Homework 1- Handed out Aug. 30, due Thurs. Sep. 6

Reading: Ch. 1.1 of the text, “Galaxies in the Universe,” by Sparke & Gallagher (pgs 1 - 23).
Do the following problems, and address the additional queries stated below:

1. **Problem 1.1** - Show that the Sun produces only about $10^{-4}$ times as much energy per unit mass as an average human giving out about 1 W kg$^{-1}$. **Also discuss:** What is the fallacy in this comparison? (Hint: How are humans “powered”? In what ways does their energy-generation mechanism differ from that of the Sun?)

2. **Problem 1.4** - What mass of hydrogen must the Sun convert to helium each second in order to supply the luminosity that we observe? If it converted all of its initial hydrogen into helium, how long could it continue to burn at this rate? Since it can burn only the hydrogen in its core, and because it is gradually brightening, it will remain on the main sequence for only about 1/10 as long. **Also:** After calculating your answer in seconds, convert it into years.

3. **Problem 1.5** Use equation 1.3 ($L = 4\pi R^2/\sigma T^4$) and data from Table 1.1 to show that when the Sun arrived on the main sequence, its radius was about 0.87 $R_\odot$.

4. **Problem 1.6** Show that if two stars of the same luminosity form a close binary pair, the apparent magnitude of the pair measured together is about 0.75 magnitudes brighter than either star individually. **Bonus** question: There is something odd about Figure 1.6. What is it? (Hint: Look at the axes.)

Facts from the Appendices (Grrr – half the point of these questions was to test your understanding of the reading and to get you to look things up in the book, including in the appendices at the back!):

- $1 M_\odot = 1$ solar mass = 1.99 x $10^{33}$ k
- $1 L_\odot = 1$ solar luminosity = 3.86 x $10^{26}$ W
- when 4 H nuclei fuse into one He nucleus, 0.7% of the mass is converted to energy
  \[
  \sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{K}^{-4}
  \]
- The initial (“ZAMS”) sun had $L = 0.69 L_\odot$ and $T = 5640$ K
- eq. 1.9: $m_1 - m_2 = -2.5 \log_{10} (F_1/F_2)$