29:50 Stars, Galaxies, and the Universe
Instructor: Spangler
Homework Assignment # 8
October 26, 2010

Note: Corresponding quiz on ICON must be completed by 8AM, Monday, November 1

1. The black hole system 0422+32 consists of a spectral class M2 main sequence star (the "primary" star) in a binary system with an unseen companion (the black hole) possessing a mass in the range 3.7 - 5.0 solar masses. Why can't the unseen companion just be a main sequence star instead of a black hole?
   (a) spectral class M2 stars don't form binaries with more massive stars
   (b) main sequence stars can't have masses that large
   (c) binary stars never consist of 2 main sequence stars
   (d) it would be far more luminous than the primary

2. The black hole system 0422+32 consists of a spectral class M2 main sequence star (the "primary" star) in a binary system with an unseen companion (the black hole) possessing a mass in the range 3.7 - 5.0 solar masses. Why can't the unseen companion be a white dwarf star instead of a black hole?
   (a) spectral class M2 stars don't form binaries with white dwarfs
   (b) white dwarf stars can't have masses that large
   (c) binary stars never consist of a main sequence star and a white dwarf
   (d) it would be far more luminous than the primary

3. The upper limit to the mass of the black hole in the Cygnus X-1 system is 13.3 solar masses. What is the Schwarzschild radius of this black hole? You will have to use a formula to answer this question. You can either use the general equation given in lecture, or a simpler, handy-dandy formula in the book.
   (a) 37 meters
   (b) 40 kilometers
   (c) 7500 kilometers
   (d) 1.2 kilometers
   (e) 0.5 astronomical units

4. The object known as the Cygnus Loop is the remnant of a massive star that collapsed and produced a supernova 5000 - 6000 years ago. What kind of object would you expect to find in the Cygnus Loop?

(a) neutron star
(b) white dwarf
(c) planetary nebula
(d) spectral class A main sequence star
(e) spiral galaxy

5. In what part of the electromagnetic spectrum were pulsars discovered? The vast majority of pulsars can only be seen in this part of the electromagnetic spectrum.
   (a) gamma rays
   (b) x-rays
   (c) ultraviolet light
   (d) visible light
   (e) radio waves

6. Pulsars are neutron stars that rotate on their axes like the Earth. Most of them have rotation periods in one of the ranges below. Choose the correct answer.
   (a) 0.8 minutes to 35 minutes
   (b) 2.5 microseconds to 0.05 milliseconds
   (c) 0.03 seconds to 5 seconds
   (d) 5 days - 27 days
   (e) 0.5 years - 3.9 years

7. The nearest pulsar is 156 parsecs away. Why do we know that the nearest neutron star is much closer than that?
   (a) pulsars have a strong tendency to be further away than neutron stars
   (b) for every observable pulsar, there are many "dead pulsars"
   (c) there are many observed, isolated neutron stars that are closer than 100 parsecs
   (d) pulsars have been thrown out of the local cloud of neutron stars by strong gravitational forces
   (e) 156 parsecs is outside of our Galaxy

8. What is the escape speed from the Schwarzschild radius of a black hole?
   (a) speed of sound
   (b) orbital speed of the Earth
   (c) 3.4×10^4 meters/sec
   (d) speed of light
   (e) Alfven speed

9. How does the escape speed from the surface of a white dwarf compare with the escape speed from the surface of a neutron star?
   (a) the escape speed from a white dwarf is much lower than from a neutron star
   (b) the escape speed from a white dwarf is much higher than from a neutron star
   (c) the escape speed from a white dwarf is the same as from a neutron star
   (d) the escape speed is not a meaningful concept for a white dwarf star