Announcements

- **Third Midterm Exam:** The third midterm exam will be taken in class this Thursday, November 29. It is similar in form to the first two midterm exams; more information about the exam can be found in the handout, “Third Midterm Exam Guide” (given out last week in class and available at the course website). Please bring a ParSCORE FORM No. F-289-PAR-L scantron form to the exam (same form as for the last two exams).

- **Reading Quiz due tonight!** The Reading Quiz for Week 13 (“Week13_quiz”) is due tonight, Tuesday, November 27, by 11:55 PM.

- **Reminder: Extra question & answer session Wednesday evening.** On Wednesday November 28 (the evening before the 3rd midterm), an extra help session will be held in Rm. 216 of the physics-astronomy building (i.e., the regular classroom for the 11 AM class) from 7:00 – 8:30 PM. Come armed with all questions that have cropped up during your studying!

- **Final exam in two weeks.** As stated in the course syllabus (i.e., p. 5 in your Reader), the final examination in this course will occur on Tuesday, December 11, and will take place at the following times and locations:
  
  **Section 9 (11 AM class):** Tuesday, December 11, 10:30 AM → 12:30 PM,  
  Room PA 216 (normal lecture room).

  **Section 5 (2 PM class):** Tuesday, December 11, 1:00 PM → 3:00 PM,  
  Room NE 60 (normal lecture room).

Details about the nature of the final exam will be given next week, but do note the following:

1. The final exam must be taken at the scheduled time, and no makeup (or early) exams will be given.
2. *The final examination is cumulative*, and will cover the entire course’s content with equal emphasis.
3. As with the midterm exams, you will again be permitted to bring an official “cheat sheet” to the final exam.

Reading Guide and Homework Assignment
(Week #14 On-Line Reading Quiz Due: Tuesday, December 4, 11:55 PM)

Note: This is the final reading assignment of the course, and covers all of the material to be presented in the final two weeks of class. Since it goes beyond what we shall cover this week alone, the full reading assignment is formally not due until the last day of class, next Thursday, Dec. 6. I am giving you the full remainder of the readings now, though, since I want you to know what you will be responsible for on the final exam well in advance. It is strongly advised that you complete this reading by the last day of class, since your final exam in here comes only two weeks from today. So, onto the readings:

Here we finally tackle the really BIG questions, and they concern our study of cosmology: Did the Universe have a beginning? Will it come to an end? What is it doing right now? These readings present to you the scientific answers to these questions. Note that I am having you (again) read some sections slightly out of order in the text, since it better reflects the way the material was presented in lecture; you may, of course, read the text in any order that you like – just be sure to read it! (Note that none of this reading assignment covers material contained on your third midterm exam.)

1. **Text — Chapter 16, Section 16.4: The Center of the Galaxy.**

   Here you take a somewhat more detailed journey to the center of the Milky Way galaxy than was presented in class, and read about all of the evidence that a “supermassive” black hole exists in the
very center of the Milky Way. Pay particular attention to the fact that it is the orbits of stars very close to the center that provides the main “proof” for the existence of a black hole in the galaxy’s center, and recall our class discussion on this subject.

2. **Text — Chapter 18, Section 18.3.1: Observational Evidence for Black Holes.**

Read here about the evidence for supermassive black holes lurking at the centers of nearly all galaxies, not just the Milky Way! And especially, note again that the main evidence comes from studying the orbital properties (i.e., Newton’s version of Kepler’s Third Law strikes again) of stuff (stars, gas, dust, etc.) located very close to the centers of these other galaxies.

3. **Text — Chapter 17, Sections 17.4.1 and 17.4.2: The Extragalactic Distance Scale: Variable Stars and Standard Bulbs.**

These sections continue the discussion of how distances are measured in the universe by recapping the use of Cepheid variable stars, and then moving on to discuss the use of Type Ia supernovae as standard candles (or ‘bulbs’). Type Ia supernovae have turned out to be astronomers’ most precise distance indicator at very large distances – distances well beyond where Cepheid variable stars can be used.

4. **Text — Chapter 17, Section 17.5: The Expanding Universe.**

Read here about how the observations of Hubble, Humason, and Slipher led to Hubble’s discovery of the expanding universe. Really make sure that you understand just how Hubble’s original velocity-distance relationship, as shown in Figure 17.18, leads naturally to the conclusion that our Universe has been expanding since a primeval explosion occurred at a specific point in time in the past.

5. On-line tutorial: On the “Week14_tutorial” section of the textbook website, look at the Active Figure called “Hubble”, and the Astronomy Exercise called “Hubble Relation”. Spend some time reading/working through this active figure and astronomy exercise to gain a good understanding of the Hubble Law.

6. **Text — Chapter 19, Section 19.3.1: The Cosmological Principle.**

Read this brief section on the cosmological principle: the assumption that, on large scales, the universe at any given time is the same everywhere; that is, it is isotropic and homogeneous.

7. **Course Reader — Pages 154 – 165: The Expanding Universe and Measuring the Expected Deceleration.**

We conclude our reading for the course with excerpts from the final pages of the popular astronomy textbook by Jay Pasachoff and Alex Filippenko, The Cosmos: Astronomy in the New Millennium. This text gives an excellent presentation of the latest results in cosmology, and is somewhat more up-to-date than our course textbook. The first part, from p. 154 – 159, is essentially a recap of material presented by your textbook, and read earlier in this assignment. The very last section, from p. 162 – 165, concerns the ultimate fate of our Universe, and is essentially what will be covered by the final lecture in the course, on Thursday, December 6.

8. On-line tutorial: On the “Week14_tutorial” section of the textbook website, look at the Active Figure called “Raisin Bread”. As discussed in class, this is the image to have in mind when you think about the expanding universe.

9. **On-line reading quiz (Due: 11:55 PM, Tuesday, December 4): Take this week’s reading quiz by clicking on the “Week14_quiz” assignment at the on-line textbook web-site.** The Reading Quiz will become available to you at 12:05 AM, Wednesday, November 28. **It consists of only *1* question,** which is an essay of a rather philosophical nature. You will receive full credit (i.e., 100%) for any answer that you give, but you must take the quiz to get your 100%! **You must complete this on-line quiz by 11:55 PM Tuesday, December 4.** You need only take the quiz one time, as you are guaranteed a 100% the first time!