The First Search for Exoplanet Weather

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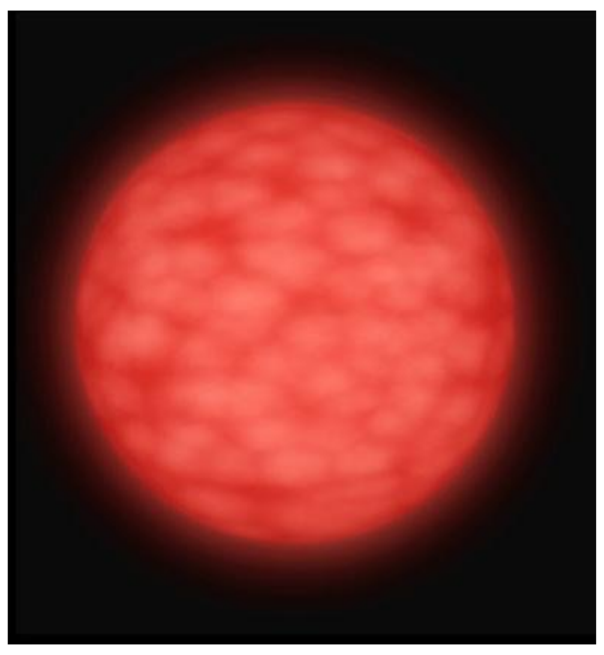
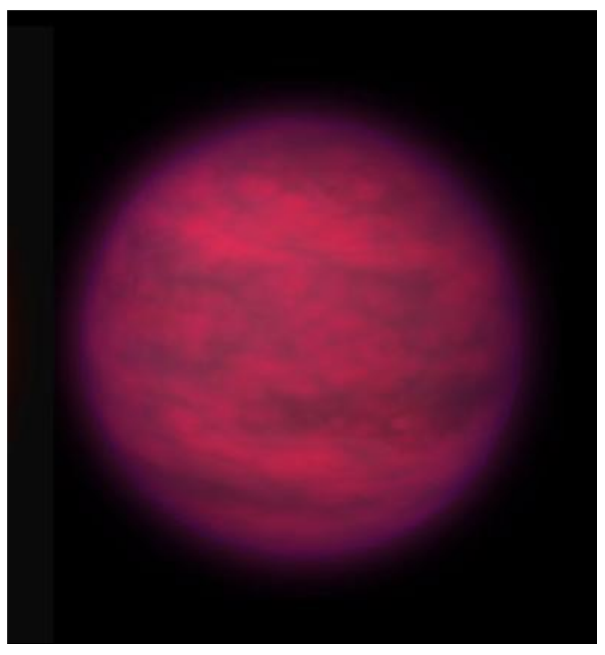
Condensate Clouds in Exoplanet Atmospheres

L Dwarfs @ 2100 K



- Formation of condensate clouds in the atmosphere

T Dwarfs @ 1200 K



- Condensate clouds sink or break up.

- The L/T transition is characterised by a J-band brightening as well as a dramatic blueward shift in the NIR color-magnitude diagram.
- Directly imaged planets occupy the same temperature regime as L/T transition brown dwarfs, and were expected to exhibit similar atmospheric properties.
- However most young exoplanets appear much redder in the near-IR than their brown dwarf counterparts at similar T_{eff} as shown in Fig. 1.

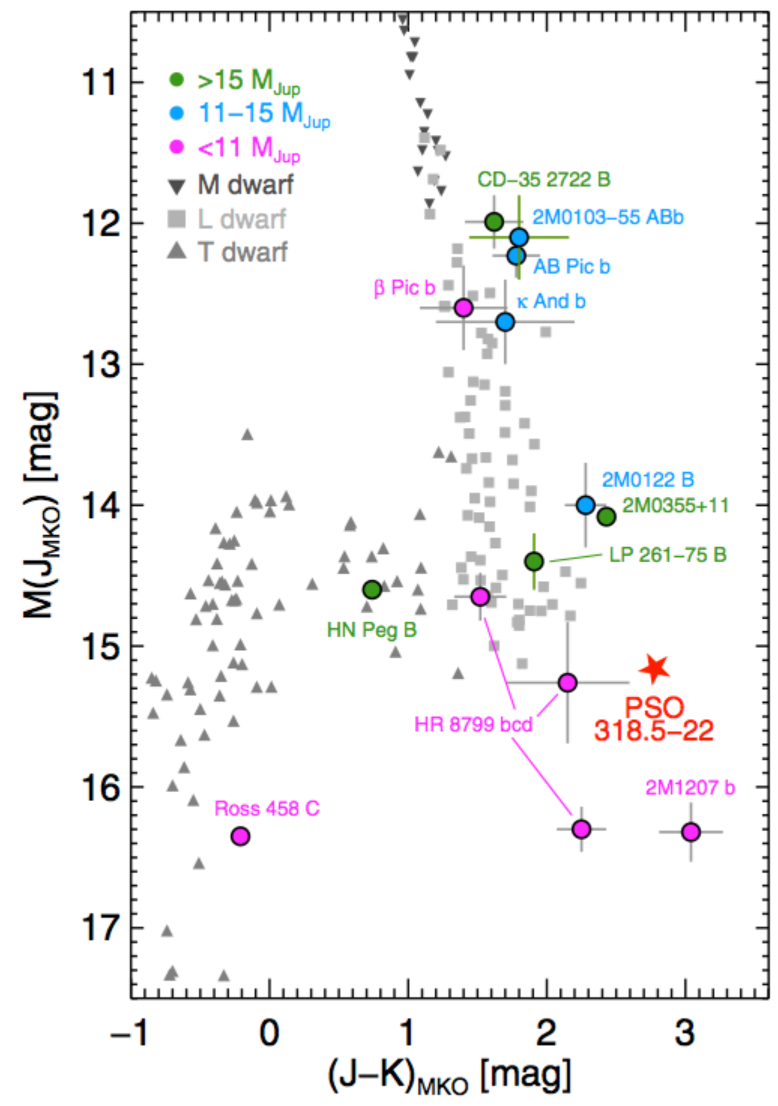


Fig. 1: Color-magnitude diagram of M, L, T brown dwarfs with directly imaged exoplanets plotted in colour (Liu et al., 2013).

Photometric Monitoring is a Key Probe of Weather Phenomena on Exoplanets

Condensate Clouds
+
Rapid Rotation

Photometric Variability

Photometric variability has been detected across the full L-T spectral range, with considerably higher variability amplitudes observed at the L/T transition. Directly imaged planets occupy the same temperature regime as L and T type brown dwarfs and are likely to exhibit similar variability.

We are conducting the first statistically significant search for weather patterns on free-floating young planetary mass objects using the SoFI instrument at the *New Technology 3.5m Telescope*.

Main Objectives:

- **To discover the first weather patterns on planetary-mass objects.**
- **To characterise these weather patterns via multi-wavelength follow-up monitoring.**

Young, Isolated Brown Dwarfs:

- Allow higher photometric precision than directly imaged planets
- Young objects are likely to have higher variability amplitudes (Metchev et al. 2015).
- By studying young objects we push further into the planetary mass regime.

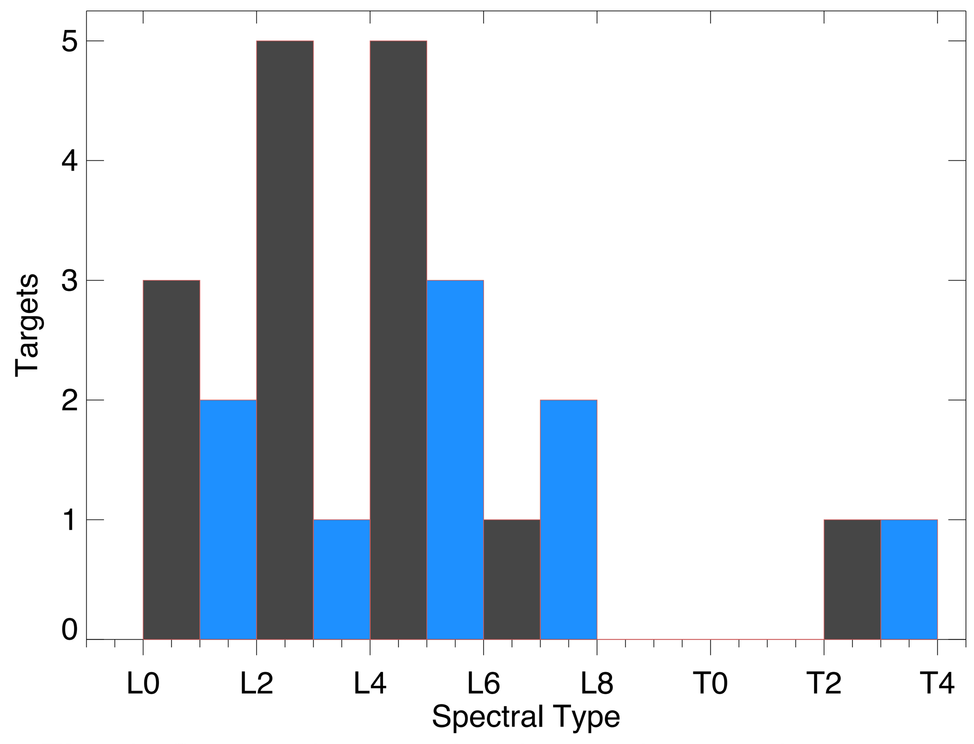


Fig. 2: Spectral type of objects observed.

Results and Future Prospects

- High-amplitude variability detection (Figure 3) for the free-floating planet PSO J318.5-22 (Biller, Vos et al. 2015).
- Multi-wavelength follow-up:
  - determine the rotational period
  - characterise vertical and horizontal cloud structures (Buenzli et al., 2012).
- 4 tentative lower-amplitude variability detections (<5%), e.g. Figure 4.

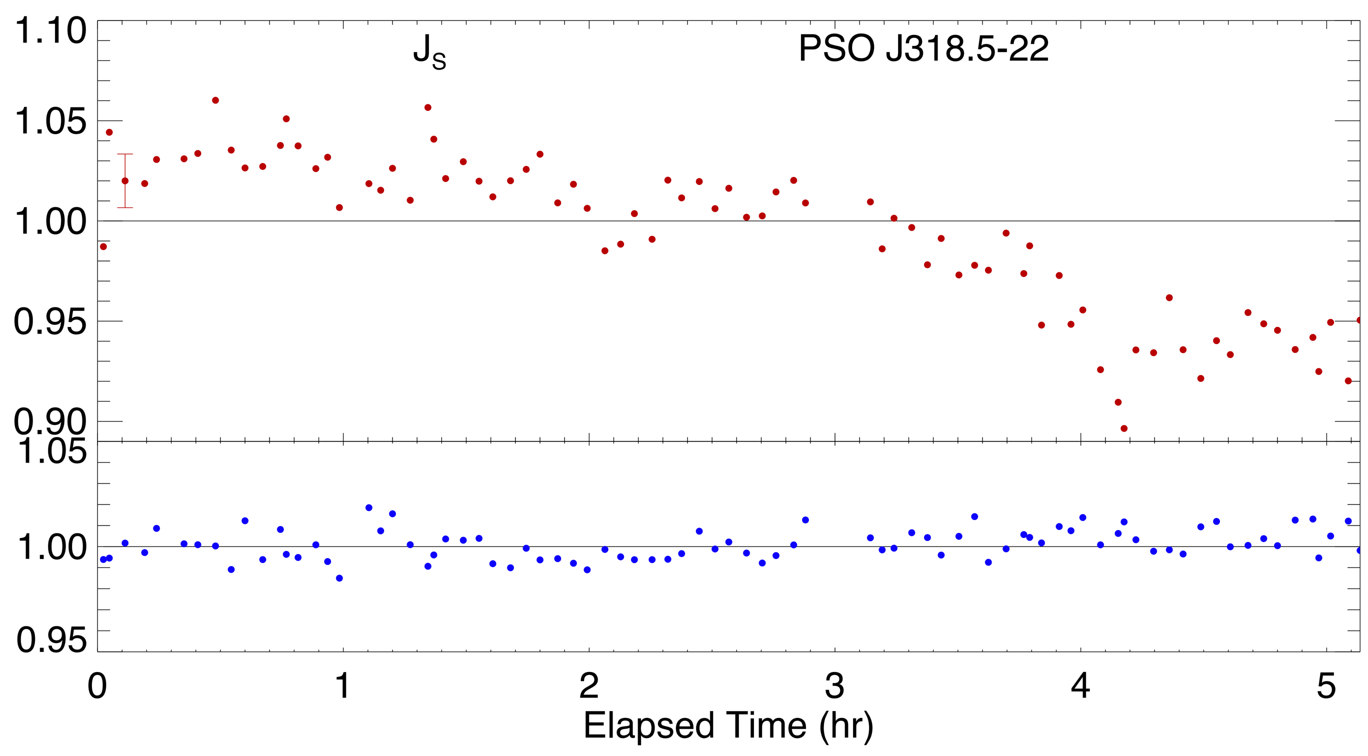


Fig. 3: High amplitude variability detection for PSO J318.5-22. Reference star light curve shown in blue. (Biller et al. 2015)

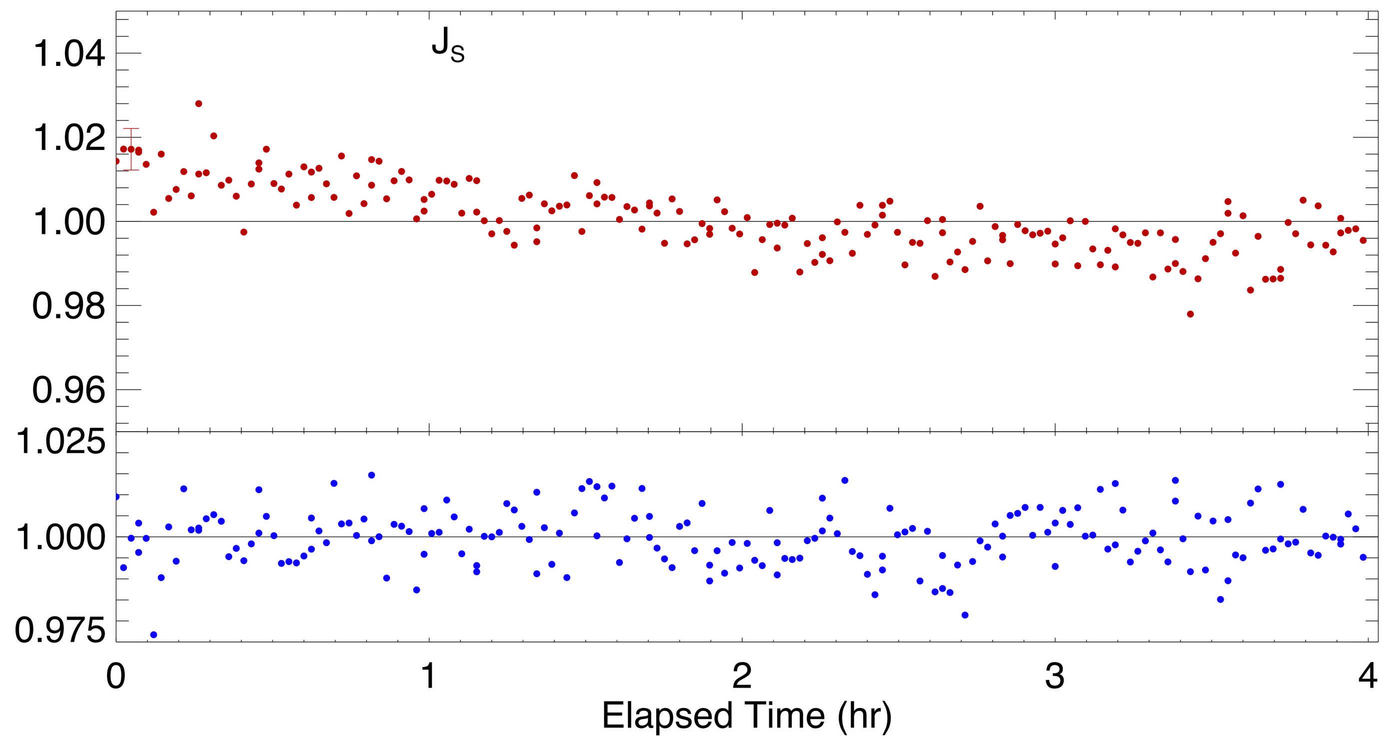


Fig. 4: Detrended light curve for a tentative variability detection shown in red. Sample reference star lightcurve shown in blue.

Future Goals:

- **Constrain the fraction which show variability on rotational timescales.**
- **Probe the effects of surface gravity on cloud structure via comparison with previous brown dwarf variability surveys such as Radigan et al. (2014).**

References

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