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

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Why L/T Dwarfs?
• Only ~20% of known brown dwarfs are in the L/T transition (spectral types ≈ L6–T5).

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.

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.

An L/T Transition Gap

L/T gap

Spectral Types L7–T5.5

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).

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.

New Discoveries

Previously Known, d < 25 pc
Discoveries, d < 25 pc

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

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

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.

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