HW 3 A2020 Out 2/02/2010 Due 02/09/2010

1. (2pts)The full moon is 0.5 degrees in diameter. How big is this in arcminutes and arcseconds?

2. (4pts)The angular resolution of a telescope is given by equation

   $\Theta(\text{arcsec}) = 2 \times 10^{-4} \times \lambda(\text{nm})/D(\text{meters})$

   What is the resolution of the
   a. The Hubble space telescope, D = 2.4 meter, λ = 600 nm
   b. The Keck Telescope, D = 10 meters, λ = 600 nm
   c. The VLBA (Very Long Baselined Array radio interferometer) D =8611 km (8611 x 10^3 meters) λ = 6 cm (6 x 10^7 nm)

   Which one has the highest and lowest angular resolution (smaller Θ means higher angular resolution)? Why might the Hubble Space Telescope in practice have higher angular resolution than the Keck telescope?

3. (4 pts) a. you take a red brick, heat it with a blowtorch (so you can feel that its hot) and put it in a dark room. Is it emitting light? At what wavelength regime (visible light, infrared light)?

   b. you turn on the light in the room. Is the brick emitting more or less light? Why does the brick appear red to the eye – is this from the emitted light?

   c. You put the brick in the refrigerator and cool it down. Then you put it back in the dark room. Is it emitting more or less light than when it was hot? Is it emitting any light?

   d. Now consider a block of glass. Is glass transparent to all wavelengths of light? You heat up the glass with a blowtorch. Does it emit light?

4. (4 pts extra credit) The Sun's luminosity is 3.8×10^{26} Watts. Using this luminosity and the equation $E=mc^2$, calculate how much mass per second is converted into energy in the Sun. To do this, you need to know two unit conversions. First, 1 Watt = 1 Joule per second where a Joule is a unit of energy (luminosity is energy radiated per time). Second, 1 Joule = 1 kg m^2/s^2 (that's kilogram meter square per second square). Thus, 1 Watt = 1 kg m^2/s^3. Putting the speed of light, *c*, in meters per second (3×10^8 m/s) and dividing c^2 into the power (i.e. luminosity of the Sun) in Watts, you will get the amount of mass converted to energy in kilograms per second (kg/s) inside the Sun.

a. What is the mass in kilograms converted to energy per second?

b. The mass of the Sun is 2×10^{30} kg. What percentage of the Sun's mass is converted to mass every second?