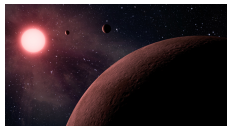
Characterizing the Cool KOIs

An Infrared Spectroscopic Survey of *Kepler* M Dwarf Planet-Candidate Hosts



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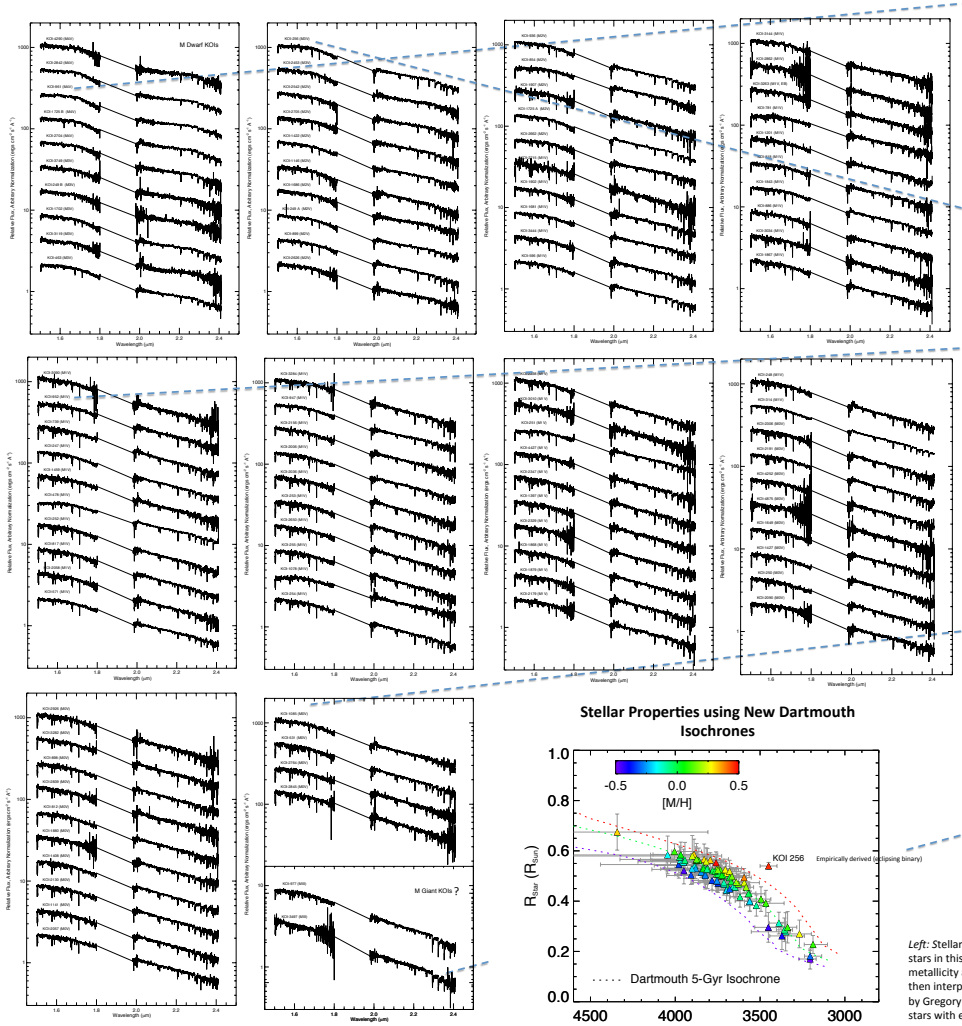
H- and *K*-Band Spectra of Cool KOIs taken with the TripleSpec Spectrograph on the Palomar 200-inch Hale Telescope *Ordered in increasing T_{Eff}*



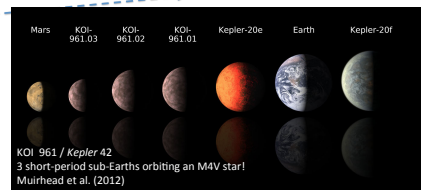
Stellar Properties using New Dartmouth Isochrones

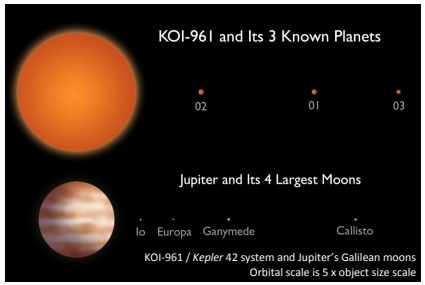
Left: Stellar effective temperature, metallicity and radius determinations for the stars in this sample. We determined stellar effective temperature and metallicity and using the calibrations of Rojas-Ayala et al. (2010, 2012). We then interpolate those values onto new 5-Gyr Dartmouth isochrones calculated by Gregory Feiden (Uppsala University). The new Dartmouth isochrones include stars with effective temperatures less than 3000 K (Muirhead et al. *in prep*).

Right: Comparison to Dressing & Charbonneau (2013), who used photometry to determine Cool KOI properties. Our results generally show good agreement,; however, there is a slight metallicity dependence to our discrepancies. Dressing & Charbonneau (2013) assumed a strict prior for their metallicity determinations due to degeneracies with temperature when using photometry:

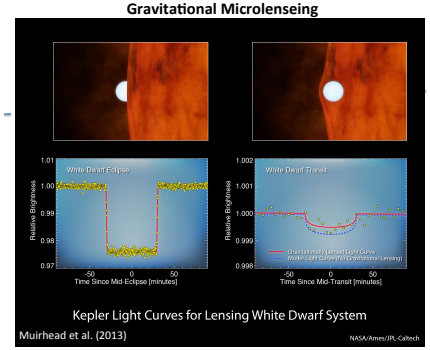
Science Highlights!

KOI-961 / *Kepler* 42: A Mid-M dwarf with 3 Short-period Sub-earths

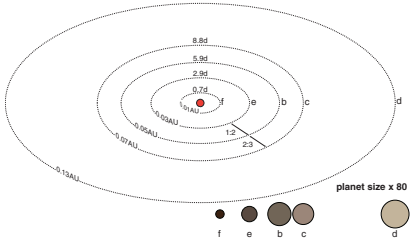




KOI-256: An M Dwarf / White Dwarf Binary with Gravitational Microlenseing

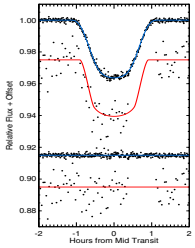


KOI-952 / *Kepler* 32: A Compact System of 5 Planets Swfit et al. (2013)



Spectra provided accurate stellar properties for analysis of KOI-952's 5 planets, aka *Kepler* 32: "A Prototype for the Formation of Compact Planetary Systems Throughout the Galaxy" (Swift et al. 2013).

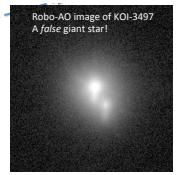
KOI-254 / *Kepler 45* – A Hot Jupiter Orbiting a Metal-Rich M dwarf (Johnson et al. 2012)



Spectra provided an accurate metallicity determination for KOI-254, aka *Kepler* 45, the only M dwarf known to host a hot Jupiter (Johnson et al. 2012). KOI-254 is significantly metal-rich ([Fe/H] = +0.32), further supporting the theory that metallicity plays a significant role in the formation of Jovian-mass planets, even around M dwarfs where Jovian-mass planets are rare (Johnson et al. 2010, Rojas-Ayala et al. 2010, 2012, Mann et al. 2012).

Left: Kepler and Lick Observatory transit measurements
Johnson et al. (2012)

KOI-3497: A False Giant Star



KOI 3497 shows a deep CO (2-0) band head indicative of a giant star, but deep Na and Ca lines are consistent with a dwarf. As noted by Rojas-Ayala, an early + late M dwarf binary can create deep CO. Robo-AO image of KOI 3497 likely confirming the suspicion! **But which star has the planet candidate?** *Image courtesy of the Robo-AO Team, including Christoph Baranec, Reed Riddle, and Nick Law.*

Comparison to Dressing & Charbonneau (2013)