Homework #1

1. What is the wavelength of the peak of the blackbody spectrum of the cosmic microwave background, which has a temperature of 2.73 K?

2. Estimate the number of photons emitted per second by the Sun.

3. Proxima Centauri is a 0.12 $M_\odot$ star that has a recoil radial velocity amplitude of 1.38 m s$^{-1}$ due to a planet that is orbiting it with a period of $P = 11.2$ days. Both masses orbit around their common center of mass, defined by $M_1 r_1 = M_2 r_2$. Let $M_1$ be the mass of the star and $M_2$ the mass of the planet, where $M_2 << M_1$.

(a) Using Kepler’s third law (to be derived later),

$$P^2 = \frac{4\pi^2 a^3}{G(M_1 + M_2)},$$

derive $a$, the orbital separation. ($G$ is Newton’s gravitational constant.)

(b) Derive the value of $r_1$ from the data given above.

(c) Derive $M_2$, the mass of the planet, from the results of (a) and (b).

(d) Why is your derived mass in part (c) more properly a minimum mass of the planet, not a definite value?

\[ a = r_1 + r_2 \]