ASTP-720 Homework 7

Zach Diermyer

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Github Link: `https://github.com/zrd7527/ASTP720.git`

1 Problem 1

I started this problem by opening the lightcurve data file and creating time and flux arrays. I also created a phase array by taking the modulus of each time by the period. I found the RMS value of the data at earlier phases than those where the planet is in front of the star. I use this RMS value for my errors when I calculate a χ^2 value. My Metropolis-Hastings function then solves for my three parameters iteratively. The three parameters I solve for are the width of the transit in days, the phase t_{ref} in days, and the change in intensity ΔI in percent of normalized intensity. The MCMC I created takes a guess value for each of these parameters and randomly adds or subtracts a small number from them. This creates a new guess value and the original guesses become the 'current' values. The function then finds r, a ratio of the likelihoods, for each new guess value to the current parameter value. If r is greater than 1 the new guess becomes the current value and the iteration continues. A plot of the folded light curve with the best fit parameter model can be seen in Figure 1. A histogram showing the distribution of the parameter ΔI can be seen in Figure 2. The best fit value I found found for ΔI is $0.00726 \pm 5 \times 10^{-10}$. I found the error on this parameter by taking numpy's variance function of the ΔI array of values.

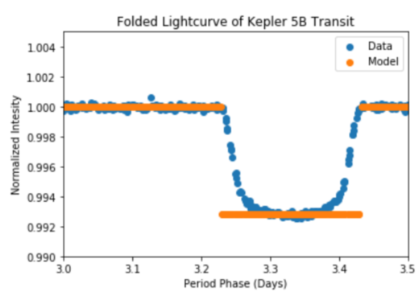

Figure 1

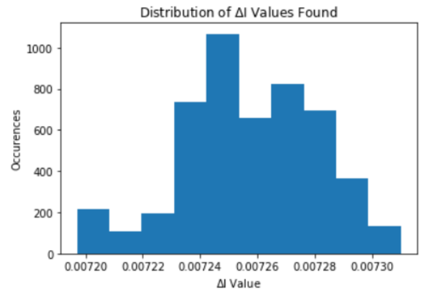

Figure 2

2 Bonus

For the bonus I used Equation 1 and the best fit value for ΔI that I found previously to solve for the planet's radius. Next I solve Kepler's third law, Equation 2, using the given period to find the semi-major axis of the planet's orbit. Assuming the planet's orbit is approximately circular, the semi-major axis and period are used to find the orbital velocity of the planet. I estimate the star's maximum radial velocity to be $220\frac{km}{s}$. The star's momentum must be equal to the planet's so the planet's mass can be solved by Equation 3. Using the planet radius, I solve for the volume of the planet. Finally I divide the planet mass by the volume to get the density. I found a density of $0.85\frac{kg}{m^3}$ implying that the planet is a gas giant.

$$R_p = \frac{\Delta I}{I}(R_*^2) \tag{1}$$

$$a = (T^2 \frac{GM_{sun}}{4\pi^2}) \tag{2}$$

$$M_p = \frac{M_* v_*}{v_p} \tag{3}$$