Secondary Eclipses and Eccentricity Estimation

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1 Description

This project tries to fit the lightcurve of exoplanets which have primary as well as clearly visible secondary eclipses. The thing I am thinking of trying is that I will see if there are similar distances between different sets of primary-secondary eclipses' dips (let's call this r) in a lightcurve. If the length r is the same throughout the lightcurve, this would mean that the exoplanet's orbit is circular. But if the distance between first primary-secondary dips is somewhat different from the distance between 2nd (and so on) primary-secondary dips, then it is on an eccentric orbit. This was an interesting idea which came to my mind, and I will try to test if I can find some interesting results from this. For this, I will be using Kepler data.

Update till now:

In the **github link** provided on Canvas, I have done the detailed analysis of the secondary eclipses of WASP-18b. I used `the Juliet` package to model the light curve and obtained the parameters that matched closely with that of the literature from which the data was taken. In the model, the transit and the eclipses were modeled simultaneouly.

$$gap_1 = \frac{P}{2} + \frac{P\ e\cos\omega}{\pi} \tag{1}$$

$$gap_2 = \frac{P}{2} - \frac{P\ e\cos\omega}{\pi} \tag{2}$$

where gap_1 is the time difference between the mid-transit and the eclipse on the right, and gap_2 the time difference between the mid-transit and the eclipse on the right

The idea is that when you have $ecc = 0$, then the two gaps should be almost the same. But the moment we have non-zero eccentricity, the two gaps can be used to estimate the eccentricity. Even when the gap difference is small, its effect on eccentricity can be huge.

2 Preliminary Results

WASP-18b:

Following the formalism discussed in equations 1 and 2, we obtained the eccentricity as $e = 0.0063$ compared to 0.00510 (Cortés-Zuleta et al. 2020), 0.00910 (Kokori et al. 2023). Similar analysis on other systems will be made in the final report.

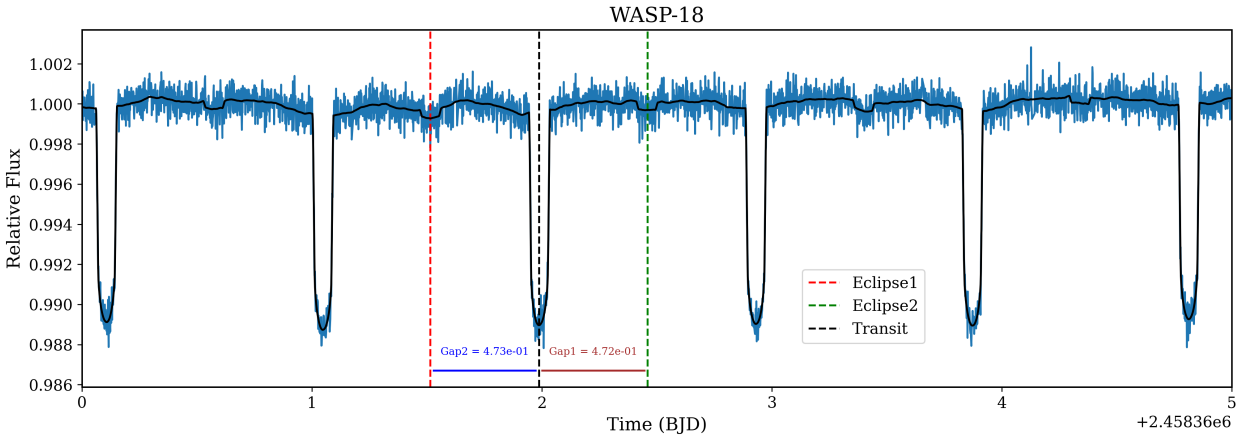

Fig. 1 Raw lightcurve of WASP-18b

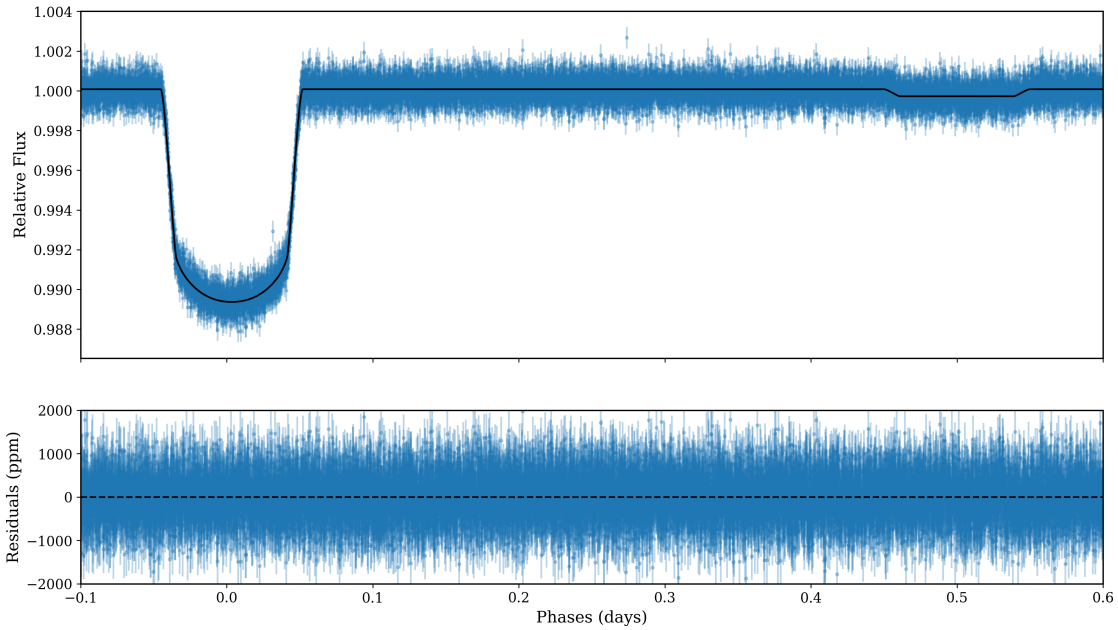

Fig. 2 Phase folded lightcurve of WASP-18b. Here, one can see the secondary eclipse clearly around phase=0.5