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 idea behind this project comes from the idea that if there are similar gaps between different sets of primary-secondary eclipses (let's call this gap_1) in a lightcurve. If this gap gap_1 is the same throughout the lightcurve, this would mean that the exoplanet's orbit is circular. But if the distance between first primary-secondary eclipse is different from the distance between 2nd (and subsequent) primary-secondary eclipse, then it is on an eccentric orbit. This is an interesting idea which we can try to test if we can find some interesting results from this. This study can be used complementarily to estimate the eccentricity.

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.

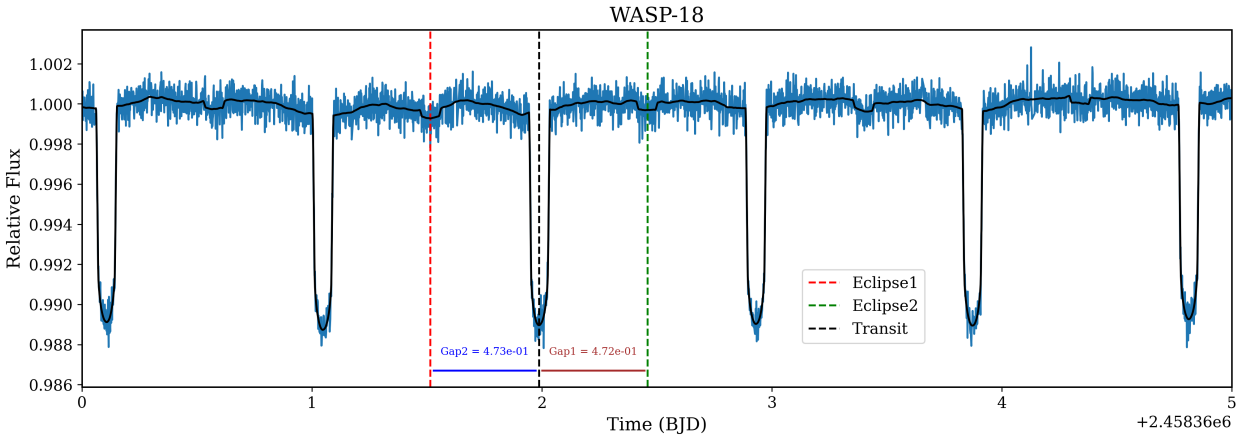

Fig. 1 Raw lightcurve of WASP-18b

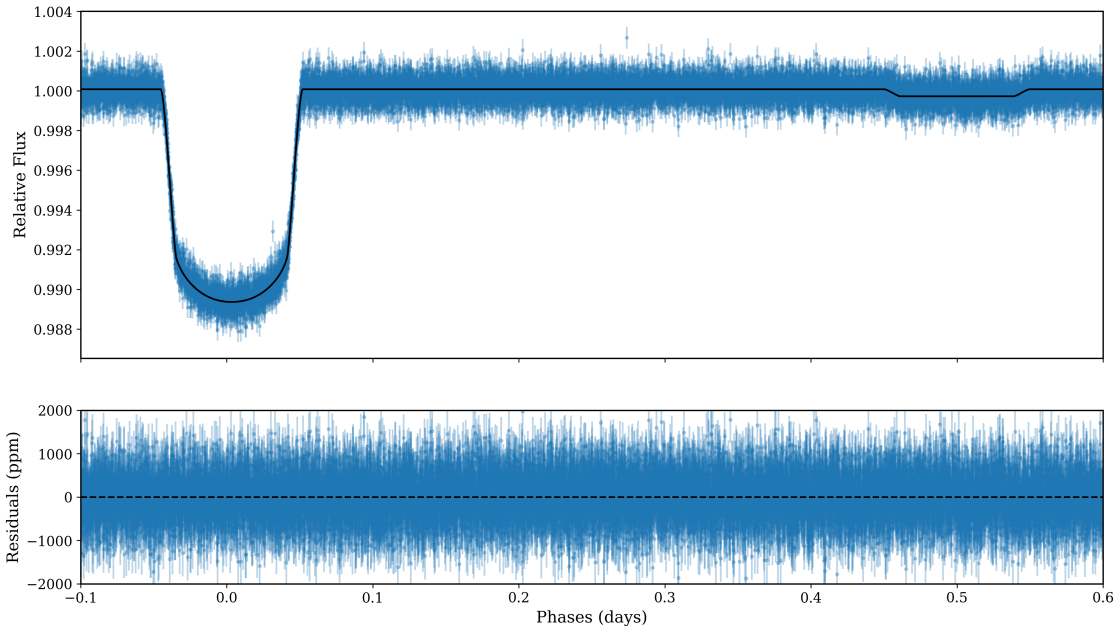

Fig. 2 Phase folded lightcurve of WASP-18b. Here, one can see the secondary eclipse clearly around phase=0.5