THE K2 + TESS SYNERGY

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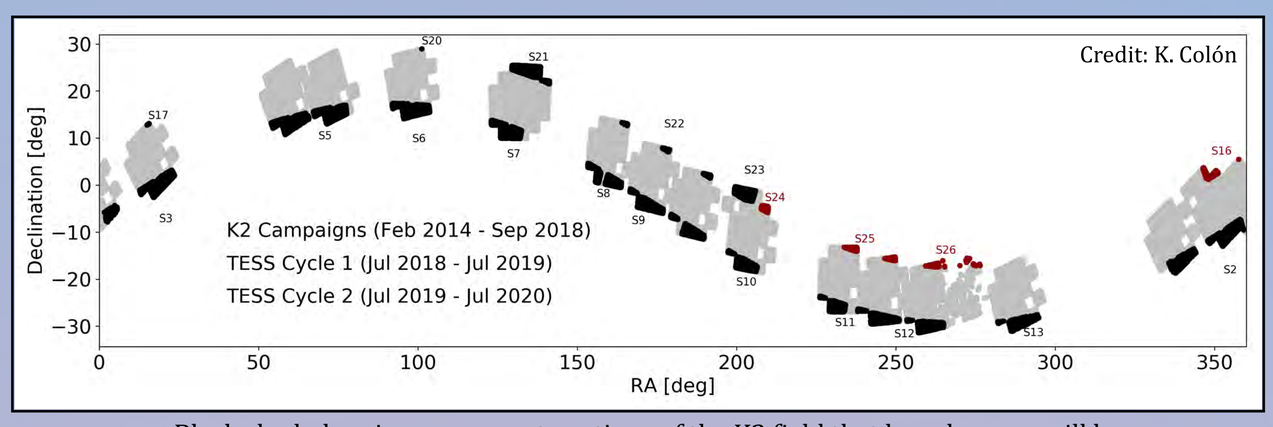
Planets in the K2-TESS Overlap

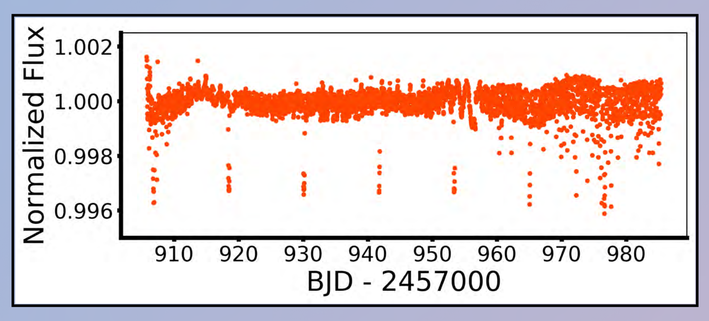
- During the first cycle of its primary mission, TESS observed 39,451 K2 targets (see poster, "An Overview of Targets Observed by both the Kepler Spacecraft and the Transiting Exoplanet Survey Satellite," by K. Colón).
- We used the combined K2+TESS data to study known exoplanetary systems, potentially discovering new planets, while providing updated ephemerides for atmospheric characterization with future facilities, such as JWST and the ELTs.
- Additionally, these observations provide the ability to aid in the vetting of TESS planet candidates.



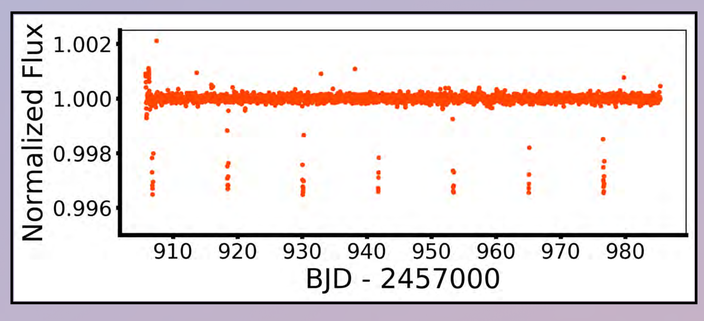
Black shaded regions represent portions of the K2 field that have been or will be observed by TESS. Regions shaded in red may not be observed due to pointing changes.

Light Curve Creation for K2 and TESS

K2

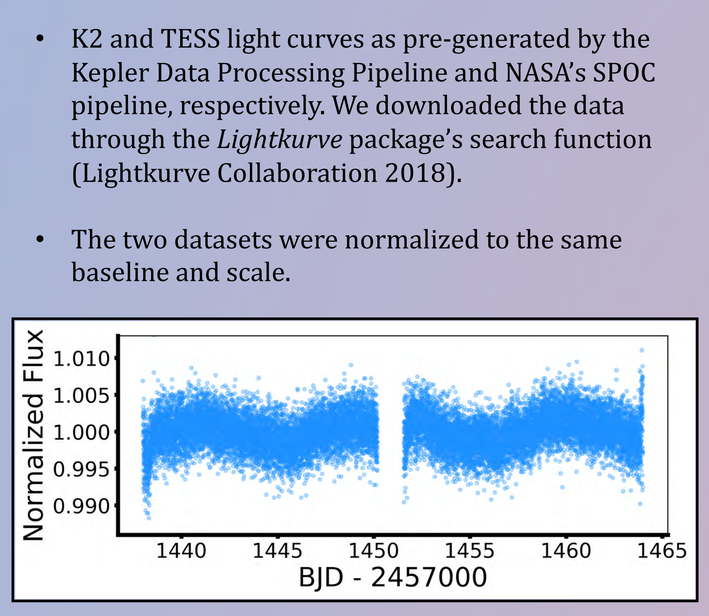


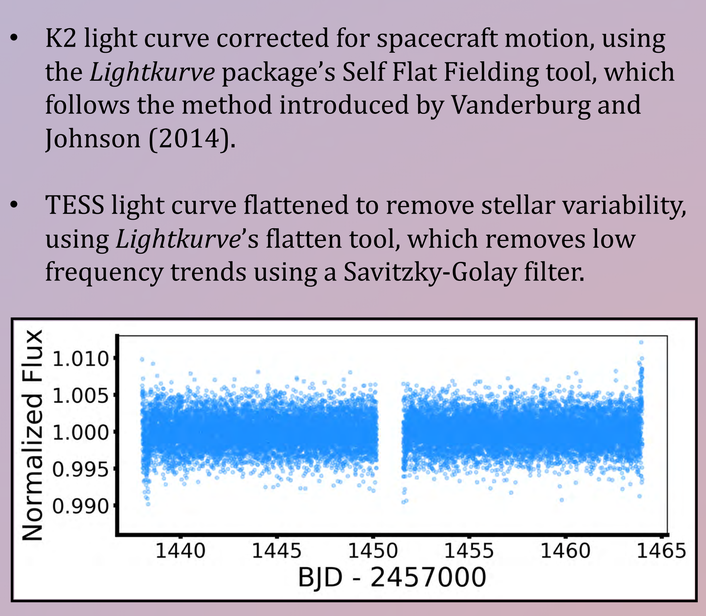
- K2 and TESS light curves as pre-generated by the Kepler Data Processing Pipeline and NASA's SPOC pipeline, respectively. We downloaded the data through the *Lightkurve* package's search function (Lightkurve Collaboration 2018).
- The two datasets were normalized to the same baseline and scale.

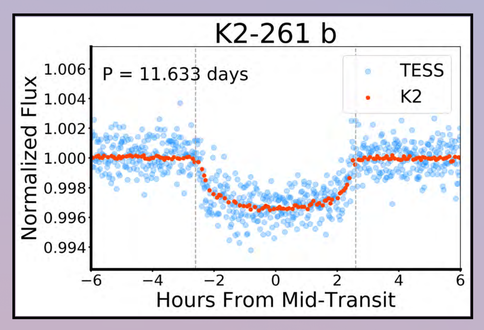


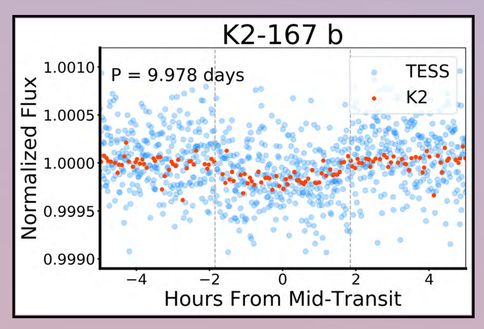
- K2 light curve corrected for spacecraft motion, using the *Lightkurve* package's Self Flat Fielding tool, which follows the method introduced by Vanderburg and Johnson (2014).
- TESS light curve flattened to remove stellar variability, using *Lightkurve*'s flatten tool, which removes low frequency trends using a Savitzky-Golay filter.

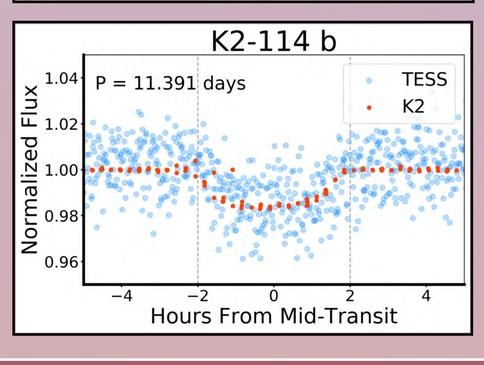
TESS



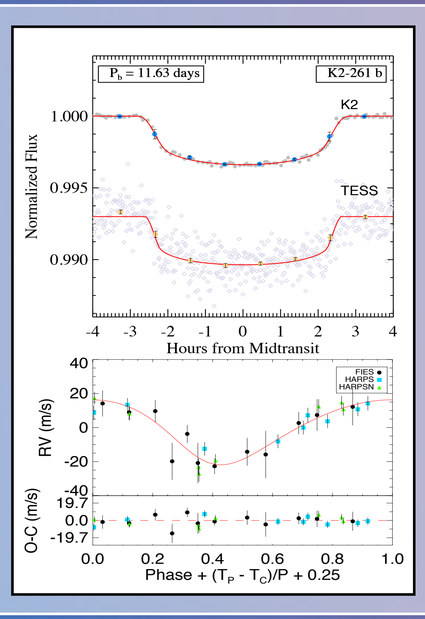








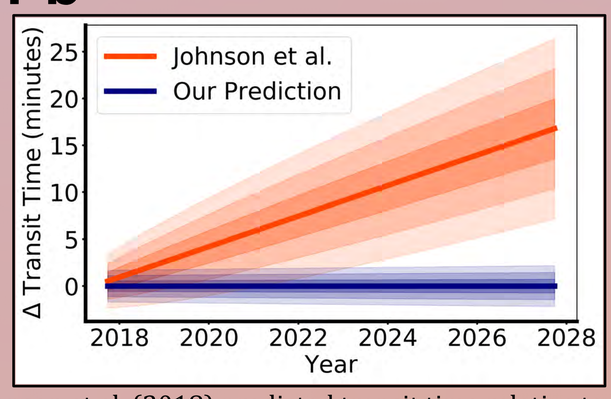
Updated EXOFASTv2 Model for K2-261 b



Parameter	Units	Values
Stellar Parameters:		
M_* ...	Mass ($M_\odot$)	$1.153^{+0.14}_{-0.064}$
R_*	Radius ($R_\odot$)	$1.690^{+0.027}_{-0.028}$
Planetary Parameters:		b
P	Period (days)	11.633476 ± 0.000018
R_P	Radius (R_J)	$0.882^{+0.024}_{-0.022}$
T_0	Transit Time (BJD_{TDB})	$2458023.17617^{+0.00039}_{-0.00042}$
e	Eccentricity	$0.272^{+0.069}_{-0.074}$
M_P ...	Mass (M_J)	0.200 ± 0.029

EXOFASTv2 median values for K2-261.

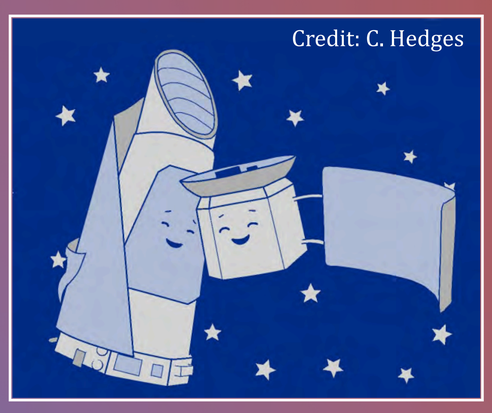
- Using the K2 dataset, Johnson et al. (2018) reported a period of 11.63344 ± 0.00012 days and a transit time $2457906.84084\ ^{+0.00054}_{-0.00067}$ BJD.
- We used EXOFASTv2 (Eastman et al. 2019) to jointly fit the combined TESS and K2 dataset and RVs for K2-261. We improved the precision of the period by a factor of 6.7 and of the transit time by a factor of 1.5.



Johnson et al. (2018) predicted transit time relative to our prediction, projected through ten years. By mid-2027, the predictions differ by over 16 minutes. Shaded regions represent 1-, 2-, and 3-sigma projected uncertainty.

Conclusions and Future Work

- Using observations from both missions, the known planetary systems discovered by K2 can be studied with significantly greater precision.
- The combined data set will be increasingly relevant, as TESS's newly approved extended mission will observe over half of the K2 field.
- These improved ephemerides will be crucial for planning JWST observations.



Sources

- Eastman, J. D., Rodriguez, J. E., Agol, E., et al. 2019, arXiv:1907.09480. (github.com/jdeast/EXOFASTv2)
- Hartman, J. D., Bakos, G. Á. 2016, Astronomy and Computing, 17, 1.
- Johnson, M. C., et al. 2018, MNRAS, 481, 1.
- Lightkurve Collaboration, Cardoso, J. V. d. M., Hedges, C., et al. 2018, Astrophysics Source Code Library, ascl:1812.013.
- Vanderburg, A., Johnson, J. A. 2014, PASP, 126, 944.