

# TOI-1830 and TOI-1312: Two EBs hosting very low-mass stellar companions in eccentric orbits



# UCSC

## Introduction

We describe in the underlying investigation the discovery of two eclipsing binary systems. In both cases, the companions are most likely fully convective low-mass stars. The TESS team initially alerted the systems as TOI-1830 (TIC20182165, HD133725) and TOI-1312 (TIC405904232), and we subsequently observed them with photometric and spectroscopic facilities.

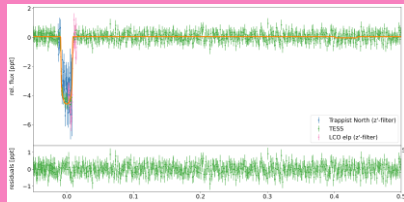
## TOI-1312 follow-up

Photometric observations were obtained with Trappist-North at the Observatory of Oukaimeden and one of the LCO 1m-unit at the McDonald Observatory (elp). TOI-1312 spectra were obtained with the Tillinghast Reflector Echelle Spectrograph (TRES) at the Whipple Observatory and the FIES spectrograph at the Roque de los Muchachos Observatory.

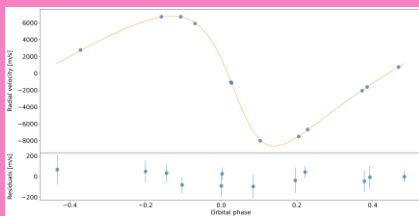
## TOI-1830 follow-up

For TOI-1830, we acquired a light curve through photometric observations at the University of Louisville Manner Telescope (ULMT). Spectra were obtained with LCO's NRES, the SONG spectrograph at the Teide Observatory, and the FIES spectrograph at the Roque de los Muchachos Observatory. We obtained additional high-angular resolution images for this system with the Gemini Speckle imager Alopeke and Keck's NIRC2.

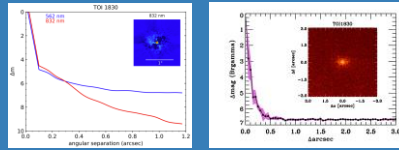
## TOI-1312 phase-folded light curve



## TOI-1312 phase-folded radial velocities

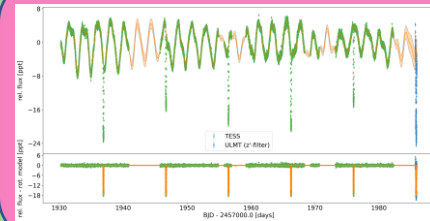


## TOI-1830 High angular res.



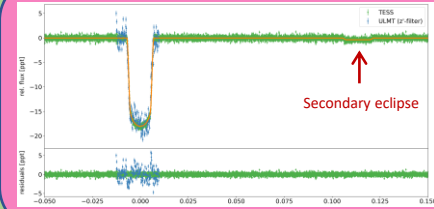
High-resolution imaging shows no close companion within 0.5 arc-seconds and down to a  $\Delta mag \sim 7$ .

## TOI-1830 light curve



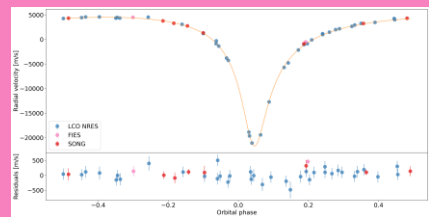
The TESS light curve of TOI-1830 is modulated with variability. We attribute this additional variability to spots on the stellar surface rotating in and out with the line of sight. The variability was modeled using Gaussian Processes [3].

## TOI-1830 phase-folded light curve



To further investigate the eclipses, we subtracted the modeled starspot variability. The resulting light curve revealed a shallow secondary eclipse.

## TOI-1830 phase-folded radial velocities



## TOI-1312 and TOI-1830 system parameters

Light curve and radial velocity curve models were generated in a data-driven Bayesian approach from the observed data using the `elc` [4], `emcee` [2], and `celerite` [3] python modules. We also run `SPC` [1] on the observed spectra for TOI-1312 and `SpecMatch-Syn` [5] for TOI-1830 to obtain the primary stars' stellar parameters spectroscopically. We find that both stars host very low-mass stellar companions in eccentric orbits.

### TOI-1312

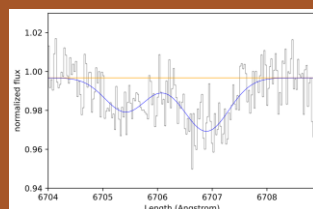
Parameter	Estimated value
$T_{\text{eff}}[\text{K}]$	$6231 \pm 50$
$\log g[\text{dex}]$	$4.05 \pm 0.10$
$[M/\text{H}]$ [dex]	$-0.11 \pm 0.08$
$v \sin i$ [km/s]	$8.9 \pm 0.5$
$R_1 [R_{\odot}]$	$1.448 \pm 0.102$
$R_2 [R_{\odot}]$	$0.092 \pm 0.007$
$i [^{\circ}]$	$89.4 \pm 2.3$
Time of mid-eclipse [BJD <sub>TDB</sub> ]	$2458688.22996^{+0.00013}_{-0.00013}$
Orbital period [d]	$11.07642^{+0.00012}_{-0.00012}$
Mass ratio	$0.060^{+0.002}_{-0.002}$
$\sqrt{e} \cos \omega$	$-0.202^{+0.016}_{-0.016}$
$\sqrt{e} \sin \omega$	$0.553^{+0.016}_{-0.016}$

### TOI-1830

Parameter	Estimated value
$T_{\text{eff}}[\text{K}]$	$6339 \pm 110$
$\log g[\text{dex}]$	$4.29 \pm 0.12$
$[M/\text{H}]$ [dex]	$-0.16 \pm 0.09$
$v \sin i$ [km/s]	$29 \pm 1$
$R_1 [R_{\odot}]$	$1.74 \pm 0.14$
$R_2 [R_{\odot}]$	$0.22 \pm 0.02$
$i [^{\circ}]$	$88.95^{+2.29}_{-2.29}$
Time of mid-eclipse [BJD <sub>TDB</sub> ]	$2458936.90677^{+0.00013}_{-0.00013}$
Orbital period [d]	$9.781667^{+0.00012}_{-0.00012}$
Mass ratio	$0.03198^{+0.00021}_{-0.00021}$
$\sqrt{e} \cos \omega$	$-0.8073^{+0.0021}_{-0.0021}$
$\sqrt{e} \sin \omega$	$0.1013^{+0.00021}_{-0.00021}$

## TOI-1830 young system

We stacked all TOI-1830 NRES spectra in order to obtain a high SNR spectrum. We found a non-negligible presence of Li in the stellar atmosphere. This might indicate a young age of the system. However, the line broadening due to the fast stellar rotation hampers an accurate abundance analysis. The plot on the left shows how the Li 6707 line is blended with the neighboring Fe line. Furthermore, the fast stellar rotation and the stellar activity seen in the light curve further indicate a young system.



## References:

- Buchhave, L. A., Latham, D. W., Johansen, A., et al. 2012, *Nature*, 486, 375
- Foreman-Mackey D., Hogg D. W., Lang D., Goodman J., 2013, *PASP*, 125, 306
- Foreman-Mackey D., Agol E., Ambikasaran S., Angus R., 2017, *AJ*, 154, 220
- Macted P. F. L., 2016, *A&A*, 591, A111
- Petigura, E. A. 2015, Ph.D. thesis, University of California, Berkeley

## Authors:

Markus Rabus, Theron Carmichael, Avi Shporer, Marshall Johnson, David W. Latham, Tim Brown, Tianjun Gan, Karen Collins, Khalid Barkaoui, Allyson Bieryla, John Kielkopf, Erica Gonzalez, Brett C. Addison, Andreea Ioana Henriksen, Lars Buchhave, René Tronsgaard Rasmussen, Nicola Astudillo-Defru, Ben Fulton, Steve B. Howell, David Ciardi, Coel Hellier, Mourad Ghachoui, Mathilde Timmermans

Acknowledgement: This work was supported by UCSC internal fund "DI-FIAI 03/2021"