

Homework Set 1

Due: March 13, 2014, *before class*

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 microprocessors have now reached a “gate width” of 22 nm. Assume this corresponds to the thickness of the “active” layer that contains microprocessors and density of silicon of 2.33 g/cm^3 . The typical die size is about 100 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 their rest mass?
- (f) What happens when you run your computer that long – having converted the rest mass of the “active” layer into energy?
- (g) What is the specific energy generation rate corresponding to an element of mass radiating away its entire rest mass in 1 s?
- (h) Assume a characteristic chemical energy content of 10 eV per nucleon, and a characteristic nuclear energy content of 10 MeV per nucleon. **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?**