A Volume-Limited Search for L/T Transition Brown Dwarfs with the Pan-STARRS 1 and WISE Surveys

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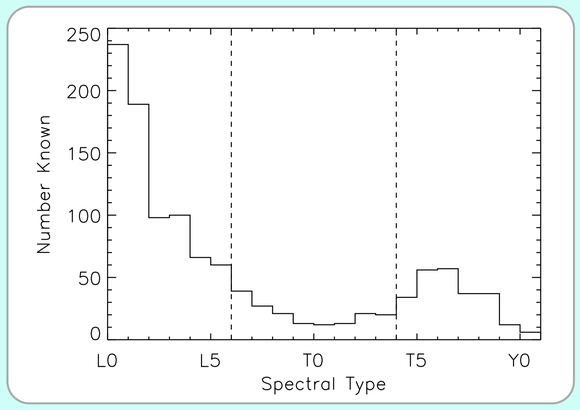
- We have searched ~30,000 deg^2 in the Pan-STARRS 1 (PS1) 3π and WISE All-Sky surveys for brown dwarfs in the L/T transition.
- Previous large-scale searches have been incomplete for L/T transition dwarfs because these objects are faint in optical bands, and have near-infrared colors that are difficult 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 123 candidates and confirmed that 71 are new L/T transition dwarfs.
- These new discoveries will...
  - increase the census of L/T dwarfs within 25 pc by ~50%;
  - significantly improve the constraints on the local substellar mass and luminosity functions;
  - help us to better understand and model the evolution of brown dwarf atmospheres through the L/T transition.

Why L/T Dwarfs?

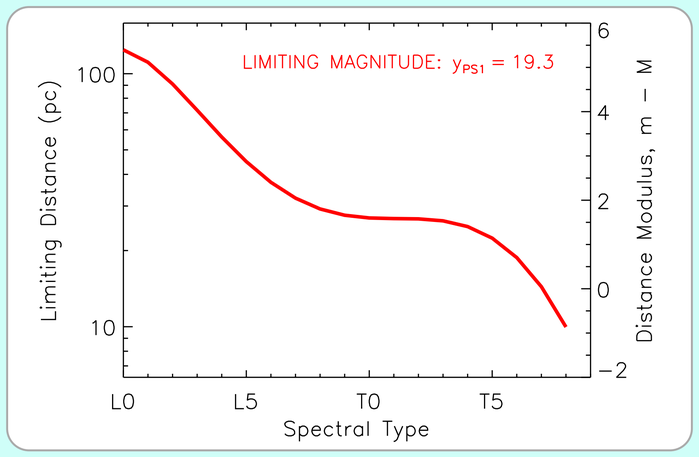
- Only ~10% of known brown dwarfs are in the L/T transition (spectral types ≈ L6–T3.5).



- 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.
- Weather-related 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 atmospheric models**.

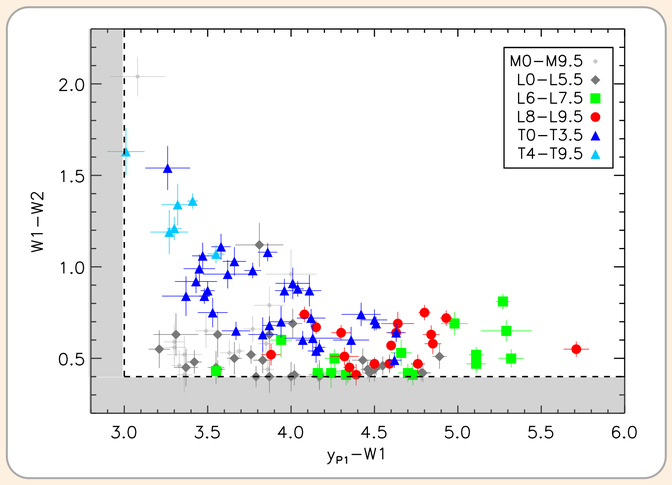
Volume-Limited at 25 pc

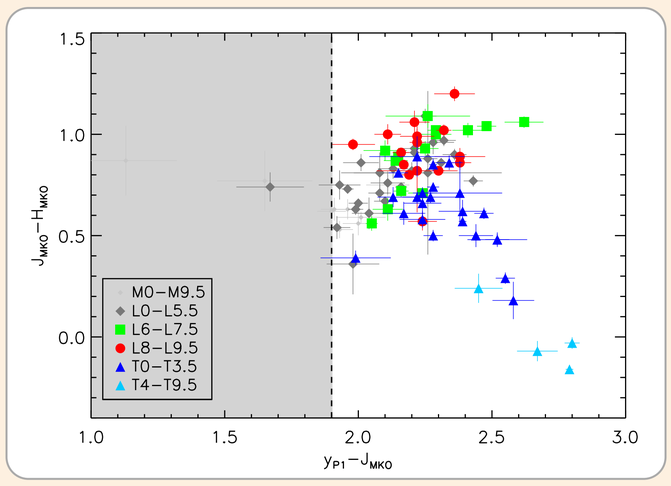
- y_{P1} is fairly constant across the L/T transition, so a magnitude-limited sample will be similar to a volume-limited one (for single objects).
- **y_{P1} ≈ 19.3 mag corresponds to a distance of 25 pc**, the same search radius as the PMSU M dwarf survey and the Gliese catalog.



Limiting distances for brown dwarfs with $y_{P1} \leq 19.3$ (S/N ≈ 12), using magnitudes for known brown dwarfs detected in y_{P1}. Parallax distances are used where available; otherwise, photometric distances are used.

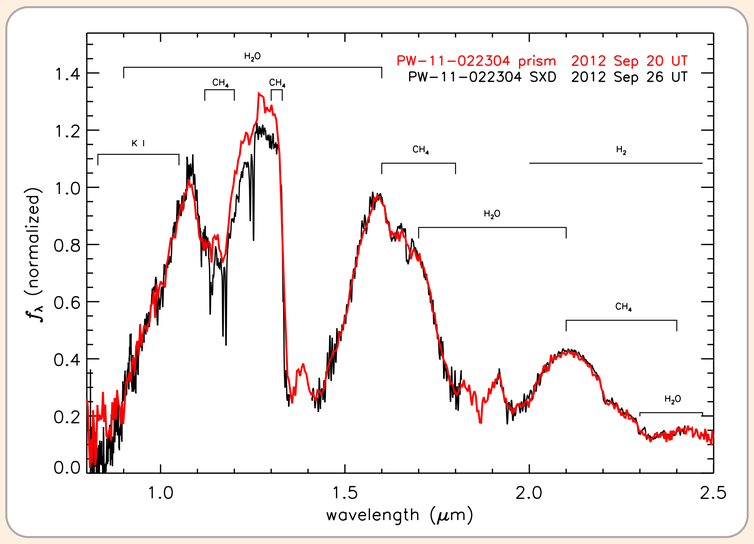
New Discoveries

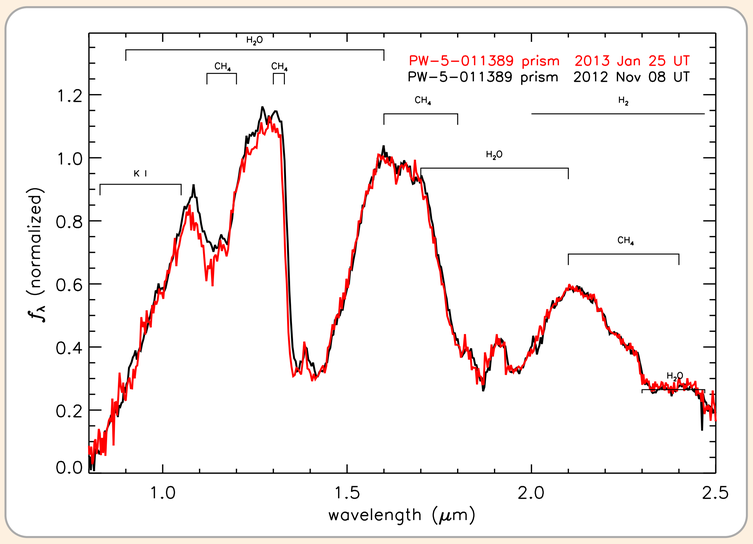




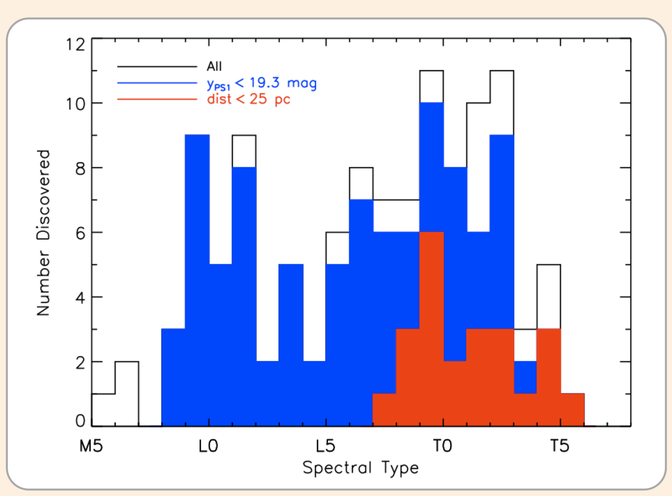
Colors of new spectroscopically confirmed ultracool dwarfs from our search. JHK photometry is from UKIDSS and UKIRT/WFCam observations. Shaded regions show colors excluded by our search process.

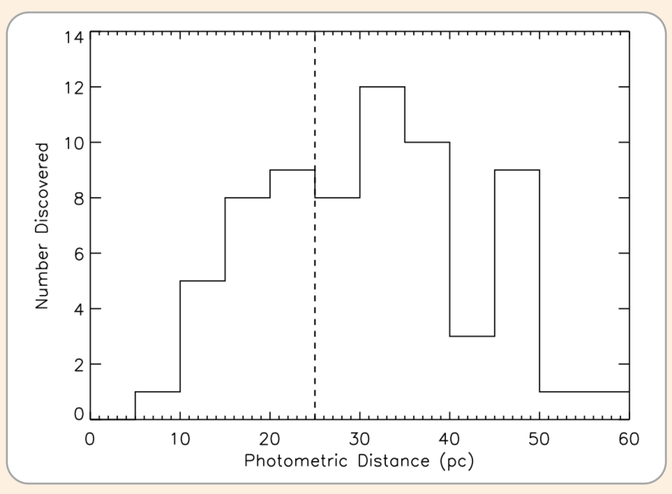
New L/T Spectroscopic Variables





We have identified a T1.5 dwarf (left) and an L9.5 dwarf (right) that each show spectroscopic variability between two epochs. All spectra have been normalized to the H-band peak (1.58 μm).





Results of spectroscopic observations. We have identified 23 brown dwarfs within 25 pc so far, all with spectral type L7 or later.

PS1 3π Survey

PS1 has mapped the entire sky north of Dec = −30° several times to date in five *grizy* filters, including y_{P1} down to ~20.3 mag (single epoch), equivalent to ~1 mag deeper than SDSS. PS1 3π is mapping the entire search area twelve times over 3.5 years (finishing in Dec 2013) in five filters, enabling internal proper motion and parallax measurements.

Search Status

Our survey is complete for about 3/4 of the search area, and we expect to finish most of the remaining observations later this year.

Brown Dwarfs Come of Age
May 2013
Fuerteventura, Canary Islands

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