

# SPITZER SECONDARY ECLIPSES OF WASP-32b

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## ABSTRACT

We observed two eclipses of WASP-32b at 3.6  $\mu\text{m}$  and 4.5  $\mu\text{m}$  using *Spitzer* in 2010 as a part of program 60003. Discovered in 2010 by Maxted et al, this hot Jupiter has a mass of  $3.6 \pm 0.07 M_J$ , a radius of  $1.18 \pm 0.07 R_J$ , an equilibrium temperature of  $1560 \pm 50$  K (assuming uniform heat redistribution and zero albedo), and an orbital period of  $2.71865 \pm 0.00008$  days around a G-type star. We present an eclipse depth estimate in the 4.5  $\mu\text{m}$  band of  $0.0013 \pm 0.00023$  and a  $3\sigma$  upper limit in the 3.6  $\mu\text{m}$  band of  $0.04$ . We also report a brightness temperature in the 4.5  $\mu\text{m}$  channel of  $1538 \pm 110$  K and reduce the uncertainties of orbital parameters, using our eclipse timing as well as amateur and professional transit and radial velocity data.

## PHOTOMETRIC ANALYSIS

The Photometry for Orbits, Eclipses, and Transits (POET, Campo et al. 2011) pipeline uses Basic Calibrated Data frames produced by *Spitzer* to make light curves. POET masks bad pixels from various sources, performs centering and aperture photometry, fits light curves to the data, and corrects for *Spitzer* systematics. Corrected systematics include a “ramp” resulting from variation in sensitivity over time and intrapixel effects. Points far from the eclipse were clipped to improve our fits.

## REFERENCES

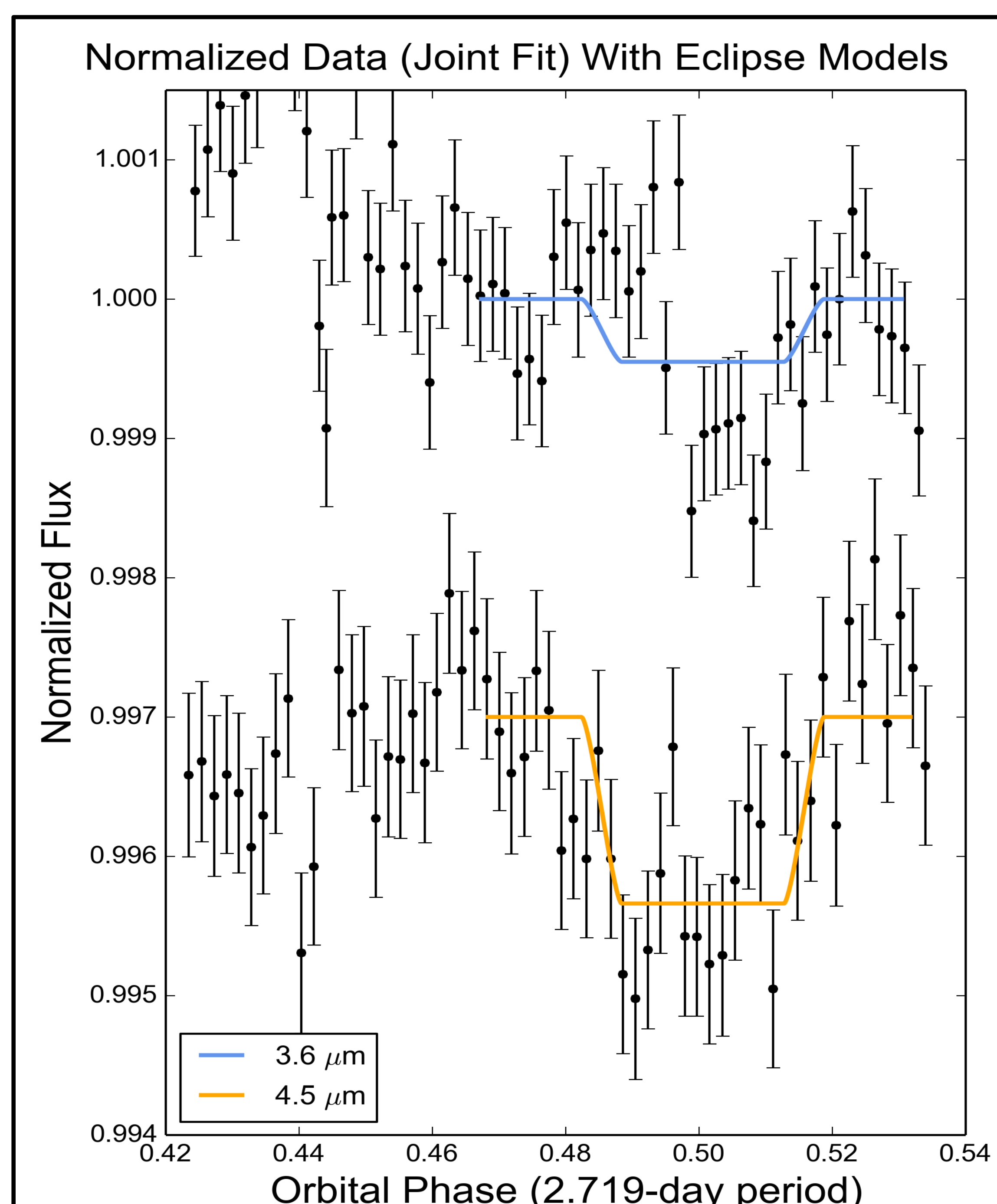
Maxted, P. F. L., Anderson, D. R., Collier-Cameron, A. et al. 2010, *PASP*, **122**, 1465  
Campo, C. J., Harrington, J., Hardy, R. A. et al. 2011, *ApJ*, **727**, 2  
Stevenson, K. B., Harrington, J., Fortney, J. J. et al. 2012, *ApJ*, **754**, 2

## ACKNOWLEDGEMENTS

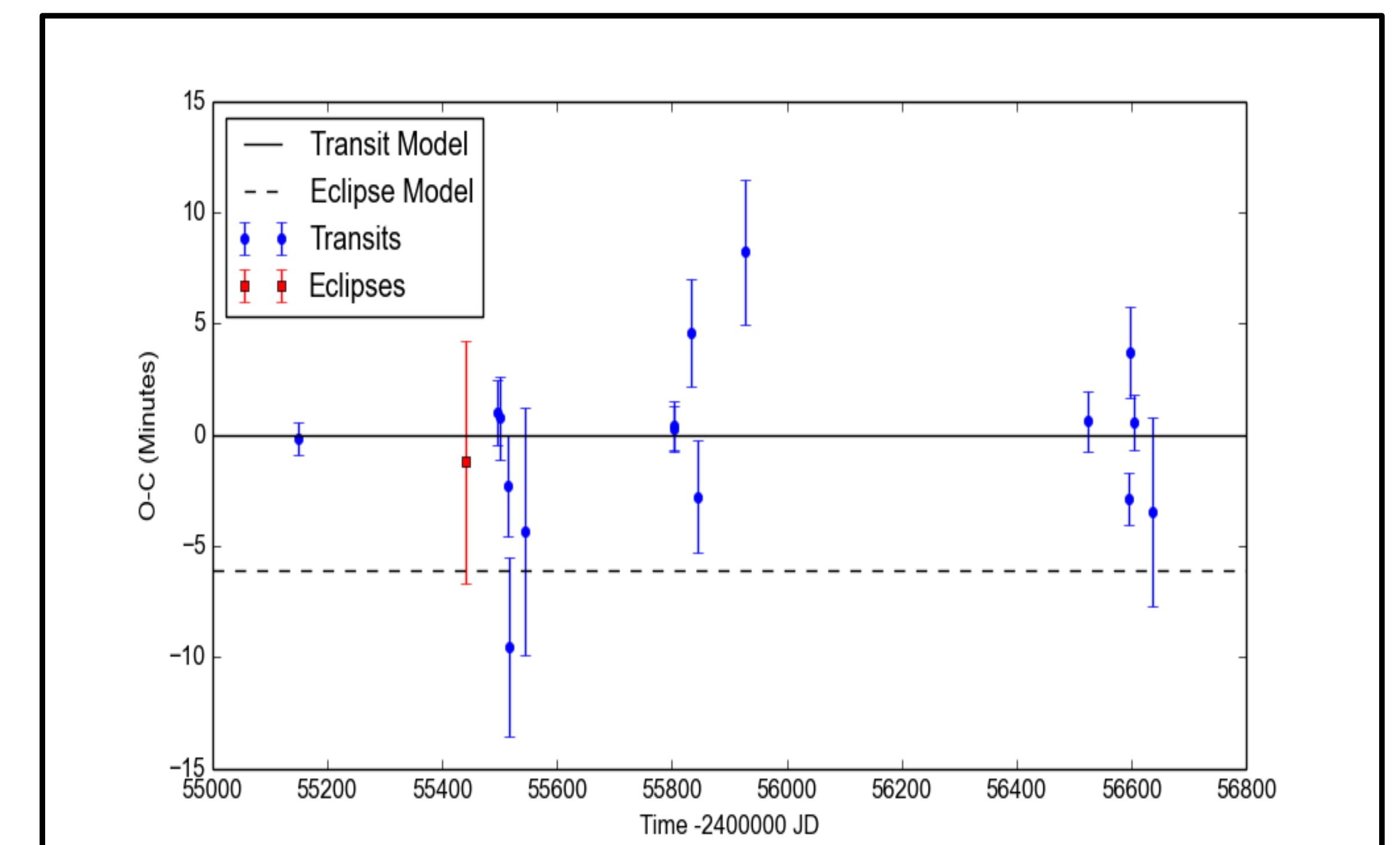
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## ORBIT

A secondary eclipse is a strong constraint on a planet's orbit. We used a Keplerian orbit model to our secondary eclipse midpoint in the 4.5  $\mu\text{m}$  band, radial velocity data from Maxted et al. 2010, and professional and amateur transit timing data to provide estimates of the system's orbital parameters. This MCMC fit gave an eccentricity of  $0.019763 \pm 0.011841$  and an argument of periaapsis of  $90.497997 \pm 8.562206$ , confirming the low eccentricity of WASP-32b's orbit. The model also provided a refined ephemeris of  $2455151.055(401) + 2.71866(12)N$ , where N is the number of orbits elapsed since the transit time. Our model agrees with previous results while reducing parameter's uncertainties.



**Figure 1:** Joint light-curve fit to 3.6  $\mu\text{m}$  and 4.5  $\mu\text{m}$  data (the upper and lower traces, respectively). Uses priors from Maxted et al. 2010 and attempts a fit using constraints to the 4.5  $\mu\text{m}$  data.



**Figure 2:** Observed-minus-calculated eclipse and transit time diagram for WASP-32b. The solid line shows the model of transit data while the dotted line shows the model for an eclipse.

## FUTURE WORK

Non-detection in one channel (such as in Stevenson et al. 2012) may indicate the presence of molecules with features in that wavelength range resulting in a non-detection. Using our 4.5  $\mu\text{m}$  brightness temperature along with our upper limit at 3.6  $\mu\text{m}$ , we are working to obtain constraints on WASP-32b's atmosphere using our group's open-source Bayesian Atmospheric Radiative Transfer (BART) retrieval routine.

## ABOUT THE LEAD AUTHOR

I am a senior undergraduate researcher currently working on a paper for publication on WASP-32b.

My research interests include exoplanets, geophysics, and statistical programming. I am currently applying for graduate school. If you are interested in a potential graduate student, please contact me at:



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