**AST 301--Review for exam 5**

This exam covers all of stellar evolution, described in Chapters 20, 21, and 22, *except* for sections 22.5-22.8 (on black holes), which we will cover on the next exam. Nearly all the material was covered in class, *except* that I will leave it to you to read the sections describing the phenomena that can occur when stars evolve in binary systems (20.6, 21.1), although you will be tested on this material, and need to understand it in order to read later sections (e.g. 22.3). Also remember that the section on star clusters at the end of chapter 20 (20.5) should be supplemented with the material we postponed from section 19.6 on the same subject.

I strongly recommend that you try all the Review and Discussion, and True-False/Multiple Choice questions at the end of each chapter (except those on black holes); 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. However I do *not* recommend that you spend most of your study time trying to find the answers to these questions: they should be attempted after you have studied, as a self-test, although a quick look at them might be good to give you an idea of how much you understand.

A good way to review is to try to "tell the story" of the evolution of stars of different masses, starting with the main sequence phase, making sure you can explain all the stages of evolution and the differences between the evolution of low-mass and high-mass stars. Each time you use some new terminology, e.g. "degenerate core," try to explain what you mean, as if you were explaining this to someone with no background.

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. How was the chemical composition of the sun different 3 billion years ago from what it is now?

a. more hydrogen now b. more helium now
c. more heavy elements now d. it won't change until the sun becomes a red giant

2. When a star evolves from the main sequence to the red giant phase

a. the core gets hotter and the luminosity increases.
b. the core gets cooler and the surface gets hotter.
c. the core gets hotter and the luminosity decreases.
d. the core and the surface both get cooler.

3. Which of the following do "open clusters" of stars tell us?

a. They allow us to estimate the size of our Galaxy.
b. As standard candles, they can be used to obtain the distances to other galaxies.
c. That when our galaxy was forming, it had a roughly spherical shape.
d. Star formation has been occurring more or less continuously over the past 10 billion years.

4. Roughly how long does it take a stellar iron core to collapse?

a) One second. b) One year. c) A few million years. d) Forever.

5. Why do the cores of massive stars evolve into iron, but not heavier elements?

a. The attempt of the star to fuse iron disrupts the stability of the core by requiring energy.
b. The temperature never gets high enough to allow the fusion of heavier elements.
c. The star goes supernova before the core has a chance to make heavier elements.
d. Iron does not become degenerate.

6. If the fusion of lighter elements with iron to form still heavier elements does not occur in a star, how is it that stars are able to synthesize many elements heavier than iron?
a. neutron capture in the s-process b. helium capture
c. photodisintegration d. neutronization

7. What is a major reason for believing that nucleosynthesis of some heavy elements occurs in stars by means of neutron capture?
a. Detection of technetium in the atmospheres of some red giant stars.
b. Detection of the neutrino burst from SN 1987A.
c. The fact that there is a peak in the cosmic abundance pattern at iron.
d. The discovery of pulsars, which are neutron stars.
e. The statement is not true—heavy elements are not made by neutron capture.

8. 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.

9. What type of object were millisecond pulsars likely to have been before becoming what they are presently?
a. single pulsars b. novae c. x-ray bursters d. gamma ray bursters

10. The masses of neutron stars
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.
e. are extremely large compared to the sun.