

Constraining the low-mass IMF with *Gaia* + TripleSpec

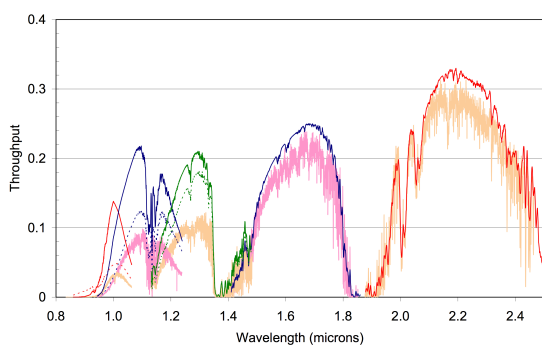
Federico Marocco & Eric Mamajek

What is TripleSpec?

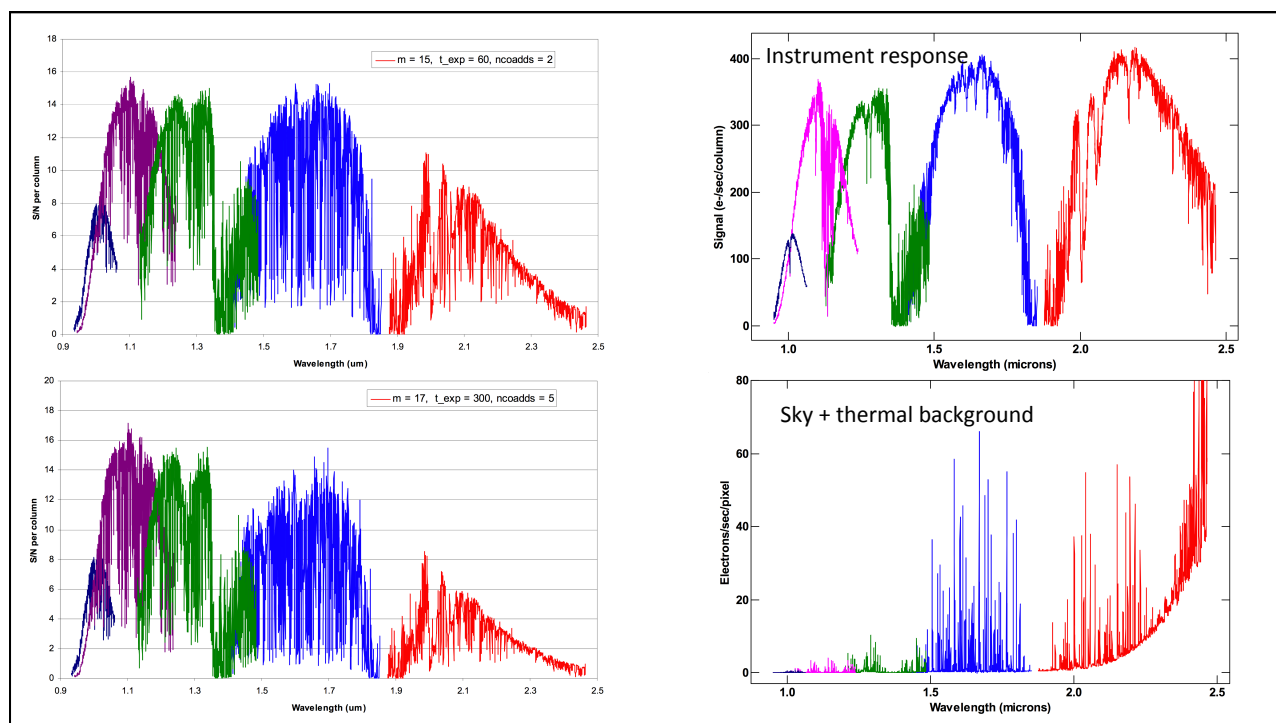
- TripleSpec is a near-infrared, cross-dispersed spectrograph covering wavelengths from 1 - 2.4 microns simultaneously at a resolution of 2700.
- It has a 1024×2048 Hawaii-II HgCdTe array, sampling the spectrum with 2.7 pixels per resolution element.
- The entrance slit is 1×30 arcseconds and the spectrum is spread over five orders in a cross-dispersed design.
- It's an almost identical twin to APO's TripleSpec, Keck's NIRES, and Blanco's (now SOAR) ARCoIRIS
- Example topics where TripleSpec used: gravitationally lensed $1.5 < z < 3$ galaxies (e.g. Belli+2013), reddened AGNs (LaMassa+2017), refining stellar parameters (e.g. effective temperature, metallicity) for exoplanet host stars (e.g. Howard+2014, Dressing+2017), exoplanet emission spectra from secondary eclipses (e.g. Zellem+2014), characterizing brown dwarfs (e.g. Loutrel+2011, Montet+2015), spectra of central sources of circumstellar shells/bubbles in Galactic plane (e.g. Flagey+2015). See examples of follow-up of targets from Spitzer, WISE, K2, Chandra, XMM, Gaia, etc.

TripleSpec – Key Characteristics

- Guider/slit viewer field of view – 4.3x4.3 arcmin
- Read noise – 10 e⁻ (down to 3.5 e⁻ with Fowler sampling)
- Time to background limit – ~300s
- Saturation level – ~28000 DN
- Gain – ~3.8 e⁻/DN
- Throughput – 20-30% in H and K band, 10% in J band
- Flexure – 0.5 pix at 45°



Herter et al. (2008)



TripleSpec – Observing and data reduction

- Documentation available at Palomar instrumentation site:

<http://www.astro.caltech.edu/palomar/observer/200inchResources/tspecspecs.html>

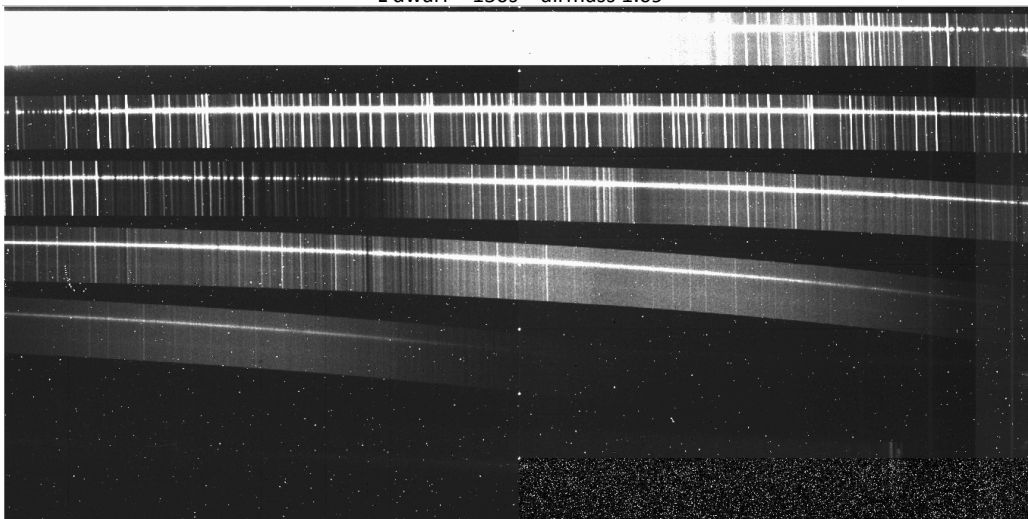
<http://www.astro.caltech.edu/palomar/observer/200inchResources/tspeccookbook.html>

Also Herter et al. 2008, SPIE 7014 (doi: 10.1117/12.789660)

- Standard NIR spectroscopy observing. Calibrations (flats + darks) taken in the afternoon. Wavelength calibration done with OH lines (no arcs).
- Data can be reduced using IDL package SpeXtool (written and maintained by M. Cushing)

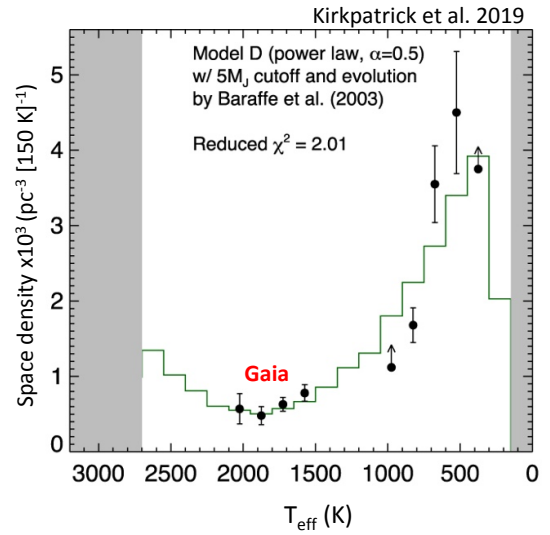
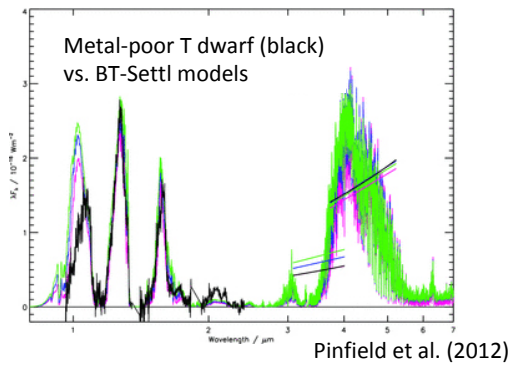
TripleSpec – Sample Data

L dwarf – 150s – airmass 1.09



TripleSpec – Follow-up of Gaia L dwarfs

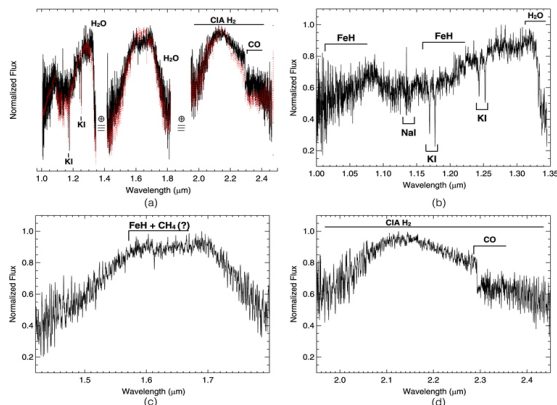
- Goals
 - (1) Completing the 30pc census -> Constraints on the low-mass IMF
 - (2) Identifying and characterizing benchmark systems -> constraints on atmospheric models



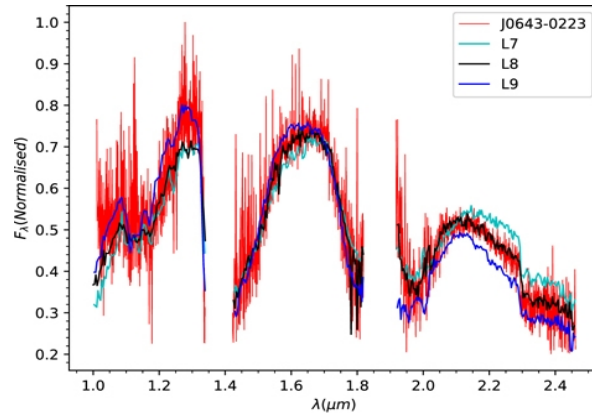
Completing the 30pc census

50+ L dwarfs within 30pc observed so far. The nearest new discoveries:

L7 at 11pc – Faherty et al. (2018)

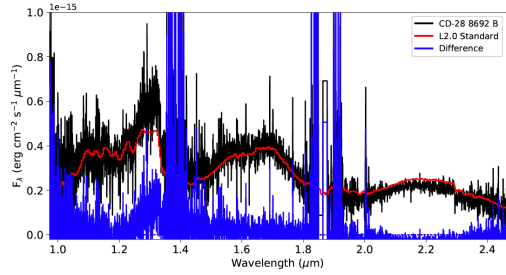


Thick disk L8 at 14pc – Mamajek et al. (2018)

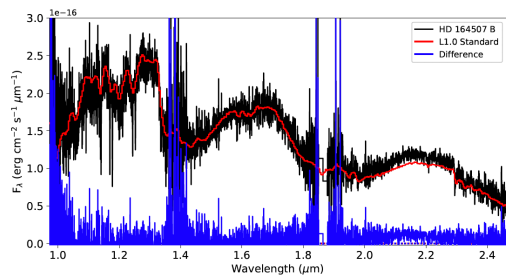


alkali absorption lines

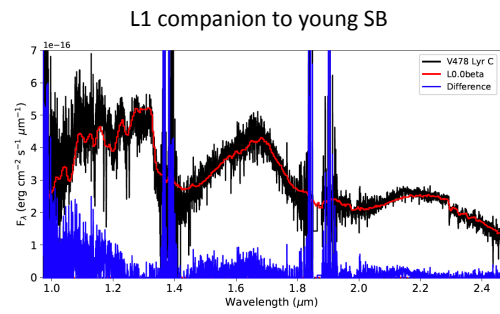
Benchmark systems



L2 companion to metal poor K5V



L1 companion to metal rich G5IV



L1 companion to young SB

Similar T_{eff} , different age/metallicity \rightarrow dependence of spectral features on metallicity/age (i.e. surface gravity)

Marocco et al. (in prep.)