EXTRA CREDIT HOMEWORK 2
Due on May 1st (noon)

1. If two stars are in a binary system with a combined mass of 5.5 solar masses and an orbital period of 12 years, what is the average distance between the two stars?

2. The star Betelgeuse has a temperature of 3400 K and a luminosity of 13,200 L_{Sun}. Calculate the radius of Betelgeuse relative to the Sun.

3. The New Horizons probe flew past Pluto in July 2015. At the time, Pluto was about 32 AU from Earth. How long did it take for communication from the probe to reach Earth, given that the speed of light in km/h is 1.08×10^9?

4. The most recently discovered system close to Earth is a pair of brown dwarfs known as Luhman 16. It has a distance of 6.5 light-years. What would the parallax of Luhman 16 be as measured from Earth?

5. The New Horizons probe that passed by Pluto during July 2015 is one of the fastest spacecraft ever assembled. It was moving at about 14 km/s when it went by Pluto. If it maintained this speed, how long would it take New Horizons to reach the nearest star, Proxima Centauri, which is about 4.3 light-years away? (Note: It isn't headed in that direction, but you can pretend that it is.)

6. Suppose that you gathered a ball of interstellar gas that was equal to the size of Earth (a radius of about 6000 km). If this gas has a density of 1 hydrogen atom per cm^3, typical of the interstellar medium, how would its mass compare to the mass of a bowling ball (5 or 6 kg)? How about if it had the typical density of the Local Bubble, about 0.01 atoms per cm^3? The volume of a sphere is $V = (4/3)\pi R^3$.

7. Calculate the transit depth for an M dwarf star that is 0.3 times the radius of the Sun with a gas giant planet the size of Jupiter.

8. If star A has a core temperature T, and star B has a core temperature $3T$, how does the rate of fusion of star A compare to the rate of fusion of star B? Remember that the fusion rate determines the energy output or luminosity of a star.

9. Consider a neutron star that has twice the mass of the Sun but a radius of 10 km. What is the acceleration of gravity at the surface of the neutron star? How much greater is this than g at the surface of Earth? What would you weigh at the surface of the neutron star (provided you could somehow not become a puddle of protoplasm)?

10. What is the radius (in solar radii) of the progenitor star that became SN 1987A? Its luminosity was 100,000 times that of the Sun, and it had a surface temperature of 16,000 K.

11. Look up G, c, and the mass of the Sun in Appendix E of the text book and calculate the Schwarzschild radius of a black hole that has the same mass as the Sun. (Note that this is only a theoretical calculation. The Sun does not have enough mass to become a black hole.)

12. The Sun orbits the center of the Galaxy in 225 million years at a distance of 26,000 light-years. Given that $a^3 = \left(M_1 + M_2\right) \times P^2$, where a is the semimajor axis in AU and P is the orbital period in years, what is the mass of the Galaxy within the Sun's orbit?