Characterizing Planetary Systems Orbiting *TESS* Cool Dwarfs

Courtney D. Dressing[1], Arjun Savel[1], Steven Giacalone[1], Charles Fortenbach[2], David R. Ciardi[3], Lea Hirsch[4], Andrew Mayo[1,*], Elliot Cantor[1], Alexander Ye[1], Ellianna Schwab Abrahams[1,*], Jordan Fleming[1], Charles A. Beichman[3], Mike Lund[3], Joshua E. Schlieder[5], & Jessie L. Christiansen[3]

[1]University of California, Berkeley, [2]San Francisco State University, [3]IPAC-NExScI, [4]Stanford University, [5]NASA Goddard Space Flight Center, [*]NSF Graduate Research Fellow

Project Overview

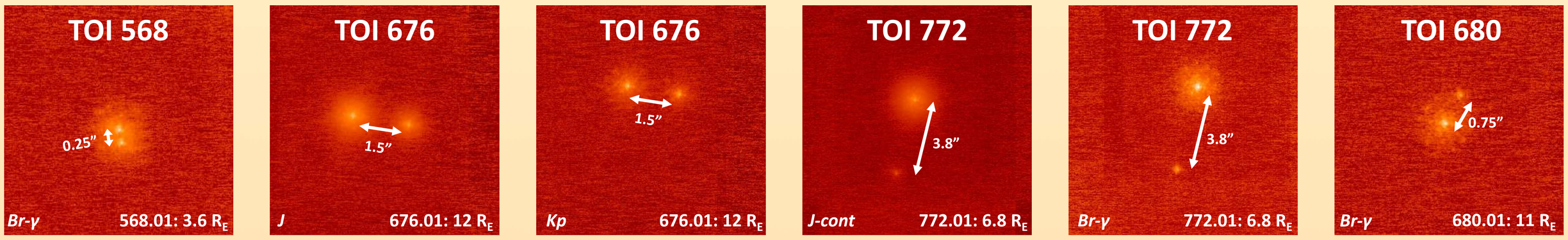
Most stars in the Milky Way Galaxy are cool dwarfs,[1,2] which means that planetary systems orbiting cool dwarfs are a crucial component of the galactic census of planets. Cool dwarfs frequently host planetary systems,[3,4,5,6,7] but the nuances of cool dwarf planet occurrence are not yet fully understood. For our Cycle 1 *TESS* GI program, we are exploring how the properties and prevalence of planetary systems orbiting cool dwarfs depend on stellar properties. The first step is to establish which cool dwarfs host planets and determine the properties of those systems. In this poster, we present initial results from our campaign to characterize *TESS* cool dwarfs and the planetary systems they harbor. We focus here on adaptive optics imaging, but we are also acquiring spectra to determine stellar metallicities, identify eclipsing binaries, and measure planet masses.

The Need for Adaptive Optics Imaging

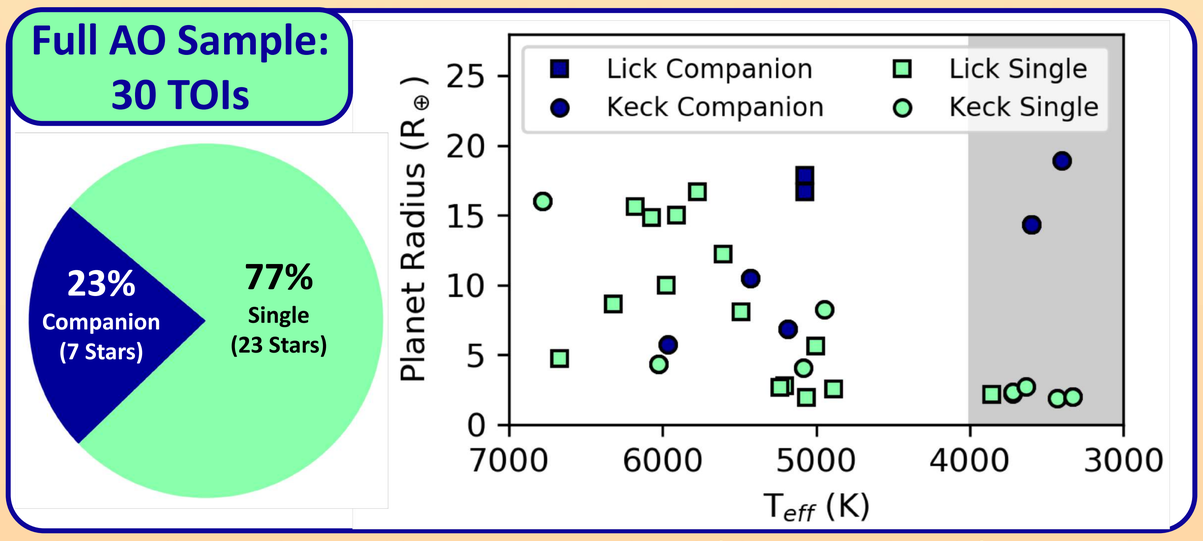
Regardless of whether nearby stars are physically associated or merely chance alignments, light from additional stars within a *TESS* aperture contributes to the observed flux and must be considered to correctly interpret transit-like signals. Ignoring the effects of nearby stars can lead to misclassified eclipsing binaries, underestimated planet radii, and inaccurate planet occurrence rates.[8,9,10]

Results: Adaptive Optics Images of 30 TOIs

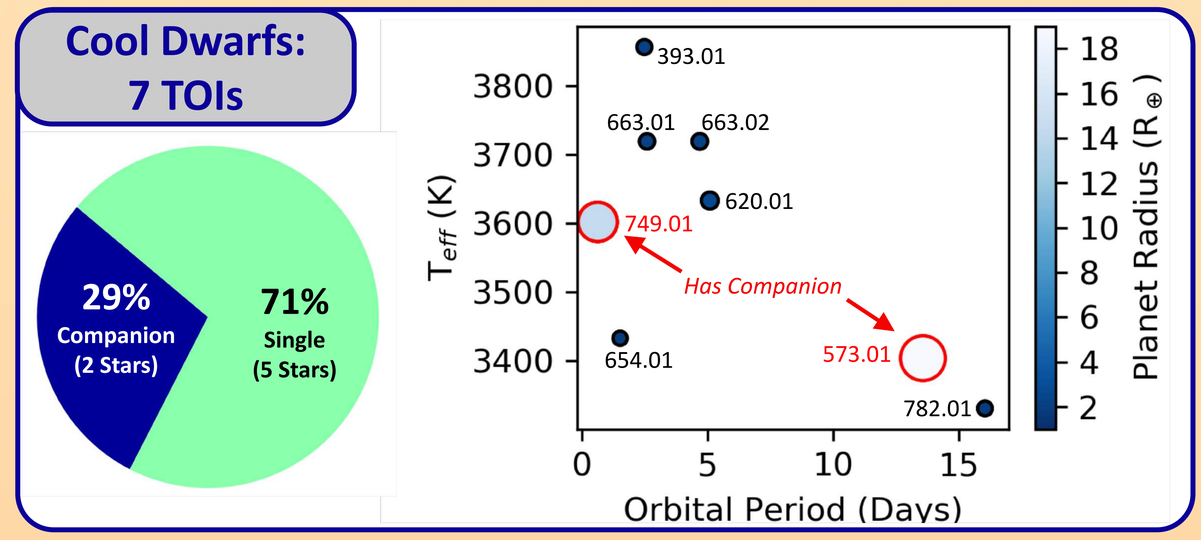
Using NIRC2 on the 10-m Keck II Telescope and ShARCS on the 3-m Shane Telescope at Lick Observatory, we have imaged 30 TOIs including 7 cool dwarfs and 23 hotter stars. We will concentrate more heavily on cool dwarfs once a larger fraction of *TESS* targets are visible from Mt. Hamilton and Maunakea.



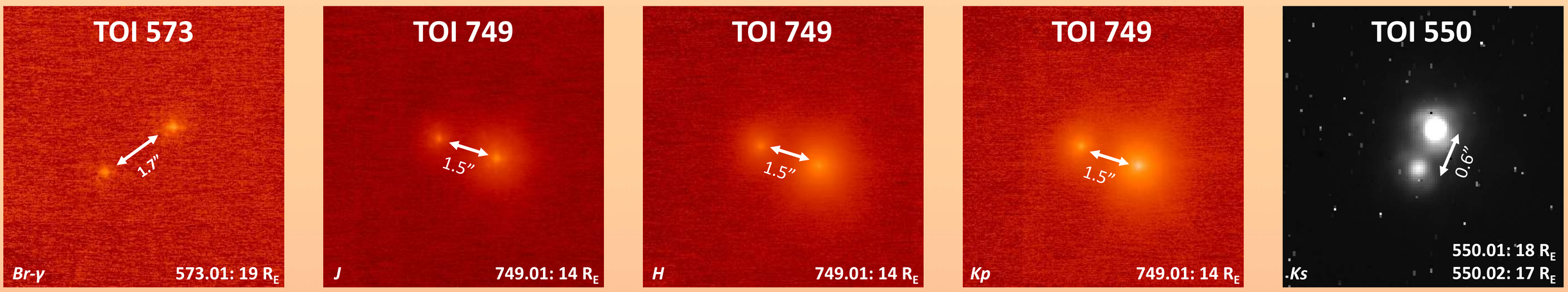
Above: *Keck/NIRC2 images of TOIs with candidate stellar companions and T_{eff} > 4000K. The bandpass of the image is displayed in the bottom left corner of each panel and the reported radii of the associated TOIs from ExoFOP are listed in the bottom right. The Kp filter is a bluer K-band filter with a central wavelength of 2.124 μm.*



Above: *All TOIs observed by our team with Lick/ShARCS and Keck/NIRC2.* ***Left Panel:*** *Fraction of TOIs with detected companions.* ***Right Panel:*** *Planet radius versus stellar T_{eff}. TOI 568 is not plotted because it is missing stellar properties on ExoFOP. The gray region marks the cool dwarf sub-sample (T_{eff} < 4000K).*



Above: *Cool dwarf TOIs observed by our team.* ***Left Panel:*** *Fraction of cool dwarf TOIs with detected companions.* ***Right Panel:*** *Stellar effective temperature and planet radius versus orbital period for cool dwarf TOIs. Note that the deepest transit-like events are associated with the stars that have detected companions.*



Above: *AO images of TOIs with candidate stellar companions. The first four images are reduced Keck/NIRC2 images of cool dwarfs. The rightmost image is a raw image of the hotter star TOI 550 obtained with Lick/ShARCS on July 20, 2019. All three stars are associated with large TOIs that are likely false positives.*

TOI	Tmag	Rp (R_{Earth})	Period (days)	Teff (K)	R* (R_{Sun})	Facility	Contrast @ 0.5” (mag)	Companion Detected?
393.01	10.72	2.2	2.5	3857	0.57	Lick	*in progress*	No
573.01	**12.519**	**19**	**13.6**	**3404**	**0.34**	**Keck**	**5.056**	**Δ_{Ks} = 0.9 Sep = 1.7”**
620.01	10.097	2.7	5.1	3633	0.46	Keck	6.859	No
654.01	12.172	1.9	1.5	3433	0.35	Keck	7.265	No
663.01	11.672	2.1	2.6	3719	0.50	Keck	7.583	No
663.02	11.672	2.2	4.7	3719	0.50	Keck	7.583	No
749.01	**13.592**	**14**	**0.6**	**3602**	**0.44**	**Keck**	**7.681**	**Δ_{Ks} = 1.7 Sep = 1.5”**
782.01	12.191	2.0	16.0	3331	0.30	Keck	7.656	No

Above: *Cool dwarf TOIs observed with Lick/ShARCS and Keck/NIRC2. Two of the seven cool dwarfs have candidate stellar companions.*

Above: *Members of the Dressing Group observing with ShARCS from UCB.* ***Left Panel (from left):*** *Mayo, Savel, Ye, & Cantor.* ***Right Panel:*** *Fortenbach & Savel.*

References

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Acknowledgements

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