AST 301—Fall 2007, Scalo
Review sheet for exam #6

This exam covers Chapter 22, and parts of Chapters 23, and 24.

Ch. 22--Study it all, except: Don't worry about "More Precisely" 22-2.

Remember: there will be a question on the current results from the gravitational wave detection "telescope" LIGO: You are supposed to search around for the present status of this project. Has a claim for detection of gravitational waves been made using this instrument? Has it been retracted? What stage of completion is it in? What kinds of objects might be sources of detectable gravitational waves?

Ch. 23: Omit: The historical discussion of "Discovery 23-1; Sec. 23.5 Galactic Spiral Arms; and Sec. 23.7, The Galactic Center) . DO read 23.6, The Mass of the Milky Way Galaxy.

The 2 most important things: How you can get distances for distant objects using variable stars (get used to the idea of "standard candles", which is just another way of saying that you are getting the distance to something by knowing (somehow—that's the hard part) its luminosity; 2. How estimates of the mass of our Milky Way led to the realization that there is "dark matter." The most important technical idea is that the rotation velocities give you the mass—this is because, unlike a star where pressure balances gravity, in disk galaxies rotation balances gravity. So the rotation of a galaxy at a certain distance from the center is related to the total gravitating mass inside of this distance. This is the "rotation curve."

Ch. 24: Try reading More Precisely 24-1, but I won't test you directly on that material.

Omit sections 24.4 (Active Galactic Nuclei), and 24.5 (The Central Engine of an Active Galaxy).

The major emphasis is on sec. 24.2, 24.3, which is about 5 pages. I will ask you about galaxy classification in the earlier sections, but not in a detailed way. **ALSO omit the final section on the Hubble Law, Sec. 24.3 (p. 661) *except* look at Figure 24.18—the "Cosmic Distance Ladder."**

I strongly recommend that you try all the Review and Discussion, and True-False/Multiple Choice questions at the end of each chapter; they are nearly all good ones, at the level that will be typical on the exam. In fact I will, as usual, take a few of the exam questions from the end-of-chapter and online questions. Of course, don't try the questions that are numerical problems, or questions that have to do with the sections you didn't read.

We spent most of our time on Chapter 22, so there will be fewer questions on 23 and 24. AND, I will not have time to cover all that material on Monday. Therefore you will have to be responsible for reading the parts of Chapters 23 and 24 that I don't cover. There will still be some lecture notes covering it, but there won't be enough class time to discuss everything.

As with Chapter 21 on the last exam, a good way to review Chapter 22 is to try to "tell the story" of the evolution of stars of different masses, this time starting with the red giant phase, when the helium has burned to carbon in the core, making sure you can explain all the events that occur after that. Each time you use some new terminology, e.g. "neutron degenerate core," try to explain what you mean, as if you were explaining this to someone with no background.

Most of Chapter 23 is concerned with how difficult it was to discover what kind of structure we live in (a galaxy, with a disk and a bulge and a halo). You should be able to explain how finding the distances to certain types of objects were the key to being able to get a picture of the galaxy we live in. You should know (roughly) the size of our galaxy (in parsecs), how far the Sun is from the Galactic Center, and the thickness of the galactic disk. Try to explain how the ages of the halo objects are known, and the ages of disk objects; how does this lead to a picture for how our Galaxy formed? Explain how the metal abundances in globular clusters are a crucial key.

There is a very basic theme running through all the material in Chapters 23 and 24: A lot of it is about learning to get distances to more and more distant objects so that we can map the structure of our own Galaxy (chapter 23) and the large-scale structure of the universe (starting with 24 and continuing in 25 on the next exam). 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.

Since I will ask you to read some of this material on your own, make sure you understand the overall theme of trying to make a map of the galaxy, or our local group of galaxies, or the cluster within that lies, or the whole universe, from the inside. AND remember that as you look back to very large distances, you are looking back in time. You should know that our Galaxy, and presumably the whole universe (see 24.3 on Hubble Law), is about 13 Gyr old, so the goal is to map the universe out to nearly 13 billion light years distance, producing a "movie" of the universe of galaxies evolving.

Here are some sample questions to see if you are prepared to take the exam. As usual, most of these tend to be a little more difficult than the average exam question.

1. The masses of neutron stars (not the original mass of their progenitor)
a. must be at least 8 solar masses. b. must be at least 1.4 solar masses.
c. are only known for those neutron stars in binary systems.
d. are only known for neutron stars that are also white dwarfs.

2. Why did it take until recently to realize that gamma ray bursts are extremely far away?
a. Previous gamma-ray telescopes were not sensitive enough.
b. Their spectroscopic parallax could not be measured because their luminosity was unknown.
c. Only recently were "afterglows" observed that allowed the distances to be estimated using spectral lines.
d. Gamma ray stars, that correspond to the gamma ray bursters, have only recently been discovered.

3. 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.

5. The key to identifying a black hole candidate, rather than some other type of stellar remnant, in a binary star system is the following.
a) one of the two stars cannot be seen
b) the unseen companion in the system must have a sufficiently high mass
c) the system must be a strong source of x-ray emission.
d) the seen companion must be an evolving main sequence or giant star
e) there must be evidence for a very hot accretion disk.

6. What type of radiation is most useful in the mapping of our Galactic structure?
a. dust emission b. visible light c. radio spectral lines d. infrared spectral lines

7. 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.

8. 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

9. Which type of galaxy is the most numerous in the Local Group?
a. giant elliptical b. spiral galaxies c. dwarf irregular and elliptical galaxies

10. What observation is used in the Tully-Fisher relationship to determine distances?
a. the maximum brightness of supernovae b. Cepheid light curves
c. recessional velocity d. neutral hydrogen gas 21-cm line broadening