Building a Volume-Limited Sample of L/T Transition Dwarfs with the Pan-STARRS 1 and WISE Surveys

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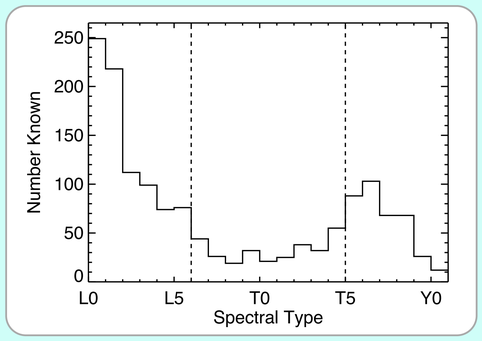
- We have searched ~30,000 deg² in the Pan-STARRS 1 (PS1) 3π and WISE All-Sky surveys for brown dwarfs in the L/T transition.
- Previous large-scale searches have been incomplete for L/T transition dwarfs because these objects are faint in optical bands, and have near-infrared colors that are difficult to distinguish from background stars.
- We have cross-matched the PS1 (optical) and WISE (mid-IR) catalogs to produce a unique multi-wavelength database.
- We have obtained near-IR SpeX spectra for 142 candidates and confirmed that 80 are new L/T transition dwarfs, 28 within 25 pc.
- These new discoveries will...
  - substantially improve the completeness of the 25 parsec L/T dwarf census;
  - refine the constraints on the local substellar mass function;
  - help us to better understand and model the evolution of brown dwarf atmospheres through the L/T transition.

Why L/T Dwarfs?

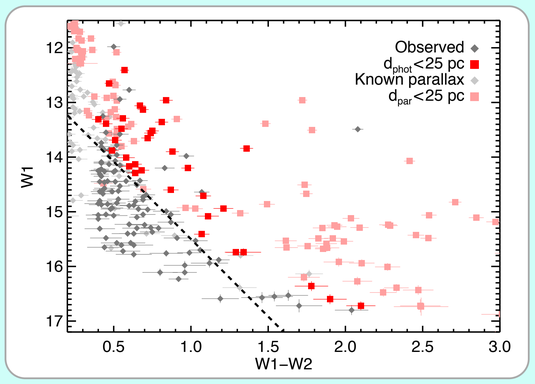
- Only ~20% of known brown dwarfs are in the L/T transition (spectral types ≈ L6-T5).



- Previous all-sky searches based on 2MASS have found few L/T objects.
- Objects undergo drastic spectral changes across the L/T transition (≈ 1300-900 K), which models find difficult to reproduce.
- Large-amplitude periodic variability has been observed in some L/T dwarfs.
- A larger, well-defined sample of L/T transition dwarfs will **improve constraints on the substellar mass function, and provide more templates for brown dwarf atmospheric models**.

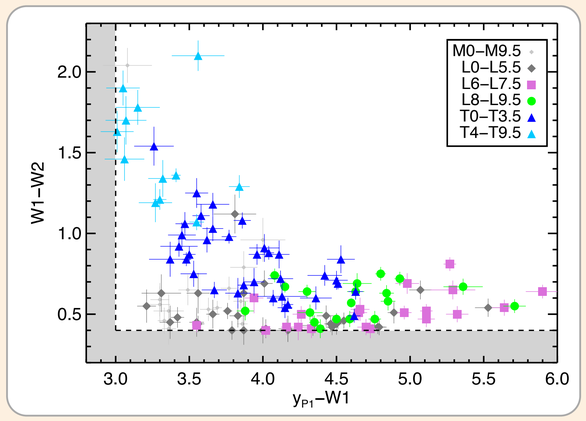
Volume-Limited at 25 pc

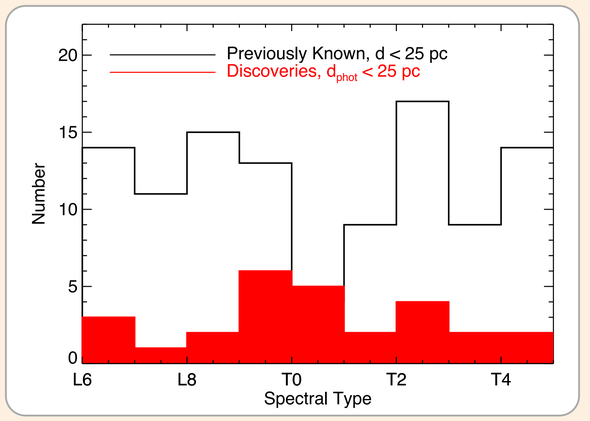
- **We want to characterize the L/T transition population within 25 pc**, the same volume as the PMSU M dwarf survey and the Gliese catalog.
- Empirically, we find that ultracool objects with **W1 ≲ 2.833×(W1-W2) + 12.667** have photometric (W2) distances < 25 pc.

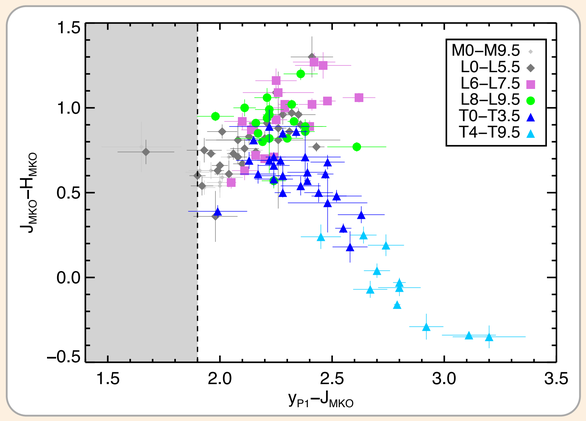


CMD of objects for which we obtained spectra (dark grey diamonds), highlighting those with photometric distances < 25 pc (red squares). Overplotted are ultracool dwarfs with parallaxes from Dupuy & Liu (2012), in light grey and pink.

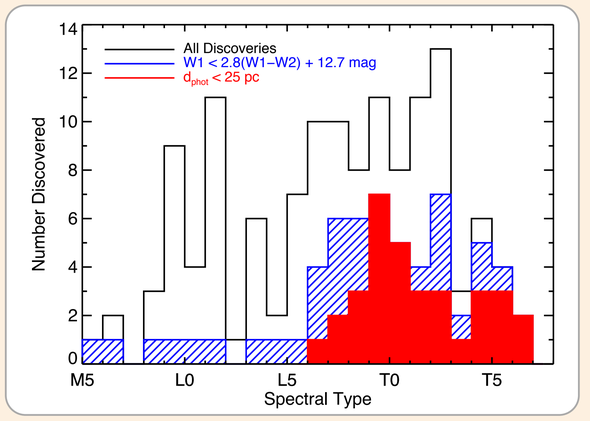
New Discoveries





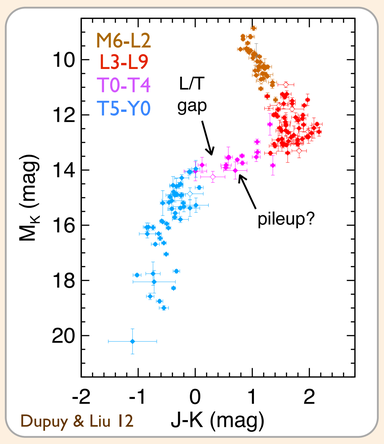


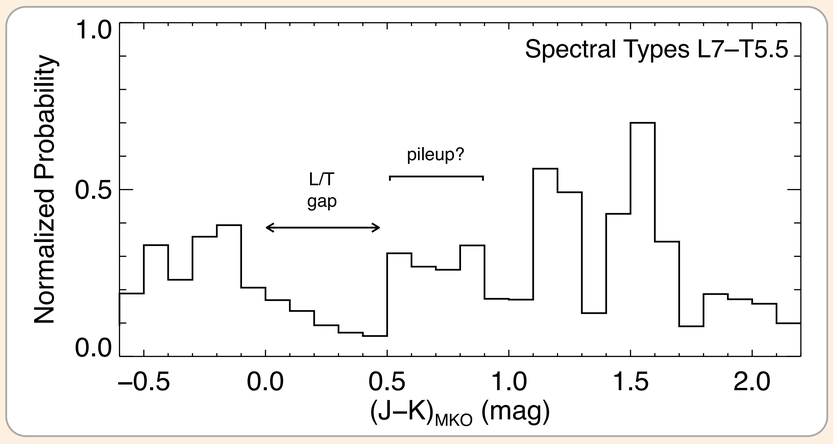
Colors of spectroscopically confirmed discoveries. **The PS1 y-band helps to distinguish late L-dwarfs from earlier-type objects.** Shaded regions indicate colors excluded by our search.



Results of spectroscopic observations. **We have identified 80 L/T transition dwarfs so far, including 28 with photometric distances within 25 pc.**

An L/T Transition Gap





Left: CMD of ultracool dwarfs with known parallaxes. Right: Distribution of J-K colors for 62 L/T transition dwarfs within 25 pc (parallax or photometric distances), computed in a Monte Carlo fashion accounting for errors in colors. **The labeled "L/T gap" and "pileup?" may be due to the removal of condensate cloud opacity**, which slows evolution across the L/T transition (Saumon & Marley 2008, Dupuy & Liu 2012).

Next: A Large Volume-Limited Sample Defined by Parallaxes

Over the next 2-3 years we will build a complete volume-limited sample of ultracool dwarfs, large enough for robust population studies and statistical analysis:

- **Spectral types L0-T6**
- **Limited at 25 parsecs**
- **All objects -30° ≤ dec ≤ 60°**
- **Total ≈400 objects**
- **≈300 new parallaxes from Pan-STARRS and UKIRT**

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