Population Properties of Brown Dwarf Analogs to Exoplanets

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Two Important Categories of Brown Dwarf Analogs to Exoplanets

“Brown Dwarf”

~1000 K

~5 M_{Jup}

“Exoplanet”

Host star

~1000 K

~5 M_{Jup}

(1) Same Temperature, Different Mass

(2) Same Temperature, Same Mass (see Faherty+2016)
GPI Spectral Library

Wavelength (μm) vs. Flux

Chilcote et al. 2017,
Rajan et al. 2017,
Greenbaum et al. 2017,
TAKE AWAY: The young brown dwarf sequence does not logically or easily follow from the field sequence.
TAKE AWAY: Clouds are prominent in young brown dwarfs and lacking in equivalent temperature old objects
GPI Discoveries

Beta Pic b
Chilcote et al. 2017

Macintosh et al. 2015

HR 8799
Greenbaum et al. 2017

HR 2562 B
Konopacky et al. 2016

51 Eri b
Konopacky et al. 2016

Size of Saturn's orbit around the Sun

10 AU
Brown Dwarf Analogs to Directly Imaged Exoplanets

- 2M0141: Kirkpatrick et al. 2006
- 2M0355: Faherty et al. 2013
- W0959: Faherty, et al. in prep
- CFBDSIR2149: Delorme et al. 2012
- PSO318: Liu et al. 2013
- W1741L46: Schneider, A. et al. 2013
- W1207: Gagne, Faherty et al. 2014

$T_{\text{eff}}$: 1000 K - 2500 K
Age: 10 - 130 Myr
Mass: $\sim$6 - 30 $M_{\text{Jup}}$
Brown Dwarf Analogs to Directly Imaged Exoplanets

PSO318
Liu et al. 2013

Free-floating planet
PSO J318.5-22

5 - 9 M_{Jup} planet
Brown Dwarf Analogs to Directly Imaged Exoplanets

$T_{\text{eff}}$: 1000 K - 2500 K
Age: 10 - 130 Myr
Mass: $\sim$6 - 30 $M_{\text{Jup}}$
Associations of Young Stars Near the Sun

Banyan Sigma Models are blue ellipses
Gagne+Faherty+ et al. 2018
Associations of Young Stars Near the Sun

More new members on the way!
Faherty et al. 2018
Gagne & Faherty 2018
Gagne & Faherty & Mamajek 2018 in press
Oh17 Catalog of Co-moving Stars
23 new associations, two within 100pc
Faherty et al. 2018; Gagne & Faherty & Mamajek 2018 in press

TAKE AWAY: Gaia is a revolutionary catalog with unprecedented insight into nearby star formation
Brown Dwarf Members of Young Associations

150 objects, 45 confirmed in groups
Faherty et al. 2016; Faherty et al. in prep
Field Objects

$M_H$ (MKO)

FAINT

BRIGHT

$(J - H)$ (MKO)

FAINT

BRIGHT

BLUE

RED
Evolution of a 10 - 13 M$_{\text{Jup}}$ Object

- 5 - 15 Myr: 1882 $\pm$ 84 K
- 30 - 45 Myr: 1793 $\pm$ 50 K
- 110 - 130 Myr: 1230 $\pm$ 27 K
- $>>$1 Gyr: 418 $\pm$ 29 K

Faherty+ in prep
25 Myr β Pictoris Moving Group

- 2375+/- 74 K, 24+/-6 M\textsubscript{Jup}
- 1708+/- 23 K, 12.7+/-0.3 M\textsubscript{Jup}
- 1225+/- 39 K, 7+/-2 M\textsubscript{Jup}
- 633+/- 16 K, 3+/-1 M\textsubscript{Jup}

PMC
Low Gravity

FAINT
BRIGHT

M\textsubscript{H} (MKO)

(J − H) (MKO)

Faherty+in prep

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Faherty+in prep
110 - 130 Myr
AB Doradus Moving Group

2637+/- 371 K, 67+/−50 M\text{Jup}

1566+/- 59 K, 23+/−6 M\text{Jup}

1346+/- 26 K, 14+/−3 M\text{Jup}

927+/- 19 K, 9+/−2 M\text{Jup}

990+/- 54 K, 9+/−2 M\text{Jup}

1230+/- 27 K, 12+/−3 M\text{Jup}

Faherty+in prep

PMC

Low Gravity
TAKE AWAY: Evolutionary models predict bluer colors than those observed for warm, young brown dwarfs and planets.
TAKEAWAYS

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• The young brown dwarf sequence does not logically or easily follow from the field sequence.

• Clouds are prominent in young brown dwarfs and lacking in equivalent temperature old objects.

• Gaia provides new members of known groups (new targets for GPI!) and entirely new associations (new targets for GPI!).

• Young brown dwarfs show a diversity in their spectral features even though they have similar Teff, and age.

• Understanding gravity, metallicity, temperature, and age effects together is critical to interpreting future exoplanet spectra.