Homework 3

Due: In class on Wednesday 10/28/09

0. Write a summary of this week's reading and include three questions.

1. Explain what would be puzzling about the discovery of a binary star system that consists of a 13 $M_\odot$ main-sequence star and a white dwarf. (Note: Stars in a binary system are generally formed at the same time from the gravitational collapse of an interstellar gas cloud.) Would you be as puzzled if the white dwarf were a neutron star instead? Why or why not?

2. **White dwarfs are dense!** Sirius B is the first white dwarf ever discovered. It is the binary companion star of Sirius A, the brightest star in the sky. The surface temperature of Sirius B is about 5 times that of the Sun, but its luminosity is only 0.0025 times that of the Sun, and its radius is 0.01 times that of the Sun.

   (1) The mass of Sirius B is very similar to that of the Sun. The Sun's average density is 1.4 g/cm^3. What is the average density of Sirius B?

   (2) Calculate the mass of a teaspoonful of the Sun in kilograms. (Assume a teaspoon holds a volume of 1 cm^3.) What about the mass of a teaspoonful of Sirius B in kilograms? How does each of them compare to your mass?

3. **Neutron stars are denser!** A neutron star has a much higher density than a white dwarf: about 4×10^{14} g/cm^3 !

   (1) Again, suppose a teaspoon holds a volume of 1 cm^3. What is the mass of a teaspoonful of a neutron star in kilograms? Calculate how many people of your mass must stand on a scale in order to balance a teaspoonful of a neutron star.

   (2) Using the density given above and the equation that relates mass, density, and radius of a spherical object, calculate the radius in kilometers of a 1.4 $M_\odot$ neutron star. (Use $1M_\odot = 2 \times 10^{33}$ g) How does this radius compare to the approximate size of the City Berkeley?

   (3) Captain Picard's radio was tuned to 1000 AM (i.e., at a frequency of 1000 kHz) while awaiting for liftoff from the surface of the neutron star. The radio lost its reception after liftoff. How should he fix it (other than changing the battery!)? A qualitative answer is sufficient, and don't worry about relativistic effects.