AST 301-Scalo
Review sheet for exam #6

This exam covers the following material:
Ch. 22.5 – 22.8 on black holes (don't worry about "More Precisely 22-2)
Ch. 23 (the whole chapter except the historical discussion of "Discovery 23-1 and the last section, and except Sec. 23.7, The Galactic Center)
Ch. 24 (the whole chapter—try reading More Precisely 24-1, but I won't test you directly on that material). Notice that 24.4, 24.5 will be covered on the exam but not in lectures.
Ch. 25 (the whole chapter). Sec. 25.4 will be covered on the exam whether or not we cover it in lectures.

The one anomaly about this exam is that I am leaving it up to you to read the sections of the text on activity at the centers of galaxies, active galactic nuclei, quasars,… which we did not cover in lecture. These are sections 24.4 (Active Galactic Nuclei), and 24.5 (The Central Engine…), and 25.4 (Black Holes and Active Galaxies). I expect you to read these, but because we didn't discuss them in class, there will only be about five questions on these topics on the exam. I am leaving them out of lectures so we can make a straight path from mapping our galaxy, then the local universe, and finally the largest scales of the universe. This leads directly into the final part of the course, cosmology.

Notice that there are a few basic themes running through all this material:
1. Learning to get distances to more and more distant objects so that we can map the structure of our own Galaxy and the large-scale structure of the universe. In our Galaxy the use of these "standard candles" allows us to see the disk-halo structure and the presence of spiral arms; RR Lyrae variables give us the globular clusters in the halo and the resulting information about the evolution of our galaxy, Cepheid variables the distances to the nearest galaxies, then supernovae, the Tully-Fisher relation, and the Hubble relation to learn about the large-scale universe. The Hubble relation is especially important, since it tells us something very important about the history of the universe and allows us to map the most distant galaxies. Try to explain how each of these standard candles is used and what we learn from it—that would be a good way to review much of this material.

2. Several lines of evidence that most of the matter in the universe is of an unknown form, called "dark matter." You should be able to explain in simple words what this evidence is—generally it is all the same kind of evidence (except for using gravitational lensing—see the amazing "dark matter map" on p. 689), but using different objects.

3. Looking back in time by observing very distant galaxies to learn something about how they have evolved. How are galaxies at large redshifts (means very distant—review the Hubble relation if this is not clear to you!) different from nearby galaxies? This is the crucial clue about how the Hubble sequence of galaxy types (ellipticals, spirals, irregulars) are related. Notice the emphasis on starburst galaxies, and galaxy collisions.

4. The central regions of galaxies have very peculiar properties. Be able to explain what these different types of objects are (active galactic nuclei, radio galaxies, quasars), and what process might provide a unified account for their properties. How do they fit in with the "normal" galaxies.

I thought the questions at the end of each chapter were nearly all very good for review. I have included some of the multiple choice questions (and also questions from the textbook web site questions) on the exam.

Here are a few sample questions (over):

1. For an object falling into a black hole, which of the following would be seen by a distant observer?
a. The object would get brighter the closer it got to the black hole.
b. Time would speed up as it got closer to the black hole.
c. Light emitted by the object would increasingly redshift as it got closer to the black hole.
d. The object would begin to flicker, giving a method for estimating the size of the event horizon.

2. The best evidence for supermassive black holes in the centers of galaxies is
a. the absence of stars there
b. rapid gas and star motions and intense energy emission
c. gravitational redshift of radiation emitted from near the center.
d. unidentified visible and X-ray spectral lines.

3. What two observations of objects allow for a determination of the Milky Way's mass?
a) mass and velocity. b) age and distance from the galactic center.
c) mass and age. d) velocity and distance from the galactic center.

4. Which of the following gives an estimate of the age of our Galaxy?
a. Cepheid variables b. globular clusters c. spiral arms d. observations of hydrogen gas

5. If there were NO dark matter, we would expect that, far from the center, the rotation curves of galaxies should
a. increase with increasing distance from the center.
b. decrease with increasing distance from the center.
c. remain constant with distance from the center. d. vary greatly from galaxy to galaxy.
e. look very similar to the light curves.

6. Using the Hubble relation, what single observation is needed of a galaxy in order to determine its distance?
a) luminosity b) line broadening c) mass d) spectrum

7. Evidence for a large population of hydrogen gas clouds throughout the universe comes from
a. Sensitive surveys of neutral hydrogen HI 21 cm line emission.

b. Quasar “mirages” due to gravitational lensing
c. The Sloan Digital Sky Survey, which has obtained spectra for millions of galaxies.
d. The “forest” of hydrogen absorption lines seen at different redshifts in the spectra of quasars.

8. It is believed that active galaxies are very luminous because they

a. are hot b. emit jets c. are undergoing starbursts d. contain supermassive black holes