland Astronomy Club

- Telescope viewing.
- Light pollution activism.
- Maryland Day.
- Free pizza!
- Etc.

Presidents: Chris Bambic, Junellie Gonzalez Quiles

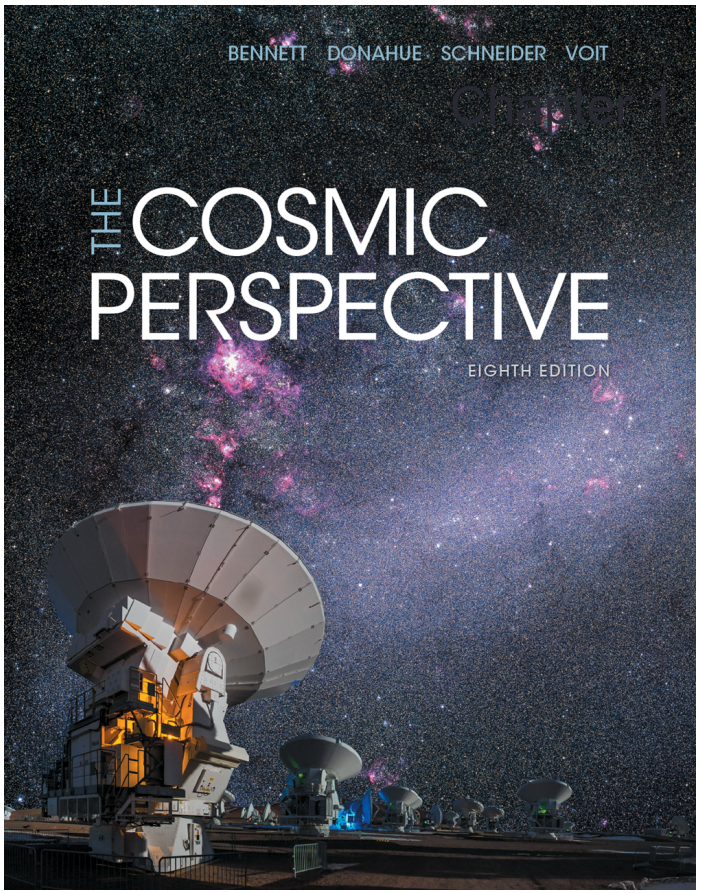
http://www.astro.umd.edu/~astroterp/

LEARNING GOALS

Ch. 1, 5.4, 14.1–14.2

For this class, you should be able to…

- … describe in general terms your place in the universe and your motion within it;
- … Understand some of the themes that we will encounter in this course



Astronomy 121—ASTR121

Professor	Dr. Cole Miller
Office	PSC 1114
Phone	301-405-1037
E-mail	miller@astro.umd.edu (or use ELMS)
Office Hours	M 10–11 am, W 2–3 pm, and by appointment
Lectures	TuTh 11 am–12:15 pm ATL 2428
Discussion	F 1–1:50 pm ATL 2428
Labs	M 11 am–1 pm (sec 0102: Joe DeMartini), M 2–4 pm (sec 0101: Mike Greklek-Mckeon): ATL 0224
Textbook	Cosmic Perspective 8e w/Modified MasteringAstronomy
Online Materials	https://myelms.umd.edu/courses/1236439
Teaching Assistant	Weizhe Liu: office hour Thu 9:45-10:45
Lab TA office hours	Joe: Wed 10:30-11:30; Mike: Tue 2-3

Syllabus Changes

1. Info on labs.
2. Other minor items. Please read everything!

Computer Labs this Semester

- TAs: Joe DeMartini (Monday 11-1) and Mike Greklek-Mckeon (Monday 2-4)
- Meetings in ATL 0224
- Intent is to (1) give you experience in measurement and analysis of uncertainties, (2) provide hands-on context for some typical measurements, (3) allow you the opportunity to think about assumptions in analysis, (4) give you practice in scientific writing.
- Regarding (4): communication is essential in science. If you can't communicate clearly and concisely, you are at a major disadvantage.
- Lab reports will be graded in part on basics (grammar!), clarity, and succinctness. Very important!

The Benefit of Working Together

- As you learned in ASTR 120, I will present you with challenging homeworks and concepts
  Look at homeworks early! Don't wait until the last minute...
- From what I can tell, many of you did an excellent job of working in groups and talking with the tutors
- Please continue! Discussions with others are extremely useful.
  In fact, teaching a topic to others is usually considered the best way to learn that topic.
  Of course, you need to write your solutions independently!
- In particular, it seems that many of you did an excellent job of supporting each other constructively
- Please continue that as well ☺
- Also, if you have not worked together with others, or if you know of students who have not, please join or encourage others to join
- Astronomy is a cooperative exercise; good to start now!

Carrot and Stick for Checking Results

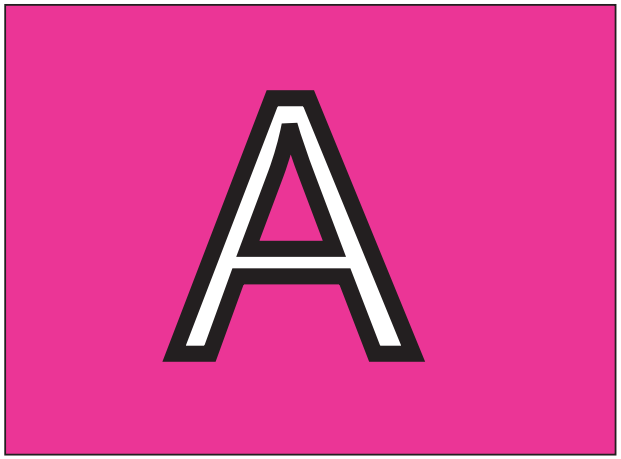
- Suppose you get an answer that is obviously wrong (a speed ten times the speed of light, a length in kilograms, etc.)
- If you notice this, say so, and say approximately what the right answer should be, you'll get substantial partial credit
- If you do *not* notice this, extra points will be taken off
- Why? I want you to develop physical intuition
- Note that checks of results (units, limits, symmetries) take much less time than the original work, and they give you insight as well
- You must commit one way or the other! Saying "I might be wrong" gets you no points, and might subtract points if your answer was actually correct

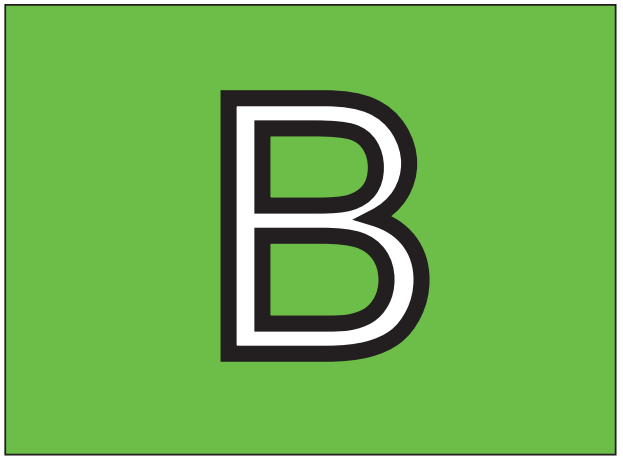
Any astro questions?

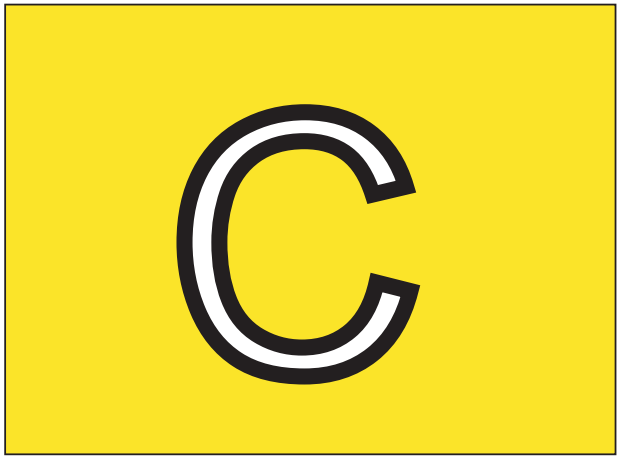
Overview and ASTR120 Review

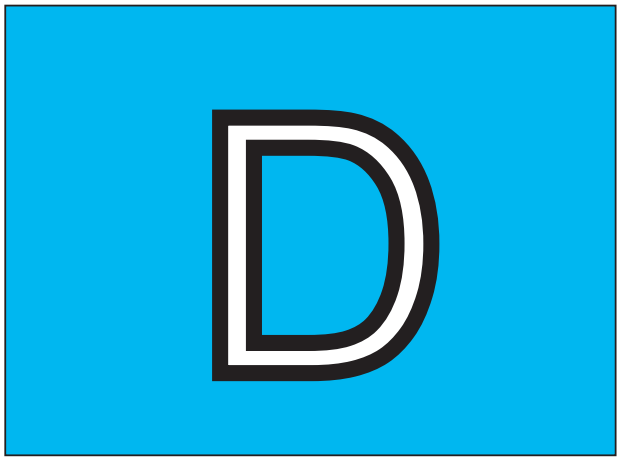
- Last semester we covered the basic tools of Astronomy.
- We discussed our solar system (and the Sun) in detail.
- We also discussed exoplanet systems.
- This semester we turn to everything else in the universe!
  - Ch. 15–18: Stars & Stellar Remnants. Midterm #1.
  - Ch. S2 & S3: Special & General Relativity.
  - Ch. 19–21: The Milky Way & Other Galaxies. Midterm #2.
  - Ch. 22 & 23: The Big Bang & the Fate of the Universe. Final Exam.
- Be sure to review Ch. 1 (cosmic motions), 5.4 (learning from light), and 14.1–14.2 (solar structure).
- Practice with units, limits, & dimensional analysis.

Voting Cards









Group Question: Gravity versus ???

- A unifying theme in astronomy is that systems can often be characterized as gravity versus everything else. In this group question, I will ask you to suggest the primary thing that opposes gravity in each case:
- Planets and galaxies
- Stars and gas giants
- Terrestrials and small bodies
- White dwarfs and neutron stars
- Black holes

Group Question: Gravity versus ???

- A unifying theme in astronomy is that systems can often be characterized as gravity versus everything else. In this group question, I will ask you to suggest the primary thing that opposes gravity in each case:
- Planets and galaxies Orbital motion
- Stars and gas giants Gas/radiation pressure gradient
- Terrestrials and small bodies Material strength
- White dwarfs and neutron stars Degeneracy press. grad.
- Black holes Nothing!

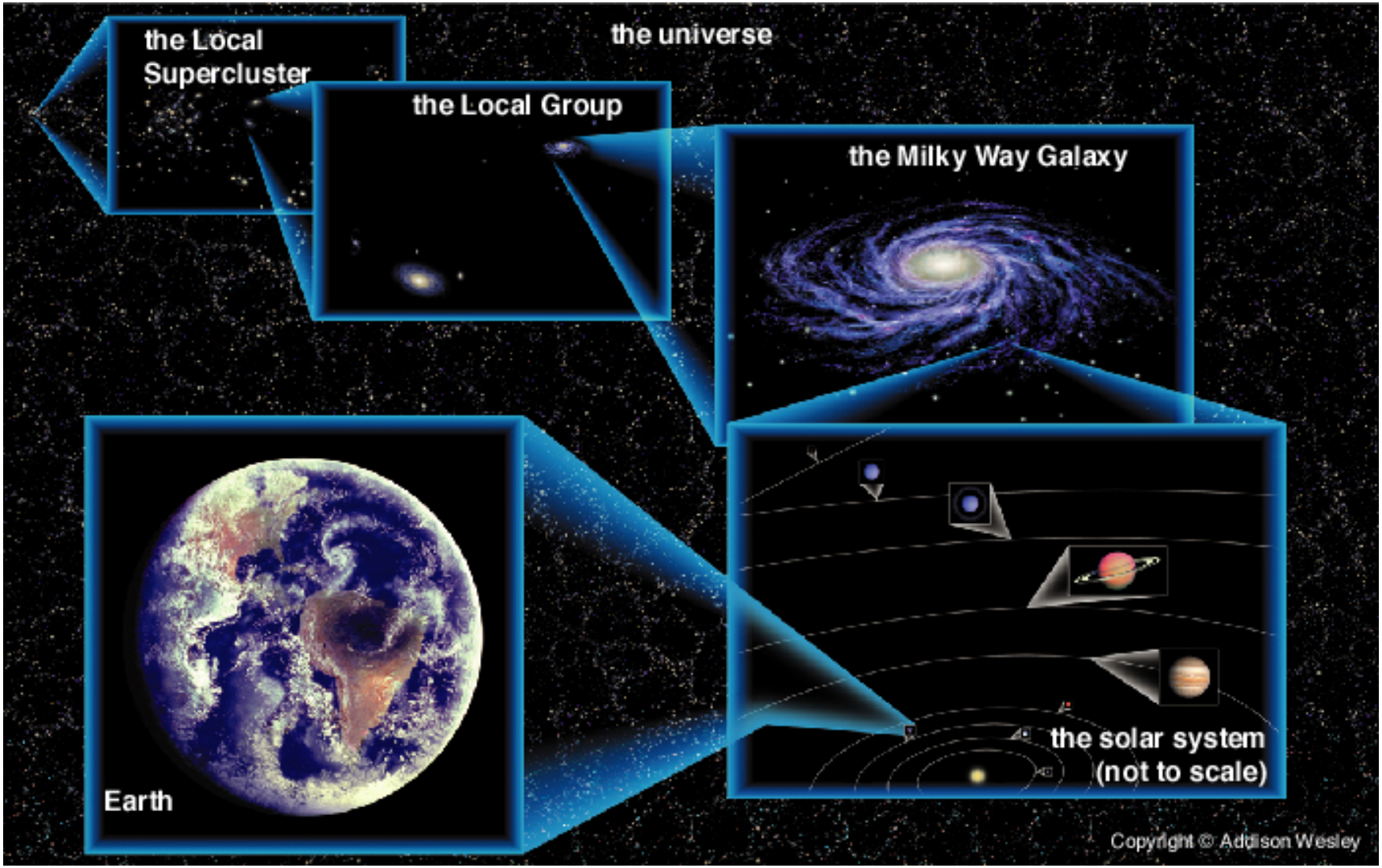
WHAT LIES BEYOND THE SOLAR SYSTEM?

Stars & Gas

The Milky Way


Other Galaxies

Our "Cosmic Address"



Universe

- The sum total of all matter and energy; that is, everything within and between all galaxies.

SURVIVAL SKILLS

Units & Dimensional Analysis Revisited

General Problem-solving Strategy

- See Mathematical Insight 1.1 in the textbook.

1. Understand the problem.
   - What will the solution look like (big? small? units?).
   - What information is needed to solve the problem (data? formulas?).
   - Consider drawing a diagram or otherwise simplifying the problem.
2. Solve the problem.
   - Carry out the necessary calculations.
3. Explain your result.
   - Does the answer make sense?
   - What did you learn by solving the problem?

Units

- Units are your friend. They can easily tell you if you've made a mistake or not.
  - If a question asks for a length, your answer better not be in years!
- Units can be used to check if a formula is correct or not.
  - E.g., consider $E = mc^2$. Do the units make sense?

$$[mc^2] = [\mathrm{M}]\frac{[\mathrm{L}^2]}{[\mathrm{T}^2]} = [\mathrm{M}]\frac{[\mathrm{L}]}{[\mathrm{T}^2]}[\mathrm{L}] = [\text{force}][\mathrm{L}] = [\text{energy}].$$

- Sometimes units can give you extra insight.
  - E.g., the units of pressure are force per unit area.
  - Notice this is the same thing as energy per unit volume!
  - So the strength of a rock, measured in Pascals, can be cast as an amount of energy required to disrupt the rock, given its volume.

Dimensional Analysis

- Often you can deduce the form of an equation just by considering the units.
- E.g., what is the force exerted on you by the wind?
  - What should it depend on?
    - Speed of the wind (faster = more force): v (units [L]/[T]).
    - Density of air (denser = more mass = more force): ρ ([M]/[vol] = [M]/[L^3]).
    - Your cross-section (bigger = more area = more force): A ([area] = [L^2]).
  - How can these quantities be combined into a force?
    - Units of force = Newtons = [mass][acceleration] = [M][L]/[T^2].
    - Notice ρv^2 has units of force/area (pressure).
    - So multiply by A to get force:

$$F = \rho v^2 A.$$

Testing Limits

- Does our expression for wind force make sense?
- The force is greater if…
  - …density is greater. ✓
  - …speed is greater. ✓
  - …cross-section is greater. ✓
- In the limit that, e.g., wind speed → zero, force → zero. ✓
- It turns out the correct formula (for "wind load") is

$$F = \tfrac{1}{2}\rho v^2 A C_d \ (C_d = \text{drag coefficient}).$$

- Close enough for Astronomy! ☺

How big is the (observable) universe?

- The Milky Way is one of ~100 billion galaxies.
- 10^{11} stars/galaxy × 10^{11} galaxies = 10^{22} stars!

As many stars as grains of (dry) sand on *all* Earth's beaches…

How can we know what the universe was like in the past?

- Light travels at a finite speed ($c \cong 300{,}000$ km/s).

Destination	Light travel time
Moon	1 second
Sun	8 minutes
Sirius	8 years
Andromeda Galaxy	2.5 million years

- Thus we see objects the way they were in the past:

The farther away we look in distance,

the further back we look in time.