Testing Young Brown Dwarf Atmospheric Properties with L-Band Spectroscopy

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The Big Questions

- Is methane a contributor to the observed atmospheric properties of young brown dwarfs?
- How do these compare to models and field dwarfs?

What Are Brown Dwarfs?

Figure 1: Artistic depiction of brown dwarfs Image by: Dr. Robert Hurt

Outside of our solar system, most people are familiar with the existence of planets and stars, but sitting in between the two are brown dwarfs. Brown dwarfs are defined by their inability to sustain hydrogen fusion, due to a lack of mass. They can have masses ranging from 1 to 72 Jupiter masses and come in four different spectral types, M, L, T and Y, with M being the brightest and hottest, and Y being the coolest.

Why Are Young Brown Dwarfs Important?

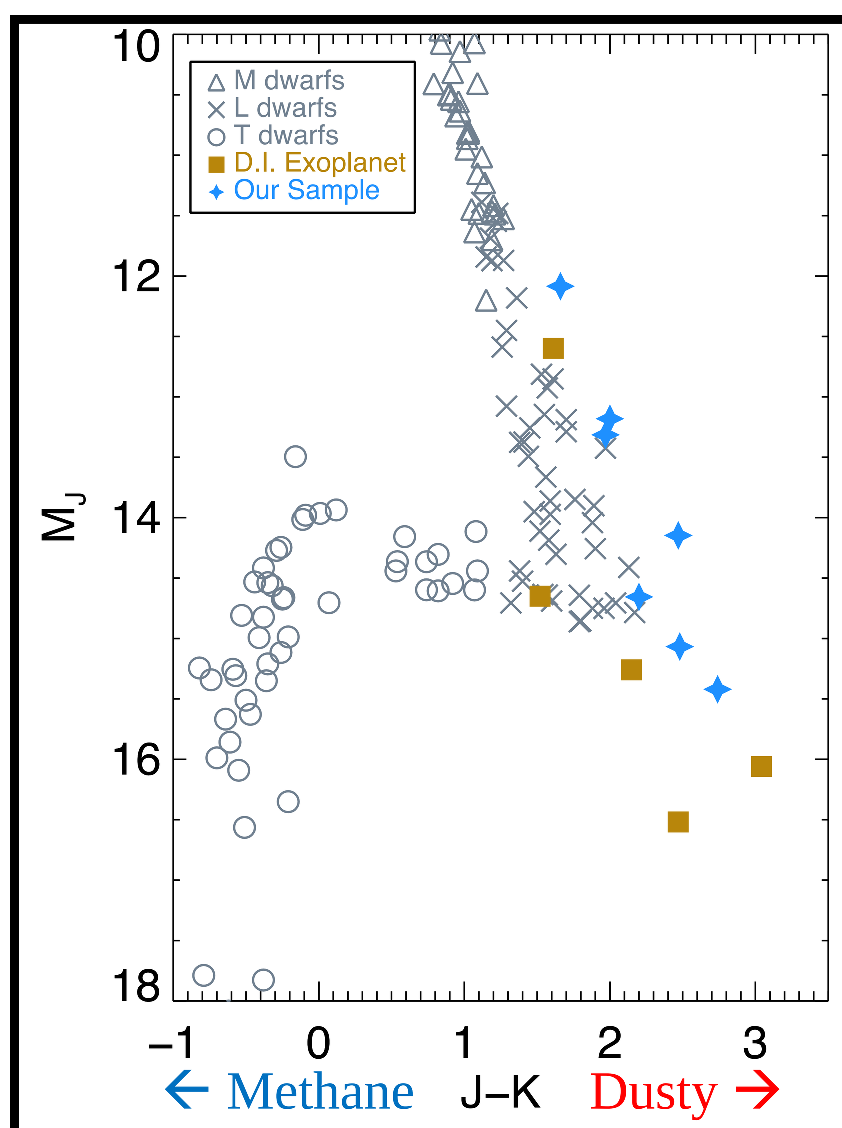

Figure 2: Color-Magnitude diagram for field brown dwarfs (Dupuy and Liu 2012) showing the transition from red, dusty L dwarfs to blue, methane-rich T dwarfs. Young, directly-imaged exoplanets (HR8799bcd, 2M1207b, and bPicb; Currie et al. 2011, Chauvin et al. 2004, Biller & Close 2007, Liu et al. 2016) show anomalously red J-K colors for their brightness. Our sample (blue points, Liu et al. 2016) consists of young exoplanet analogues.

Is There Methane?

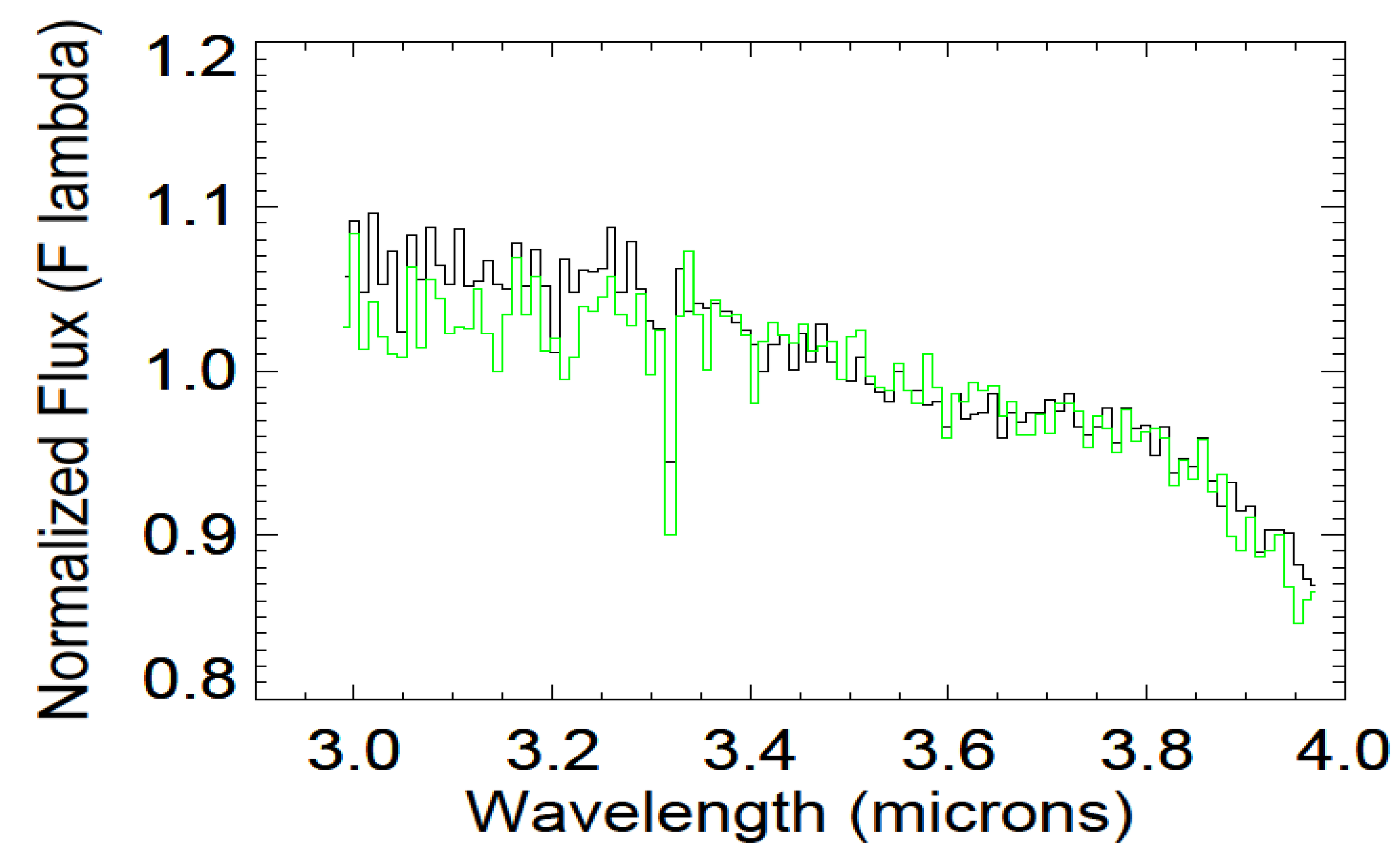

Figure 3: L-Band spectra of 2MJ0501-00 (L3 VL-G) from two different nights.

Several of our spectra show absorption at 3.3 microns, even after telluric correction, indicating methane is found in these objects.

How Do Young Brown Dwarfs Compare To Field Dwarfs?

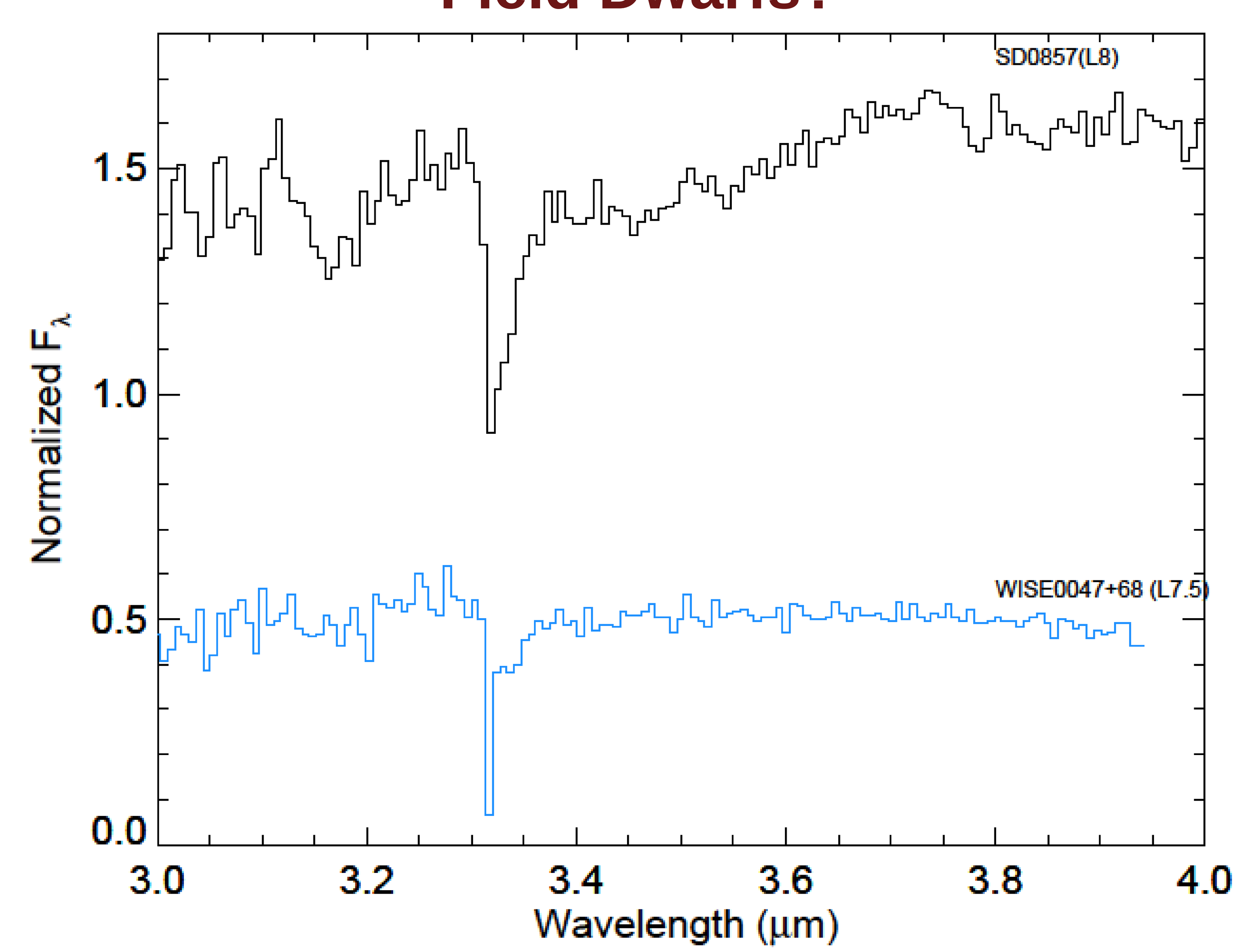

Figure 3: In black is the spectrum for the L8 field dwarf SD0857 (Cushing et al 2005), and in blue is our spectrum for WISE0047, which has a spectral type of L7.5. The field dwarf has slightly deeper and broader methane absorption band than it's young dwarf counter part, however both field and young dwarfs show the onset of methane absorption at around the same spectral type (L3).

Comparisons to Models

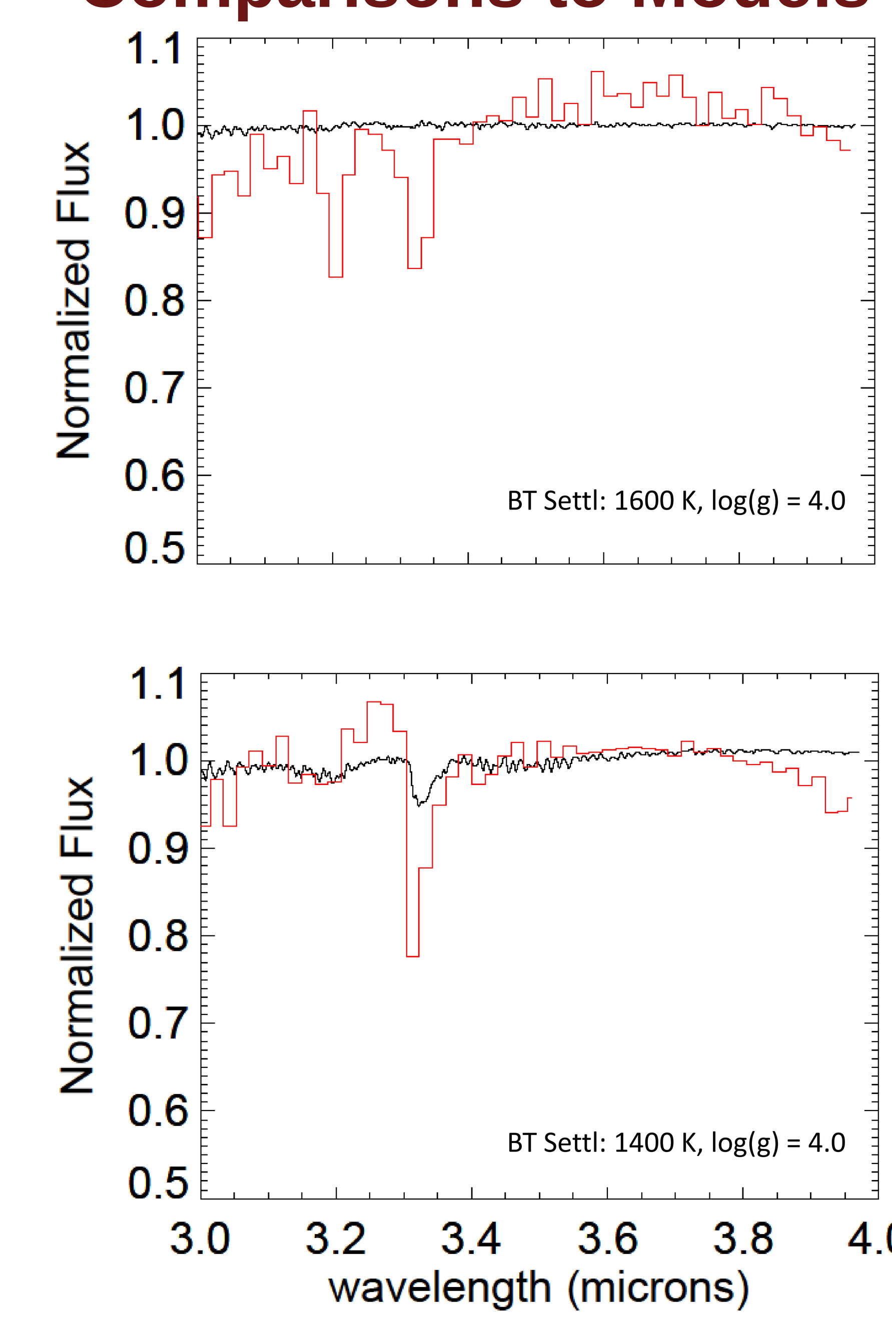

Figure 4 and 5: In red, PSOJ318.5-22 (top) and WISE 0047+68 (bottom) binned spectra compared to BT Settl models (Allard et al. 2011). The atmospheric models (black) have the best-fit parameters as determined from near-IR (1-2.5 micron) spectroscopy (Gizis et al. 2015, Liu et al. 2013). The models clearly underestimate the methane absorption at 3.3 microns, which is consistent with the near-IR model fits being too hot.

What Comes Next?

The next step is to begin stitching together our L-band spectra with that spectra from other bands. This will require us to flux calibrate our spectra using existing photometry and atmospheric models. We are also looking to compare these spectra to a wider variety of models.

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