Study Questions for "The Cosmos at a Glance"
(Lectures Jan. 21 – Jan 28)

1) What is the closest star to the Earth? (Careful!)

2) What is the "Milky Way?"

3) In class, I showed a slide taken very recently of the Andromeda Galaxy. Is it therefore correct to say about this picture that it shows how the Andromeda Galaxy looks now? Why or why not?

4) What is Olbers' paradox, and what does it tell us about the universe? For which of the two possible ways out of the paradox do we have additional evidence?

5) What is the Doppler effect? Give examples from everyday life.

6) What does the Doppler effect tell us about distant galaxies?

7) What is Hubble's law? How do we know it is true?

8) What do we mean by the Big Bang? Where in space did it take place?

9) What are electromagnetic waves? How fast do they move?

10) Put the following in order from lowest frequency to highest: red light, FM radio, gamma rays, microwaves. Put the following in order from shortest wavelength to longest wavelength: green light, x-rays, radar, orange light.

11) What is a photon, and how does its energy depend on its frequency? How does its energy depend on its wavelength?

12) What happens to a photon as the universe expands? How does this affect the photon's energy? How does this affect the temperature of the photons?

13) Which of the following objects make up which other ones: neutrons, atoms, quarks, nuclei, electrons, protons? What force holds each composite object together?

14) Why are atoms "neutral?'' (i.e., why is their electric charge zero?)

15) What are isotopes? Give 2 examples.

16) What is antimatter? Give examples. What happens when matter collides with antimatter?

17) How is Einstein's equation $E=mc^2$ relevant to the answer to the previous question?

18) What do we mean when we say that the early universe (at the size of a beach ball) was in equilibrium?

19) Put the following "milestones" of the Big Bang in chronological order: nucleosynthesis, decoupling, electron-positron annihilation, formation of protons and neutrons (and annihilations of proton-antiprotons & neutrons-antineutrons), baryogenesis, matter domination. For each milestone, tell what happened and give a brief explanation of why it happened.

20) Perhaps the three most important pieces of evidence for the Big Bang theory are the redshifts of distant galaxies, primordial nuclear abundances, and the cosmic microwave background. For each of these, explain what it is and what causes it. Then explain why it supports the Big Bang theory.