Homework Set 1

Due: March 7, 2016, *before class*

Please do calculations and provide results using cgs units.

1. **Energy Generation**

   (a) **Compute the specific energy generation rate of the Sun as a whole.**

   (b) **Assume a human of weight 100 kg has a "luminosity" of 100 W.**
   Compute the specific energy generation rate of a this human.

   (c) **Compare the results from (a) and (b).**

   (d) **Modern CPUs.** Modern micoprocessors have now reached a "gate width" of 14 nm. Assume this corresponds to the thickness of the "active" layer that contains micoprocessors and density of silicon of $2.33\,\mathrm{g/cm^3}$. The typical die size is about $100\,\mathrm{mm^2}$ and they have a power up about 100 W.
   What is the specific energy generation rate of the active layer?

   (e) **How long does it take for the "active" layer of the CPU to release as much energy as its rest mass?**

   (f) **What happens when you run your computer that long – having converted the rest mass of the "active" layer into energy?**

   (g) Dimensional Analysis
   What is the specific energy generation rate corresponding to an element of mass radiating away its entire rest mass in 1 s?
   Consider Units.

   (h) Assume a characteristic chemical energy content of 1 eV per nucleon for chemical burning, and a characteristic nuclear energy content of 7 MeV per nucleon for complete nuclear burning. Convince yourself that these numbers are reasonable and make sense.
   Compute the energy content (supply) of the sun for each of these assumptions. How long could the sun shine at its current luminosity from each of these energy sources?