Astro 102
Group Problems #2
2006-June-12

Useful Data

$$1\,\text{year} \;=\; 3.156 \times 10^{7}\,\text{seconds}$$

Age of Solar System: 4.6 billion years

Age of the Universe: 13.7 billion years

$$M_{\odot} \;=\; 1.99 \times 10^{30}\,\text{kg}$$
$$R_{\odot} \;=\; 6.97 \times 10^{8}\,\text{m}$$
$$L_{\odot} \;=\; 3.8 \times 10^{26}\,\text{J}\,\text{s}^{-1}$$
$$c \;=\; 3.00 \times 10^{8}\,\text{m}\,\text{s}^{-1}$$
$$G \;=\; 6.67 \times 10^{-11}\,\text{kg}\,\text{m}^{3}\,\text{s}^{-2}$$

1. If the Sun burns up *all* of its fuel at its current rate, how long will its total lifetime be?

2. Vega is just under 3 times the mass of the Sun, and is about 100 times as bright as the Sun. If the Sun is going to live for 10 billion years, how long do we expect Vega to live?

3. Barnard's star is just about 0.2 times the mass of the Sun, and is about 1/100th as bright as the Sun. How long do we expect Barnard's star to live?

4. If all stars the mass of Barnard's star have the same luminosity as Barnard's star, have any of those stars died?

5. Have any stars the mass and luminosity of the Sun died?

6. The Solar Wind is a stream of particles coming off of the surface of the Sun. Most of those particles are protons and electrons— that is, Hydrogen atoms where the electrons have been stripped off and are free. The Sun loses about 1×10^{36} protons a second to the Solar Wind.

   (a) How much mass does the Sun lose to the Solar Wind in a million years?

   (b) What fraction of the Sun's mass is lost during a million years?

   (c) What fraction of the Sun's mass is lost to energy from fusing in a million years?