

IACTEC

Review Talk

Discoveries of Brown Dwarfs in Large-Scale Surveys

Nicolas Lodieu



BD30years, La Gomera

01 September 2025



Outline



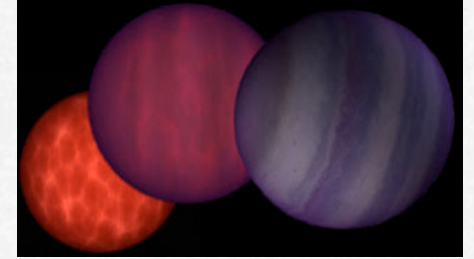
1) Definition of Brown Dwarfs:

- a) Brown Dwarfs
- b) Link to exoplanets

2) Large-scale surveys:

1. History
2. DENIS
3. 2MASS
4. SDSS
5. UKIDSS
6. CFHT-BD survey
7. Pan-STARRS
8. WISE

Brown Dwarfs



1) Definition:

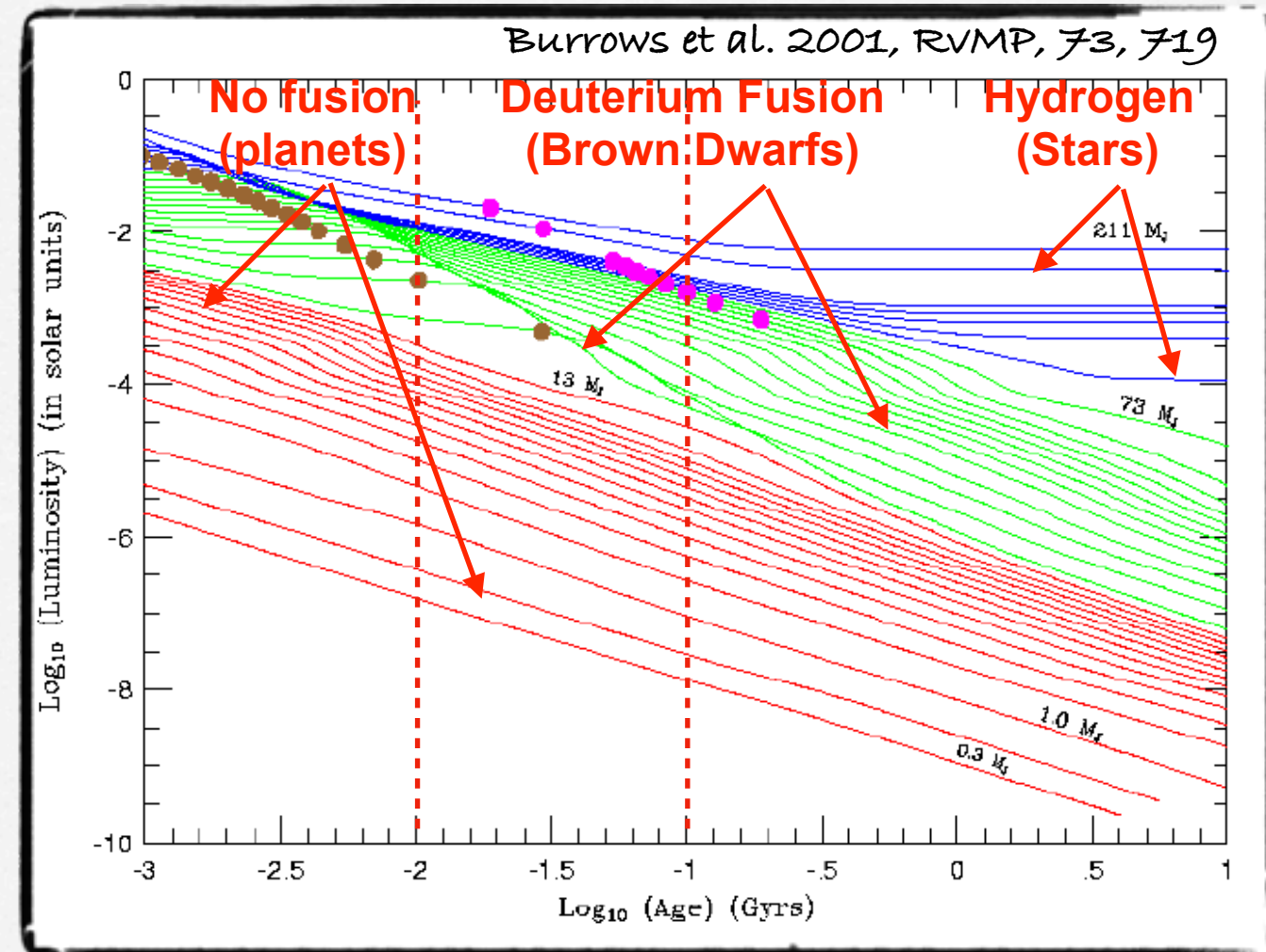
- a) Objects unable to burn hydrogen in their cores
- b) Masses below $0.072 M_{\odot}$
- c) Temperatures below $\sim 2200\text{K}$
- d) Spectral types M, L, T y Y
- e) Link between very low-mass stars and planetary-mass objects

2) Observations:

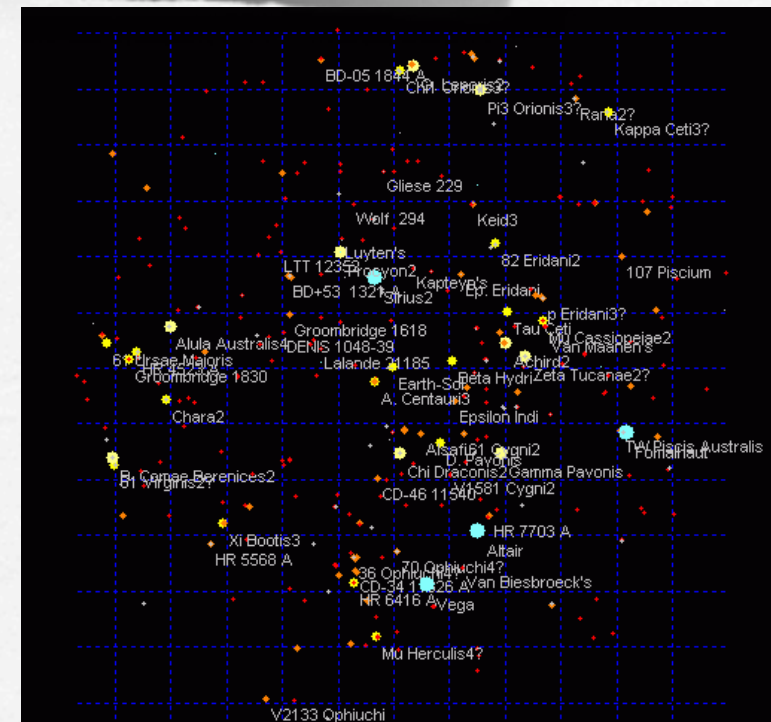
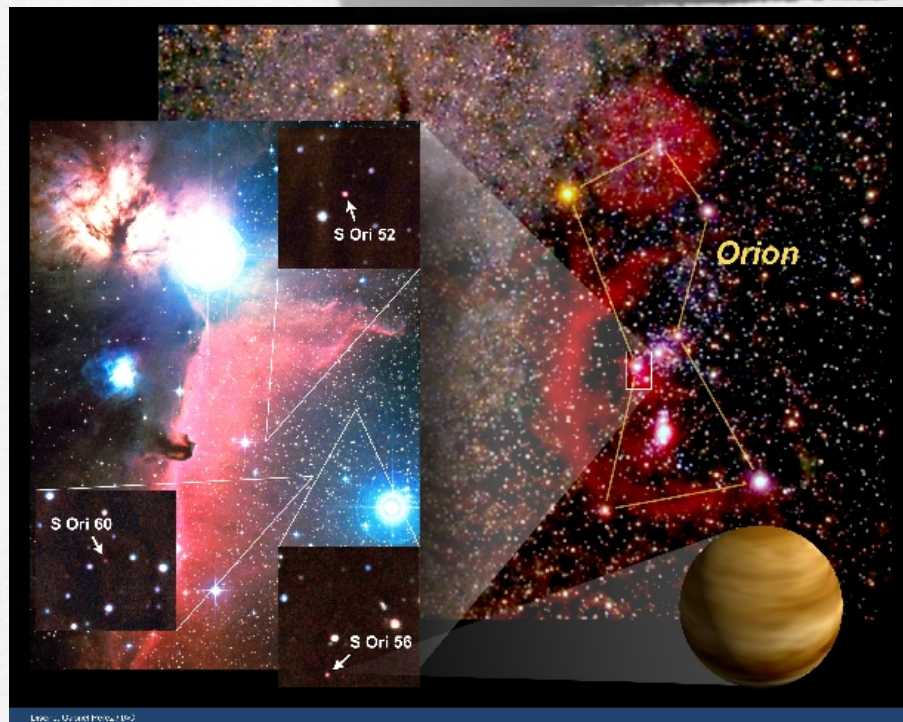
- a) Nearest: Luhman16AB @ 2 pc
- b) Thousands BDs known in the field
- c) Many BDs in clusters with $> M6$

3) Open questions:

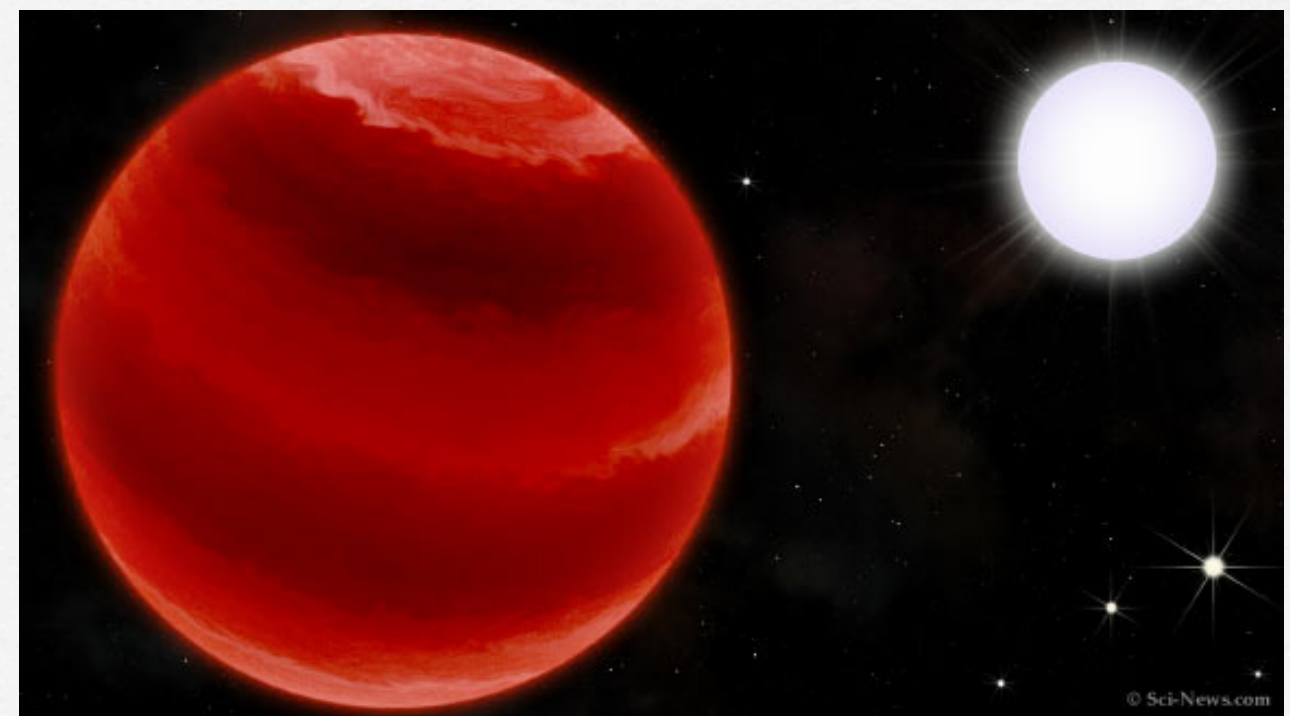
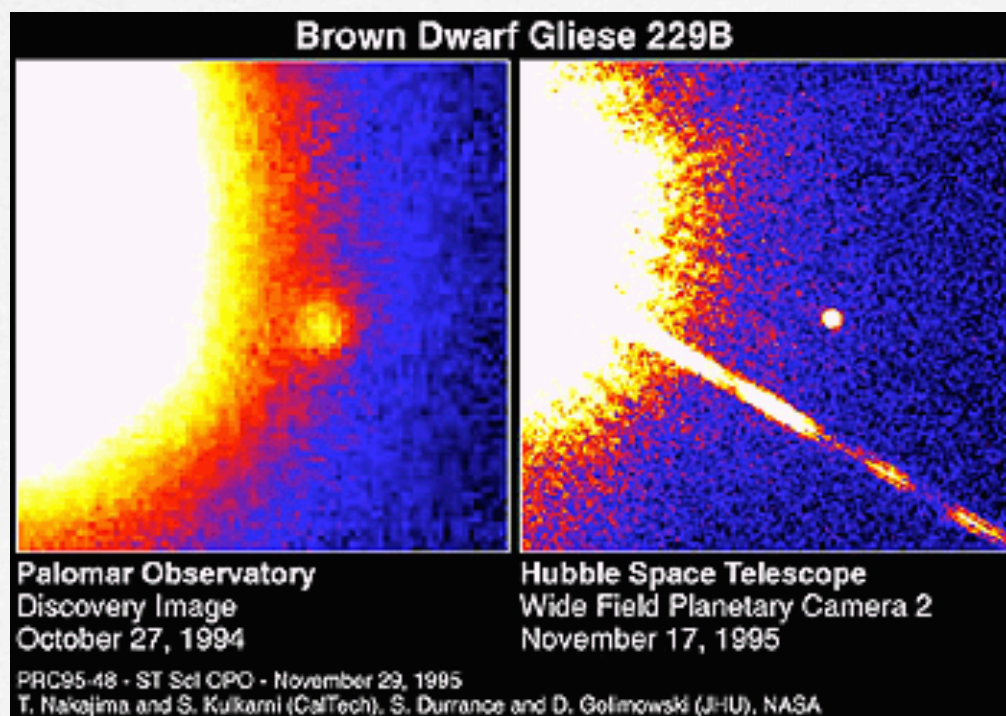
- a) How do physical properties of change with age and metallicity ?
- b) Is the Initial Mass Function universal ?
- c) What is the lowest mass fragments that mother nature can form ?



Brown Dwarfs



~27% of the census within 8 pc are substellar



Link between BDs and Exoplanets

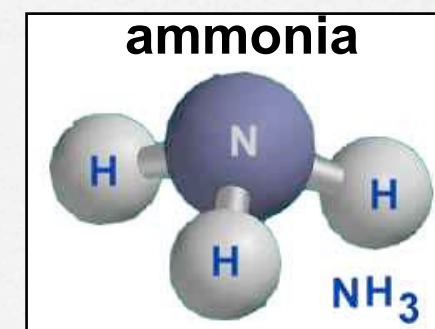
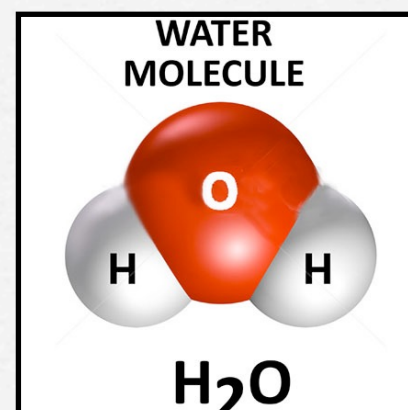
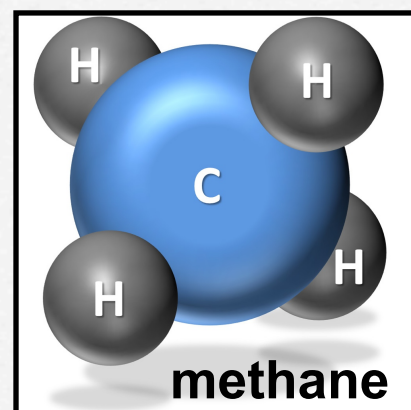
1) Temperature



2) Radius

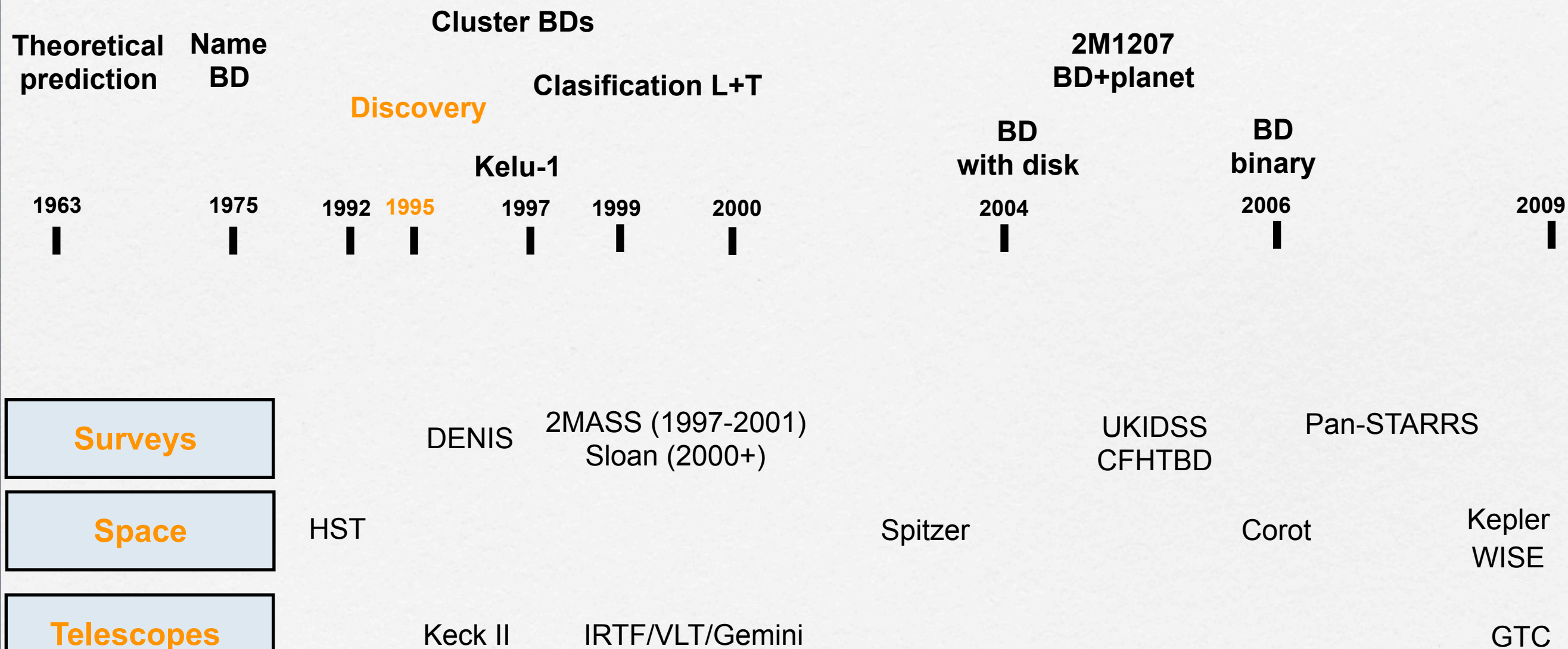


3) Composition



Large-scale surveys

History of large-scale surveys



DENIS

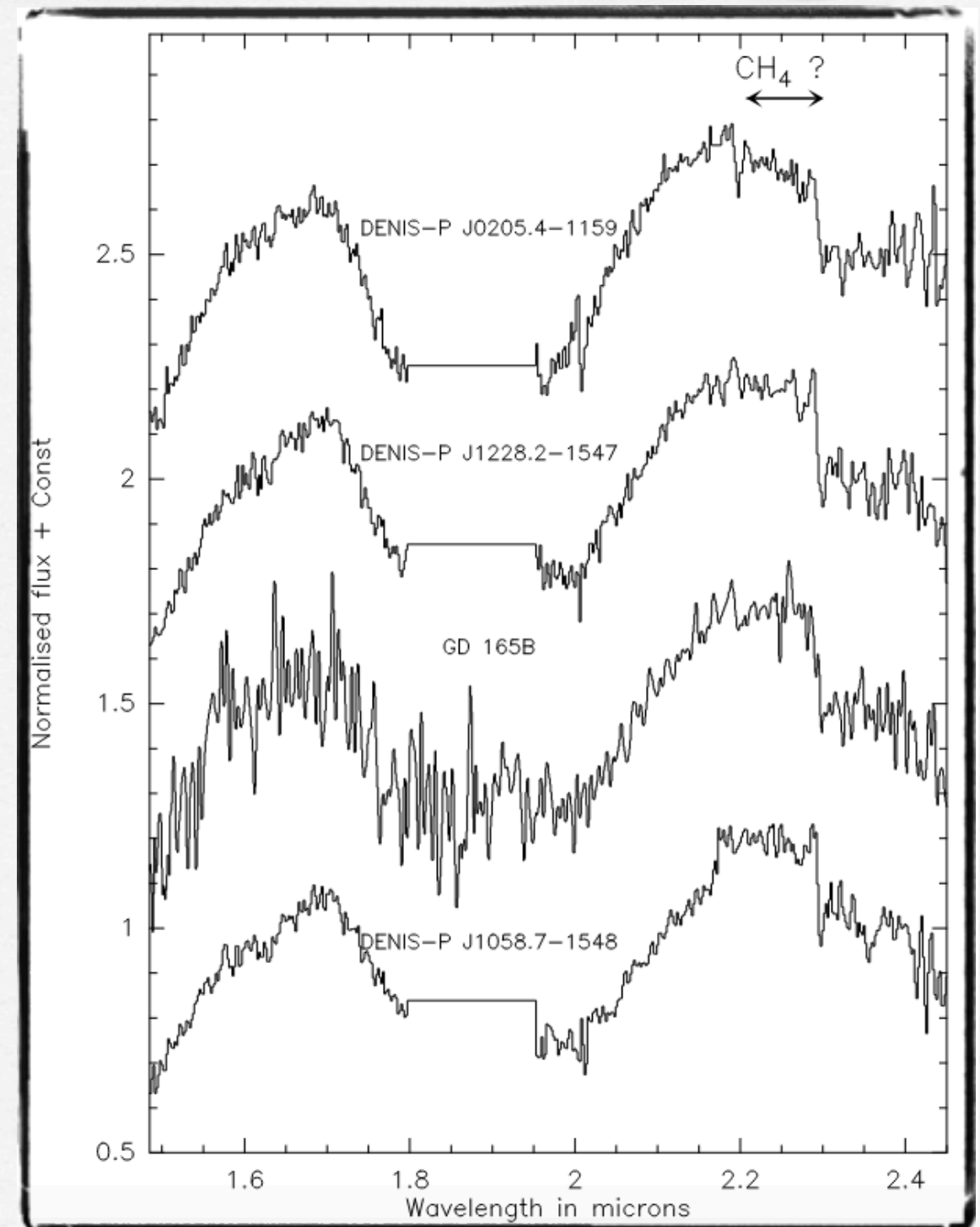
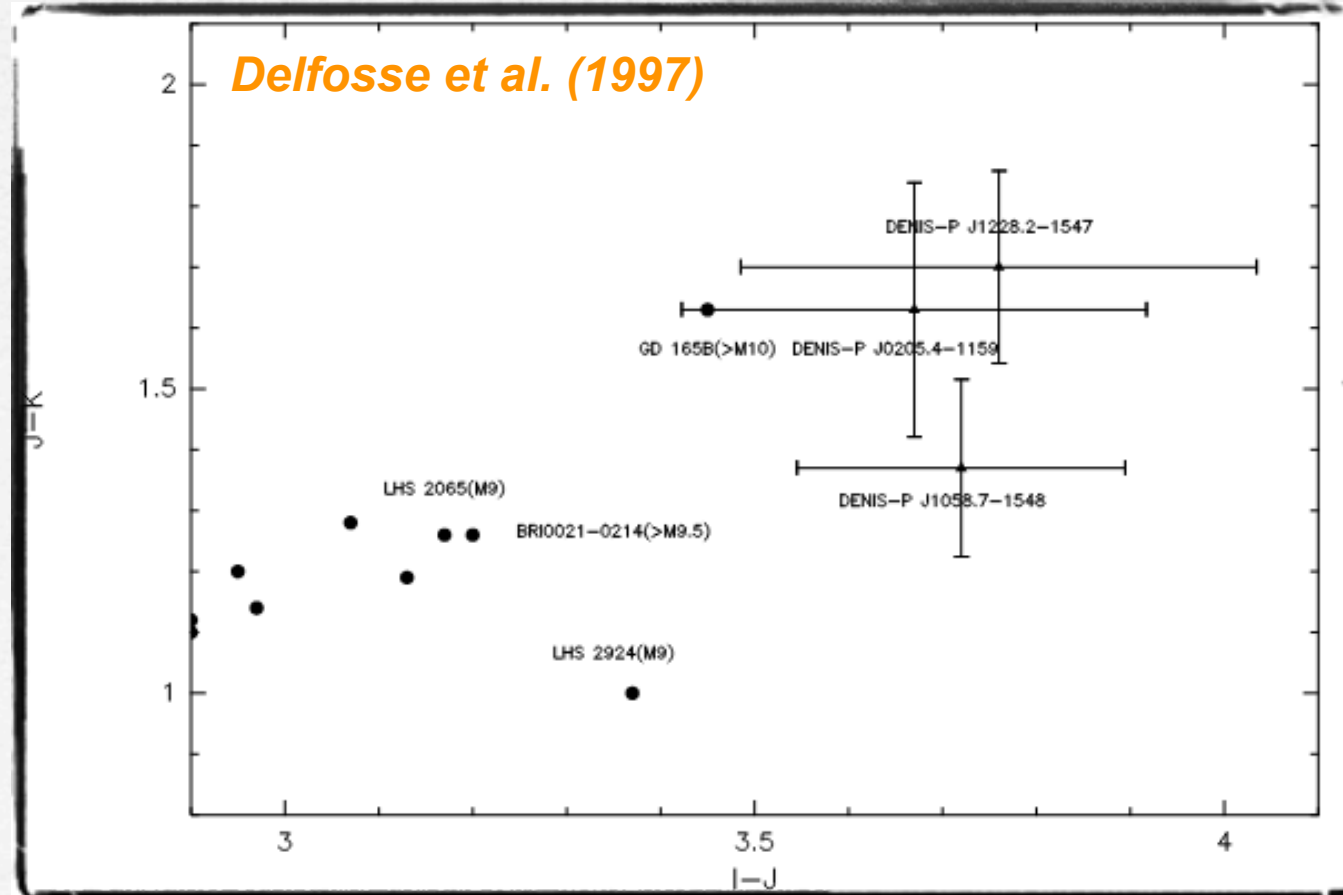
- 1 ☐ 1999Sci...283.1718M 1999/03 cited: 122   
A Search for Companions to Nearby Brown Dwarfs: The Binary DENIS-P J1228.2-1547
Martin, E. L.; Brandner, W.; Basri, G.
- 2 ☐ 1999AJ....117.1010T 1999/02 cited: 64   
K-Band Spectra and Narrowband Photometry of DENIS Field Brown Dwarfs
Tokunaga, A. T.; Kobayashi, N.
- 3 ☐ 1999A&AS..135...41D 1999/02 cited: 105   
Searching for very low-mass stars and brown dwarfs with DENIS
Delfosse, X.; Tinney, C. G.; Forveille, T. *and 5 more*
- 4 ☐ 1998A&A...338.1066T 1998/10 cited: 54   
Optical spectroscopy of DENIS mini-survey brown dwarf candidates
Tinney, C. G.; Delfosse, X.; Forveille, T. *and 1 more*
- 5 ☐ 1997ApJ...490L..95T 1997/11 cited: 60   
DENIS-P J1228.2-1547---A New Benchmark Brown Dwarf
Tinney, C. G.; Delfosse, X.; Forveille, T.
- 6 ☐ 1997A&A...327L..29M 1997/11 cited: 128   
Keck HIRES spectra of the brown dwarf DENIS-P J1228.2-1547
Martin, E. L.; Basri, G.; Delfosse, X. *and 1 more*
- 7 ☐ 1997A&A...327L..25D 1997/11 cited: 225   
Field brown dwarfs found by DENIS
Delfosse, X.; Tinney, C. G.; Forveille, T. *and 11 more*

DENIS

Deep Near-Infrared Survey of the Southern Sky

16,700 sq. deg (southern sky)

$I \approx 18.5$, $J \approx 16$, $Ks \approx 13.5$ mag (10σ)



DENIS

Martin et al. (1999)

SPECTROSCOPIC CLASSIFICATION OF LATE-M AND L FIELD DWARFS

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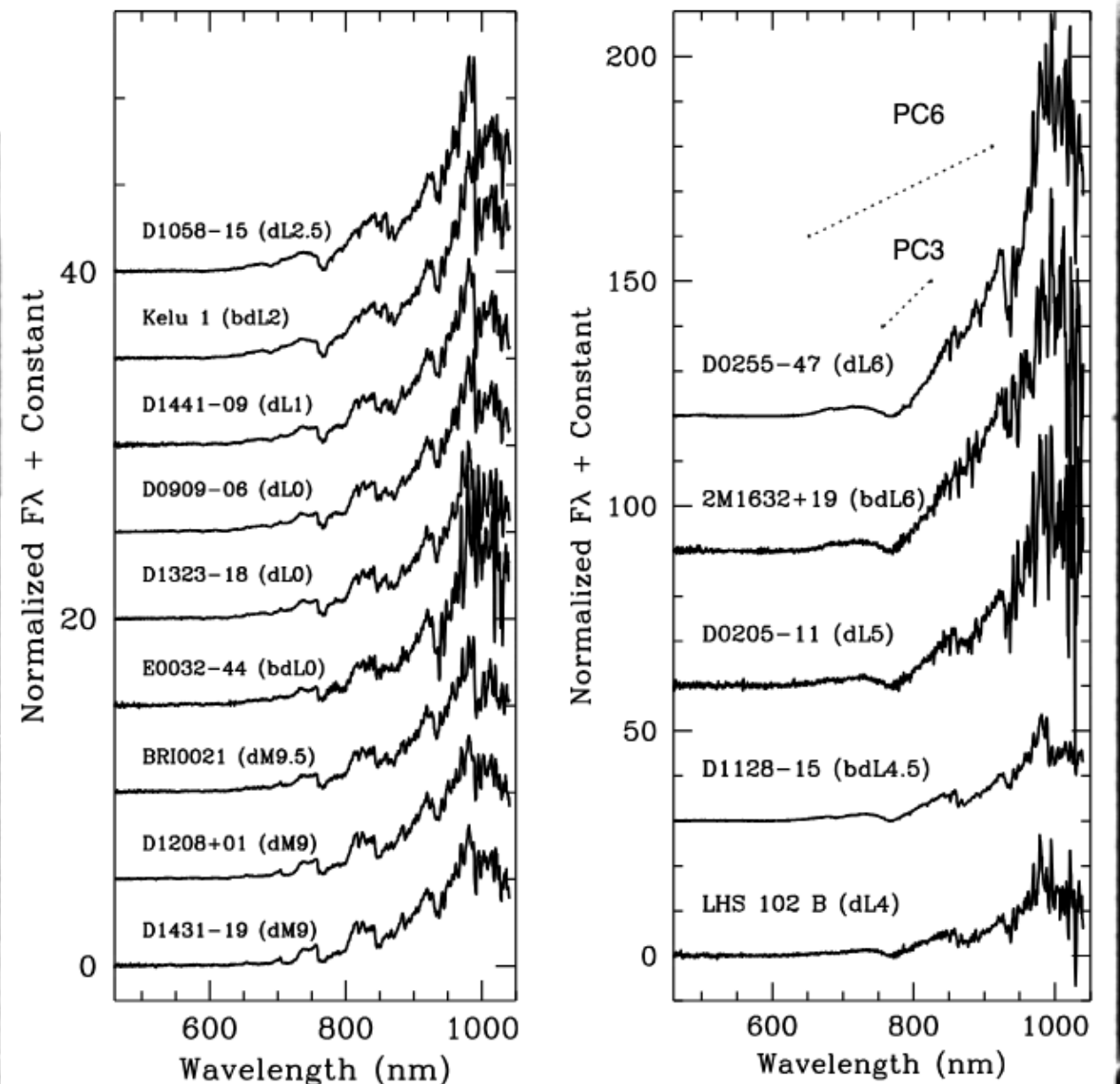
Instituto de Astrofísica de Canarias, Via Lactea, E-38200 La Laguna, Spain; ege@popsicle.berkeley.edu

Received 1999 June 23; accepted 1999 July 27

ABSTRACT

We present spectra for 12 new ultracool dwarfs found in the DENIS infrared survey. Seven of them have spectral types at the bottom of the M-class (M8–M9.5), and the other five belong to the cooler “L” class. We also present spectra for the two new L dwarfs found by the EROS 2 proper-motion survey. We introduce a scheme for L dwarf classification that is based on an extension to cooler spectra of a pseudocontinuum ratio previously defined for M dwarfs. For calibrating the spectral subclasses, we use a temperature scale for late-M and L dwarfs recently obtained by Basri et al. from synthetic spectrum fitting of high-resolution profiles of Cs I and Rb I resonance lines. We define that the subclass range from L0 to L6 corresponds to the temperature range from 2200 K to 1600 K. Our subclasses L0, L1, and L2 agree with recent findings by Kirkpatrick et al., but then they diverge such that our L6 is equivalent to their L8. We find that late-M and L dwarf subclasses can be assigned either in the optical with the PC3 index or in the near-infrared with the H₂O H-band index. We discuss the main photospheric features present in L dwarf spectra, in particular in the region 400–650 nm, which has never been shown before. The TiO bands at 549.7, 559.7, 615.9, and 638.4 nm fade with decreasing temperature, but do not vanish until well inside the L domain (~L5). The Na I 589.0, 589.6 nm resonance doublet in our latest object (L6) becomes the broadest atomic feature ever seen in any cool dwarf. We do not detect H₂ emission in our L dwarfs later than L3. We discuss the ages and masses of our objects using their temperatures and absence or presence of lithium. Finally, we compare two L1 dwarfs with different gravities (one with lithium and one without it) and discuss differences in spectral features.

Key words: stars: evolution — stars: fundamental parameters — stars: low-mass, brown dwarfs
























2MASS

Two Micron All Sky Survey

All-Sky

$J \approx 15.8$, $H \approx 15.1$, $K_s \approx 14.3$ (10σ)

- 1 ☐ 2004AJ....127.2856B 2004/05 cited: 288   
[The 2MASS Wide-Field T Dwarf Search. III. Seven New T Dwarfs and Other Cool Dwarf Discoveries](#)
Burgasser, Adam J.; McElwain, Michael W.; Kirkpatrick, J. Davy *and 3 more*
- 2 ☐ 2004ApJ...604L..61C 2004/03 cited: 95   
[2MASS J05185995-2828372: Discovery of an Unresolved L/T Binary](#)
Cruz, Kelle L.; Burgasser, Adam J.; Reid, I. Neill *and 1 more*
- 3 ☐ 2003AJ....126.2487B 2003/11 cited: 60   
[The 2MASS Wide-Field T Dwarf Search. II. Discovery of Three T Dwarfs in the Southern Hemisphere](#)
Burgasser, Adam J.; McElwain, Michael W.; Kirkpatrick, J. Davy
- 4 ☐ 2003AJ....125..850B 2003/02 cited: 72   
[The 2Mass Wide-Field T Dwarf Search. I. Discovery of a Bright T Dwarf within 10 Parsecs of the Sun](#)
Burgasser, Adam J.; Kirkpatrick, J. Davy; McElwain, Michael W. *and 3 more*
- 5 ☐ 2002AJ....123.2744B 2002/05 cited: 48   
[A Search for Variability in the Active T Dwarf 2MASS 1237+6526](#)
Burgasser, Adam J.; Liebert, James; Kirkpatrick, J. Davy *and 1 more*
- 6 ☐ 2000AJ....120.1100B 2000/08 cited: 104   
[Discovery of a Bright Field Methane \(T-Type\) Brown Dwarf by 2MASS](#)
Burgasser, Adam J.; Wilson, John C.; Kirkpatrick, J. Davy *and 8 more*
- 7 ☐ 2000ApJ...531L..57B 2000/03 cited: 230   
[Discovery of a Brown Dwarf Companion to Gliese 570ABC: A 2MASS T Dwarf Significantly Cooler than Gliese 229B](#)
Burgasser, Adam J.; Kirkpatrick, J. Davy; Cutri, Roc M. *and 10 more*

2MASS

DWARFS COOLER THAN "M": THE DEFINITION OF SPECTRAL TYPE "L" USING DISCOVERIES FROM THE 2-MICRON ALL-SKY SURVEY (2MASS)¹

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Received 1998 November 30; accepted 1999 February 16

























ABSTRACT

Kirkpatrick et al. (1999)

Before the 2-Micron All-Sky Survey (2MASS) began, only six objects were known with spectral types later than M9.5 V. In the first 371 deg² of actual 2MASS survey data, we have identified another 20 such objects spectroscopically confirmed using the Low Resolution Imaging Spectrograph (LRIS) at the W. M. Keck Observatory. Because the TiO and VO bands, which dominate the far-optical portions of late-M spectra, disappear in these cooler dwarfs, we define a new spectral class "L" in which metallic oxides are replaced by metallic hydrides and neutral alkali metals as the major spectroscopic signatures. We establish classification indices and type all 25 L dwarfs. The 26th "post-M9.5" object—Gl 229B—is the prototype of a methane-dominated spectral class, which we propose as class "T." At least five of the 20 2MASS L dwarfs show the 6708 Å lithium doublet at low resolution, the strongest having an equivalent width of 18.5 Å. For objects this cool, the presence of lithium proves that they are substellar. Two other 2MASS objects appear to have lithium lines at the limit of our detectability, which if verified means that at least one-third of our L dwarfs are bona fide brown dwarfs. All of the 2MASS brown dwarfs discovered so far have $J - K_s > 1.30$. We have not yet, despite deliberately searching for them, found any brown dwarfs with colors resembling Gl 229B ($J - K_s \approx -0.1$).

Sloan Digital Sky Survey

2000-2008: L dwarfs

- 1 ☐ 2008ApJ...676.1281M 2008/04 cited: 132   
A Cross-Match of 2MASS and SDSS: Newly Found L and T Dwarfs and an Estimate of the Space Density of T Dwarfs
Metchev, Stanimir A.; Kirkpatrick, J. Davy; Berriman, G. Bruce *and 1 more*
- 2 ☐ 2008MNRAS.383..565D 2008/01 cited: 231   
The 2dF-SDSS LRG and QSO survey: QSO clustering and the L-z degeneracy
da Ângela, J.; Shanks, T.; Croom, S. M. *and 12 more*
- 3 ☐ 2007AJ....134.1330B 2007/10 cited: 58   
SDSS J080531.84+481233.0: An Unresolved L Dwarf/T Dwarf Binary
Burgasser, Adam J.
- 4 ☐ 2006ApJ...647.1393L 2006/08 cited: 145   
SDSS J1534+1615AB: A Novel T Dwarf Binary Found with Keck Laser Guide Star Adaptive Optics and the Potential Role of Binarity in the L/T Transition
Liu, Michael C.; Leggett, S. K.; Golimowski, David A. *and 5 more*
- 5 ☐ 2006AJ....131.2722C 2006/06 cited: 272   
Seventy-One New L and T Dwarfs from the Sloan Digital Sky Survey
Chiu, K.; Fan, X.; Leggett, S. K. *and 5 more*
- 6 ☐ 2005ApJ...634L.177B 2005/12 cited: 61   
SDSS J042348.57-041403.5AB: A Brown Dwarf Binary Straddling the L/T Transition
Burgasser, Adam J.; Reid, I. Neill; Leggett, S. K. *and 3 more*
- 7 ☐ 2002AJ....123.3409H 2002/06 cited: 388   
Characterization of M, L, and T Dwarfs in the Sloan Digital Sky Survey
Hawley, Suzanne L.; Covey, Kevin R.; Knapp, Gillian R. *and 29 more*
- 8 ☐ 2002AJ....123..458S 2002/01 cited: 41   
L Dwarfs Found in Sloan Digital Sky Survey Commissioning Data. II. Hobby-Eberly Telescope Observations
Schneider, Donald P.; Knapp, Gillian R.; Hawley, Suzanne L. *and 21 more*
- 9 ☐ 2000AJ....119..928F 2000/02 cited: 137   
L Dwarfs Found in Sloan Digital Sky Survey Commissioning Imaging Data
Fan, Xiaohui; Knapp, G. R.; Strauss, Michael A. *and 37 more*

Sloan Digital Sky Survey = SDSS

Bands: u (354 nm), g (477 nm), r (623 nm), i (763 nm), z (913 nm).

Coverage: $\approx 14,500$ sq. deg (primarily the Northern Galactic Cap, plus some southern stripes).

Depths (5σ , point sources, AB):

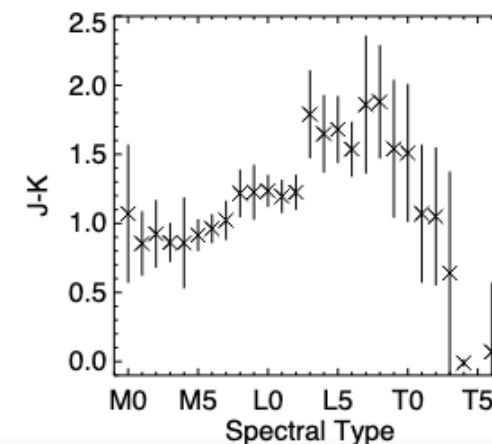
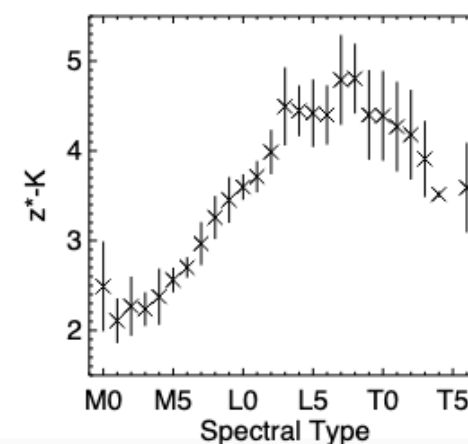
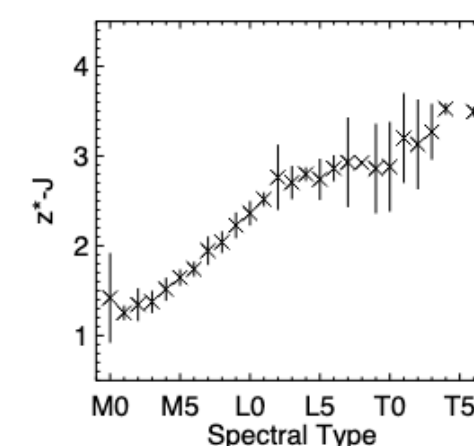
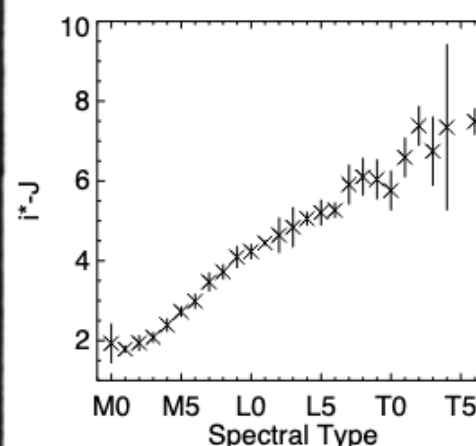
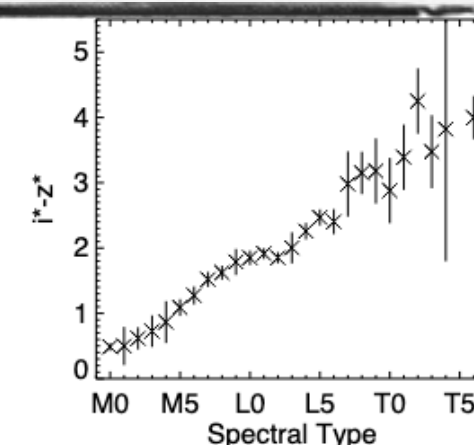
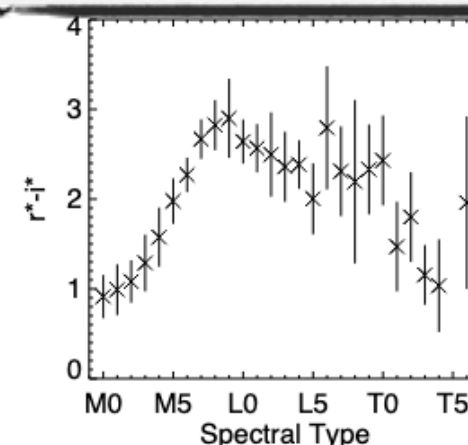
- u ≈ 22.0
- g ≈ 22.2
- r ≈ 22.2
- i ≈ 21.3
- z ≈ 20.5

Sloan Digital Sky Survey

Hawley et al. (2002)

TABLE 3
AVERAGE COLOR BY SPECTRAL TYPE

Spectral Type	$r^* - i^*$	$i^* - z^*$	$z^* - J$	$i^* - J$	M_J
M0.....	0.91 (0.24)	0.49 (0.06)	1.42 (0.50)	1.93 (0.50)	6.45
M1.....	0.99 (0.28)	0.50 (0.29)	1.25 (0.08)	1.78 (0.10)	6.72
M2.....	1.09 (0.26)	0.62 (0.17)	1.36 (0.18)	1.94 (0.20)	6.98
M3.....	1.29 (0.32)	0.73 (0.24)	1.38 (0.12)	2.08 (0.13)	7.24
M4.....	1.57 (0.33)	0.87 (0.32)	1.52 (0.13)	2.39 (0.17)	8.34
M5.....	1.98 (0.25)	1.09 (0.13)	1.65 (0.09)	2.72 (0.13)	9.44
M6.....	2.27 (0.19)	1.27 (0.14)	1.74 (0.08)	2.99 (0.19)	10.18
M7.....	2.67 (0.22)	1.52 (0.11)	1.95 (0.16)	3.47 (0.24)	10.92
M8.....	2.82 (0.28)	1.62 (0.11)	2.04 (0.12)	3.72 (0.19)	11.14
M9.....	2.89 (0.44)	1.79 (0.20)	2.23 (0.14)	4.09 (0.28)	11.43
L0.....	2.64 (0.25)	1.85 (0.11)	2.36 (0.14)	4.23 (0.19)	11.72
L1.....	2.56 (0.27)	1.92 (0.08)	2.52 (0.08)	4.45 (0.08)	12.00
L2.....	2.50 (0.47)	1.85 (0.09)	2.76 (0.36)	4.64 (0.45)	12.29
L3.....	2.34 (0.39)	2.00 (0.24)	2.71 (0.19)	4.84 (0.50)	12.58
L4.....	2.38 (0.27)	2.26 (0.13)	2.80 (0.08)	5.06 (0.18)	12.87
L5.....	2.00 (0.40)	2.47 (0.12)	2.74 (0.23)	5.21 (0.32)	13.16
L6.....	2.79 (0.69)	2.40 (0.19)	2.86 (0.15)	5.27 (0.20)	14.31
L7.....	2.31 (0.50)	2.98 (0.50)	2.93 (0.50)	5.91 (0.50)	14.45
L8.....	2.19 (0.91)	3.15 (0.32)	2.93 (0.02)	6.11 (0.47)	14.58
L9.....	2.33 (0.50)	3.18 (0.50)	2.86 (0.50)	6.04 (0.50)	14.72
T0.....	2.43 (0.50)	2.88 (0.50)	2.88 (0.50)	5.76 (0.50)	14.86
T1.....	1.47 (0.50)	3.39 (0.50)	3.20 (0.50)	6.59 (0.50)	14.99
T2.....	1.80 (0.50)	4.25 (0.50)	3.13 (0.50)	7.38 (0.50)	15.13
T3.....	1.16 (0.33)	3.48 (0.56)	3.27 (0.31)	6.75 (0.87)	15.27
T4.....	1.04 (0.52)	3.82 (2.02)	3.53 (0.06)	7.35 (2.09)	15.40
T5.....	15.54
T6.....	1.96 (0.96)	4.00 (0.33)	3.49 (0.06)	7.49 (0.33)	15.68



Sloan Digital Sky Survey

The Missing Link: Early Methane ("T") Dwarfs in the Sloan Digital Sky Survey

Show affiliations

Show all authors

Leggett, S. K. ; Geballe, T. R. ; Fan, Xiaohui ; Schneider, Donald P. ; Gunn, James E. ; Lupton, Robert H. ; Knapp, G. R.  ; Strauss, Michael A. ; McDaniel, Alex ; Golimowski, David A. ; Henry, Todd J. ; Peng, Eric  ; Tsvetanov, Zlatan I. ; Uomoto, Alan ; Zheng, Wei ; Hill, G. J. ; Ramsey, L. W. ; Anderson, Scott F. ; Annis, James A. ; Bahcall, Neta A. ; ...

We report the discovery of three cool brown dwarfs that fall in the effective temperature gap between the latest L dwarfs currently known, with no methane absorption bands in the 1-2.5 μm range, and the previously known methane (T) dwarfs, whose spectra are dominated by methane and water. The newly discovered objects were detected as very red objects in the Sloan Digital Sky Survey imaging data and have JHK colors between the red L dwarfs and the blue Gl 229B-like T dwarfs. They show both CO and CH₄ absorption in their near-infrared spectra in addition to H₂O, with weaker CH₄ absorption features in the H and K bands than those in all other methane dwarfs reported to date. Due to the presence of CH₄ in these bands, we propose that these objects are early T dwarfs. The three form part of the brown dwarf spectral sequence and fill in the large gap in the overall spectral sequence from the hottest main-sequence stars to the coolest methane dwarfs currently known.

Unified T classification

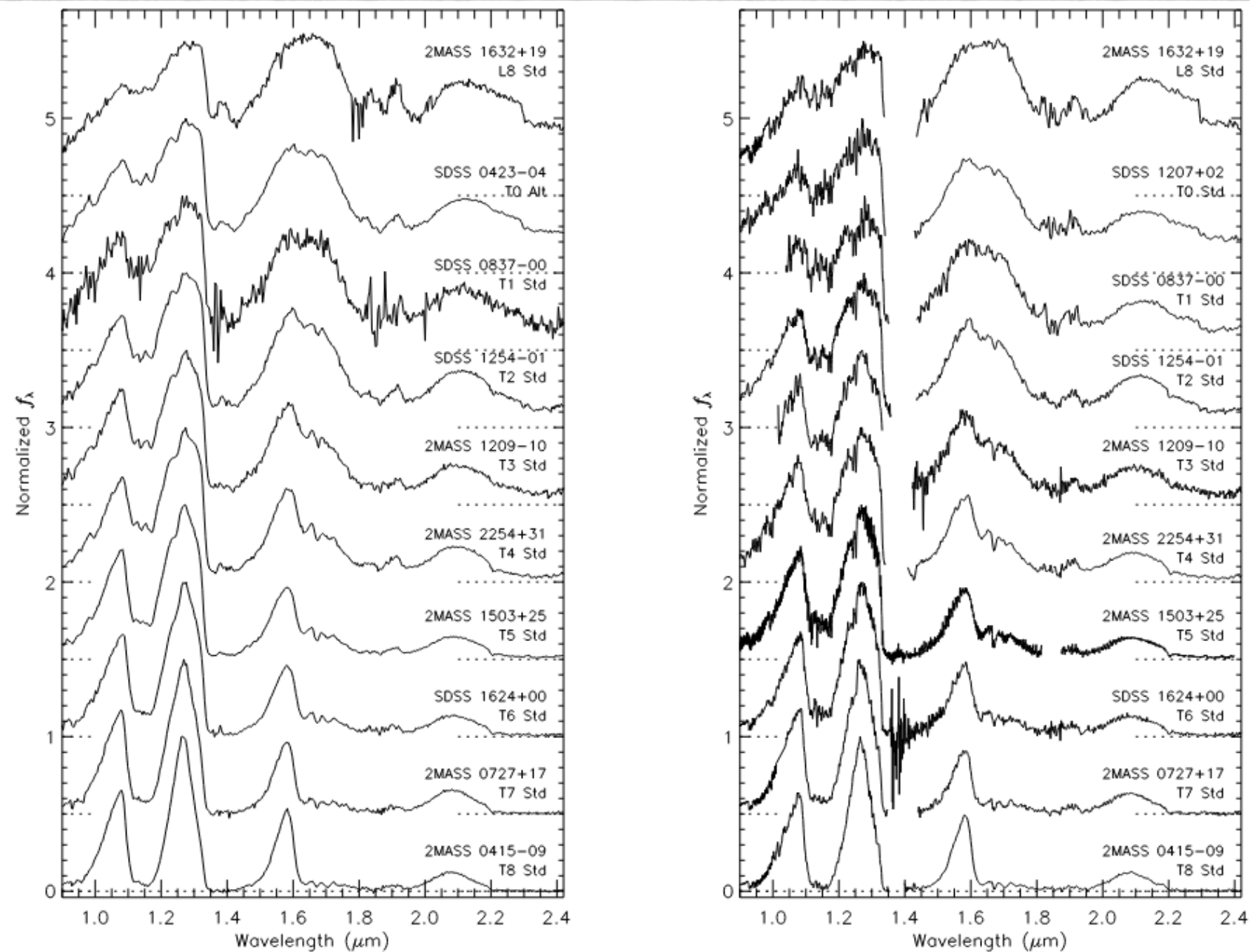


FIG. 2.—NIR spectra of T dwarf standards, along with the L8 optical standard 2MASS 1632+1904 (Kirkpatrick et al. 1999). *Left*: Low-resolution SpeX sample (note the substitution of the alternate T0 standard SDSS 0423-0414AB). *Right*: Moderate-resolution CGS4 sample (with SpeX cross-dispersed data for 2MASS 1503+2525). All spectra are normalized at 1.25 μm and offset by a constant (dotted lines).

Burgasser et al. (2006)

UKIDSS



































UKIRT Infrared Deep Sky Survey

Coverage: ~3,700–4,000 sq. deg

Originally SDSS infrared counterpart

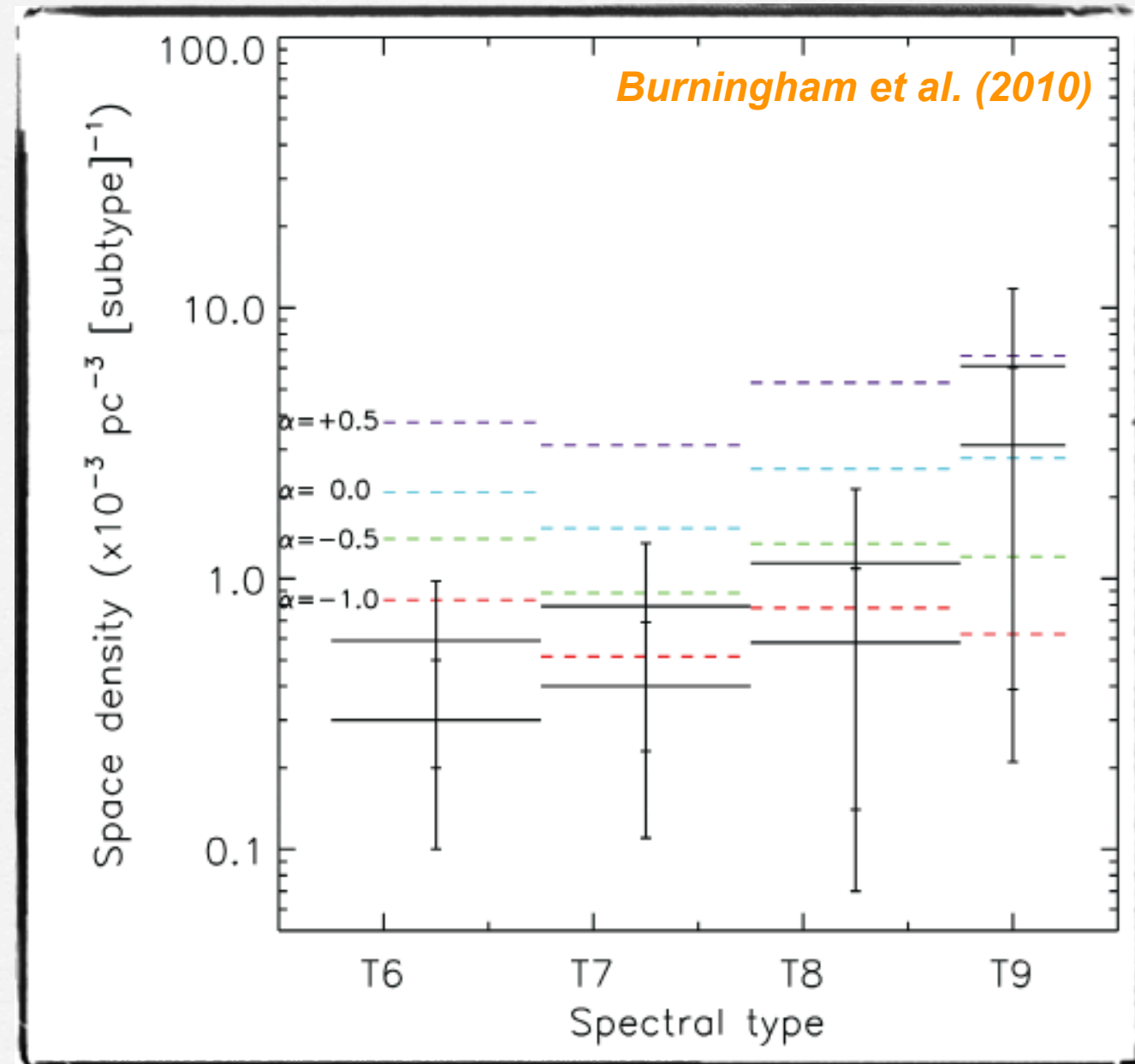
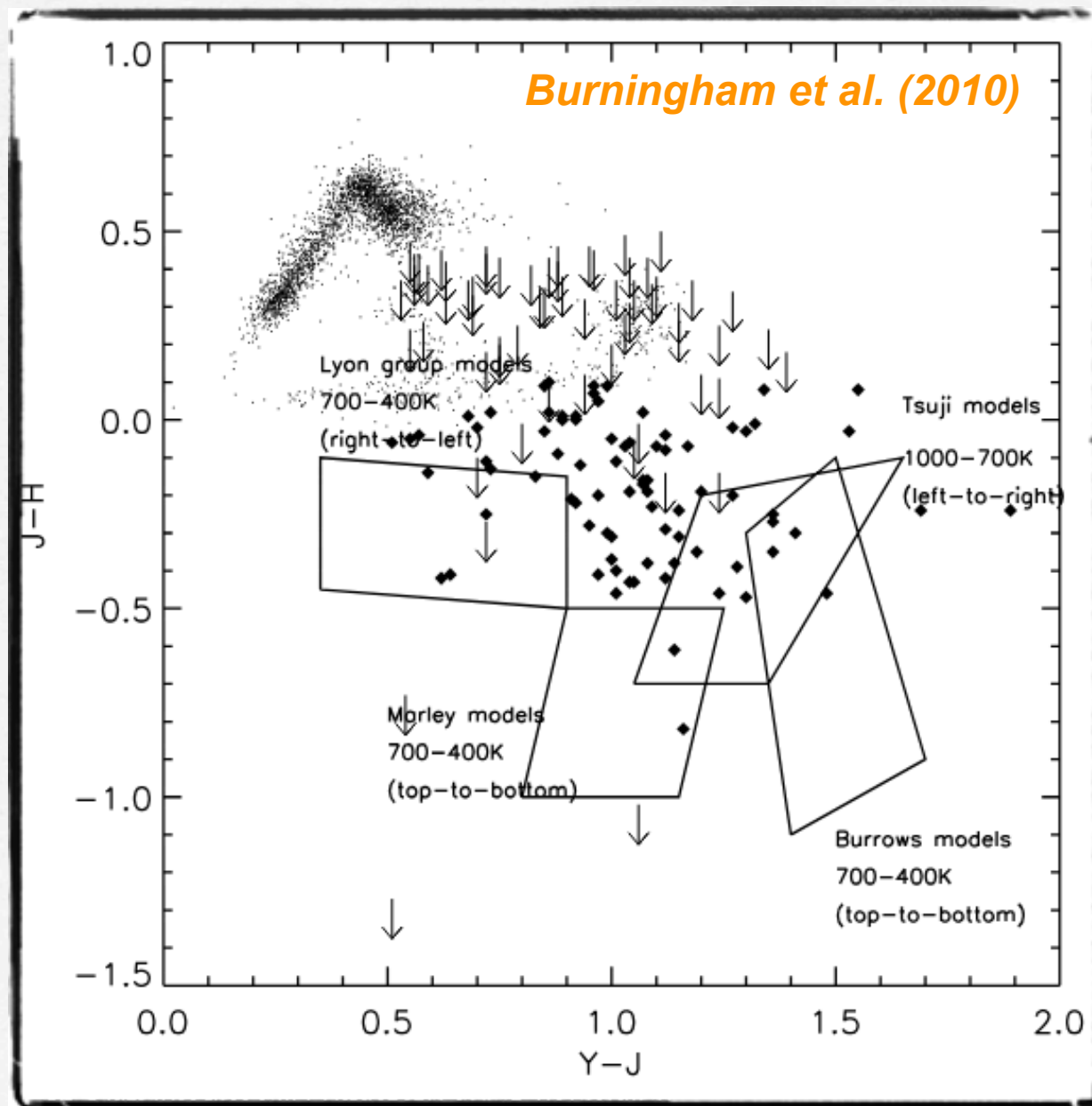
Depth LAS: $J \approx 19.5$, $H \approx 18.8$, $K \approx 18.2$ (Vega)

5 sub-surveys: LAS, GCS, GPS, DXS, UDS

- 5 ☐ 2010MNRAS.406.1885B 2010/08 cited: 127   
[47 new T dwarfs from the UKIDSS Large Area Survey](#)
Burningham, Ben; Pinfield, D. J.; Lucas, P. W. *and 16 more*
- 6 ☐ 2010MNRAS.405.1140G 2010/06 cited: 124   
[A new benchmark T8-9 brown dwarf and a couple of new mid-T dwarfs from the UKIDSS DR5+ LAS](#)
Goldman, B.; Marsat, S.; Henning, T. *and 2 more*
- 7 ☐ 2010A&A...515A..92S 2010/06 cited: 81   
[Hip 63510C, Hip 73786B, and nine new isolated high proper motion T dwarf candidates from UKIDSS DR6 and SDSS DR7](#)
Scholz, R. -D.
- 8 ☐ 2010A&A...510L...8S 2010/02 cited: 68   
[ULAS J141623.94+134836.3 - a faint common proper motion companion of a nearby L dwarf. Serendipitous discovery of a cool brown dwarf in UKIDSS DR6](#)
Scholz, R. -D.
- 9 ☐ 2009MNRAS.397..258L 2009/07 cited: 18   
[Identifying nearby field T dwarfs in the UKIDSS Galactic Clusters Survey](#)
Lodieu, N.; Burningham, B.; Hambly, N. C. *and 1 more*
- 10 ☐ 2009MNRAS.394..857D 2009/04 cited: 34   
[The UKIDSS-2MASS proper motion survey - I. Ultracool dwarfs from UKIDSS DR4](#)
Deacon, N. R.; Hambly, N. C.; King, R. R. *and 1 more*
- 11 ☐ 2008MNRAS.390..304P 2008/10 cited: 98   
[Fifteen new T dwarfs discovered in the UKIDSS Large Area Survey](#)
Pinfield, D. J.; Burningham, B.; Tamura, M. *and 31 more*
- 12 ☐ 2008MNRAS.385L..53C 2008/03 cited: 29   
[Four faint T dwarfs from the UKIRT Infrared Deep Sky Survey \(UKIDSS\) Southern Stripe](#)
Chiu, Kuenley; Liu, Michael C.; Jiang, Linhua *and 6 more*
- 13 ☐ 2007MNRAS.381.1400W 2007/11 cited: 117   
[A very cool brown dwarf in UKIDSS DR1](#)
Warren, S. J.; Mortlock, D. J.; Leggett, S. K. *and 21 more*
- 14 ☐ 2007MNRAS.379.1423L 2007/08 cited: 78   
[Eight new T4.5-T7.5 dwarfs discovered in the UKIDSS Large Area Survey Data Release 1](#)
Lodieu, N.; Pinfield, D. J.; Leggett, S. K. *and 34 more*
- 15 ☐ 2007A&A...466.1059K 2007/05 cited: 35   
[Two T dwarfs from the UKIDSS early data release](#)
Kendall, T. R.; Tamura, M.; Tinney, C. G. *and 30 more*
- 16 ☐ 2007MNRAS.374..372L 2007/01 cited: 97   
[New brown dwarfs in Upper Sco using UKIDSS Galactic Cluster Survey science verification data](#)
Lodieu, N.; Hambly, N. C.; Jameson, R. F. *and 3 more*

UKIDSS LAS

Colour selection + optical follow-up + infrared spectroscopy => space density & IMF



UKIDSS GCS

Identifying nearby field T dwarfs in the UKIDSS Galactic Clusters Survey

Show affiliations

[Lodieu, N.](#) ; [Burningham, B.](#) ; [Hambly, N. C.](#) ; [Pinfield, D. J.](#)

We present the discovery of two new late-T dwarfs identified in the UKIRT Infrared Deep Sky Survey (UKIDSS) Galactic Clusters Survey (GCS) Data Release 2 (DR2). These T dwarfs are nearby old T dwarfs along the line of sight to star-forming regions and open clusters targeted by the UKIDSS GCS. They are found towards the α Per cluster and Orion complex, respectively, from a search in 54deg^2 surveyed in five filters. Photometric candidates were picked up in two-colour diagrams, in a very similar manner to candidates extracted from the UKIDSS Large Area Survey (LAS) but taking advantage of the Z filter employed by the GCS. Both candidates exhibit near-infrared J-band spectra with strong methane and water absorption bands characteristic of late-T dwarfs. We derive spectral types of $T6.5 \pm 0.5$ and $T7 \pm 1$ and estimate photometric distances less than 50 pc for UGCS J030013.86+490142.5 and UGCS J053022.52-052447.4, respectively. The space density of T dwarfs found in the GCS seems consistent with discoveries in the larger areal coverage of the UKIDSS LAS, indicating one T dwarf in $6\text{-}11\text{deg}^2$. The final area surveyed by the GCS, 1000deg^2 in five passbands, will allow expansion of the LAS search area by 25 per cent, increase the probability of finding ultracool brown dwarfs, and provide optimal estimates of contamination by old field brown dwarfs in deep surveys to identify such objects in open clusters and star-forming regions.

UKIDSS

Photometric brown-dwarf classification

II. A homogeneous sample of 1361 L and T dwarfs brighter than $J = 17.5$ with accurate spectral types

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Received <date> / Accepted <data>

ABSTRACT

We present a homogeneous sample of 1361 L and T dwarfs brighter than $J = 17.5$ (of which 998 are new), from an effective area of 3070 deg², classified by the *photo-type* method to an accuracy of one spectral sub-type using *izYJHKW1W2* photometry from SDSS+UKIDSS+WISE. Other than a small bias in the early L types, the sample is shown to be effectively complete to the magnitude limit, for all spectral types L0 to T8. The nature of the bias is an incompleteness estimated at 3% because peculiar blue L dwarfs of type L4 and earlier are classified late M. There is a corresponding overcompleteness because peculiar red (likely young) late M dwarfs are classified early L. Contamination of the sample is confirmed to be small: so far spectroscopy has been obtained for 19 sources in the catalogue and all are confirmed to be ultracool dwarfs. We provide coordinates and *izYJHKW1W2* photometry of all sources. We identify an apparent discontinuity, $\Delta m \sim 0.4$ mag., in the $Y - K$ colour between spectral types L7 and L8. We present near-infrared spectra of nine sources identified by *photo-type* as peculiar, including a new low-gravity source ULAS J005505.68+013436.0, with spectroscopic classification L2 γ . We provide revised *izYJHKW1W2* template colours for late M dwarfs, types M7 to M9.

CFHT-BD survey

Finding ultracool brown dwarfs with MegaCam on CFHT: method and first results

Show affiliations

Delorme, P. ; Willott, C. J.  ; Forveille, T. ; Delfosse, X. ; Rey, C. ; Bertin, E.  ; Albert, L. ; Artigau, E. ; Robin, A. C. ; Allard, F. ; Doyon, R. ; Hill, G. J.

Aims: We present the first results of a wide field survey for cool brown dwarfs with the MegaCam camera on the CFHT telescope, the Canada-France Brown Dwarf Survey, hereafter CFBDS. Our objectives are to find ultracool brown dwarfs and to constrain the field-brown dwarf mass function thanks to a larger sample of L and T dwarfs.

Methods: We identify candidates in CFHT/MegaCam i' and z' images using optimised psf-fitting within Source Extractor, and follow them up with pointed near-infrared imaging on several telescopes.

Results: We have so far analysed over 350 square degrees and found 770 brown dwarf candidates brighter than $z'_{AB}=22.5$. We currently have J-band photometry for 220 of these candidates, which confirms 37% as potential L or T dwarfs. Some are among the reddest and farthest brown dwarfs currently known, including an independent identification of the recently published ULAS J003402.77-005206.7 and the discovery of a second brown dwarf later than T8, CFBDS J005910.83-011401.3. Infrared spectra of three T dwarf candidates confirm their nature, and validate the selection process.

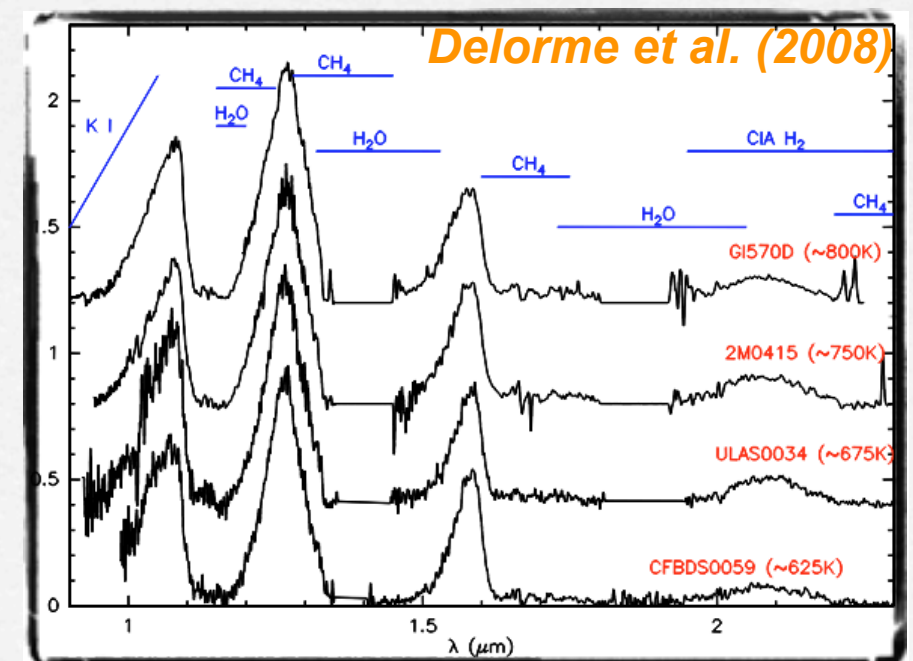
Conclusions: The completed survey will discover ~ 100 T dwarfs and ~ 500 L dwarfs or M dwarfs later than M8, approximately doubling the number of currently known brown dwarfs. The resulting sample will have a very well-defined selection function, and will therefore produce a very clean luminosity function.

- 1 ☐ 2011AJ....141..203A 2011/06 cited: 58   
37 New T-type Brown Dwarfs in the Canada-France Brown Dwarfs Survey
Albert, Loïc; Artigau, Étienne; Delorme, Philippe *and 4 more*
- 2 ☐ 2010A&A...522A.112R 2010/11 cited: 76   
The ultracool-field dwarf luminosity-function and space density from the Canada-France Brown Dwarf Survey
Reylé, C.; Delorme, P.; Willott, C. J. *and 7 more*
- 3 ☐ 2010A&A...518A..39D 2010/07 cited: 42   
Extending the Canada-France brown dwarfs survey to the near-infrared: first ultracool brown dwarfs from CFBDSIR
Delorme, P.; Albert, L.; Forveille, T. *and 8 more*

Optical survey with NIR follow-up

Coverage: ~ 520 sq. deg

Depth: $z \approx 22.5$ (AB; 10σ)



Pan-STARRS

Panoramic Survey Telescope and Rapid Response System.

Coverage: 3π steradians for $\text{dec} > -30^\circ \approx 30,000$ sq. deg.

Depth (stacked): $g \approx 23.3$, $r \approx 23.2$, $i \approx 23.1$, $z \approx 22.3$, $y \approx 21.4$ mag (5σ)

Photometry and Proper Motions of M, L, and T Dwarfs from the Pan-STARRS1 3π Survey

Show affiliations

Best, William M. J.  ; Magnier, Eugene A.  ; Liu, Michael C.  ; Aller, Kimberly M. ; Zhang, Zhoujian  ; Burgett, W. S.  ; Chambers, K. C.  ; Draper, P.  ; Flewelling, H.  ; Kaiser, N.  ; Kudritzki, R. -P. ; Metcalfe, N.  ; Tonry, J. L.  ; Wainscoat, R. J.  ; Waters, C. 

We present a catalog of 9888 M, L and T dwarfs detected in the Pan-STARRS1 3π Survey (PS1), covering three-quarters of the sky. Our catalog contains nearly all known objects of spectral types L0-T2 in the PS1 field, with objects as early as M0 and as late as T9, and includes PS1, 2MASS, AllWISE, and Gaia DR1 photometry. We analyze the different types of photometry reported by PS1 and use two types in our catalog in order to maximize both depth and accuracy. Using parallaxes from the literature, we construct empirical SEDs for field ultracool dwarfs spanning 0.5-12 μm . We determine typical colors of M0-T9 dwarfs and highlight the distinctive colors of subdwarfs and young objects. We combine astrometry from PS1, 2MASS, and Gaia DR1 to calculate new proper motions for our catalog. We achieve a median precision of 2.9 mas yr^{-1} , a factor of ≈ 3 -10 improvement over previous large catalogs. Our catalog contains proper motions for 2405 M6-T9 dwarfs and includes the largest set of homogeneous proper motions for L and T dwarfs published to date, 406 objects for which there were no previous measurements, and 1176 objects for which we improve upon previous literature values. We analyze the kinematics of ultracool dwarfs in our catalog and find evidence that bluer but otherwise generic late-M and L field dwarfs (i.e., not subdwarfs) tend to have tangential velocities higher than those of typical field objects. With the public release of the PS1 data, this survey will continue to be an essential tool for characterizing the ultracool dwarf population.

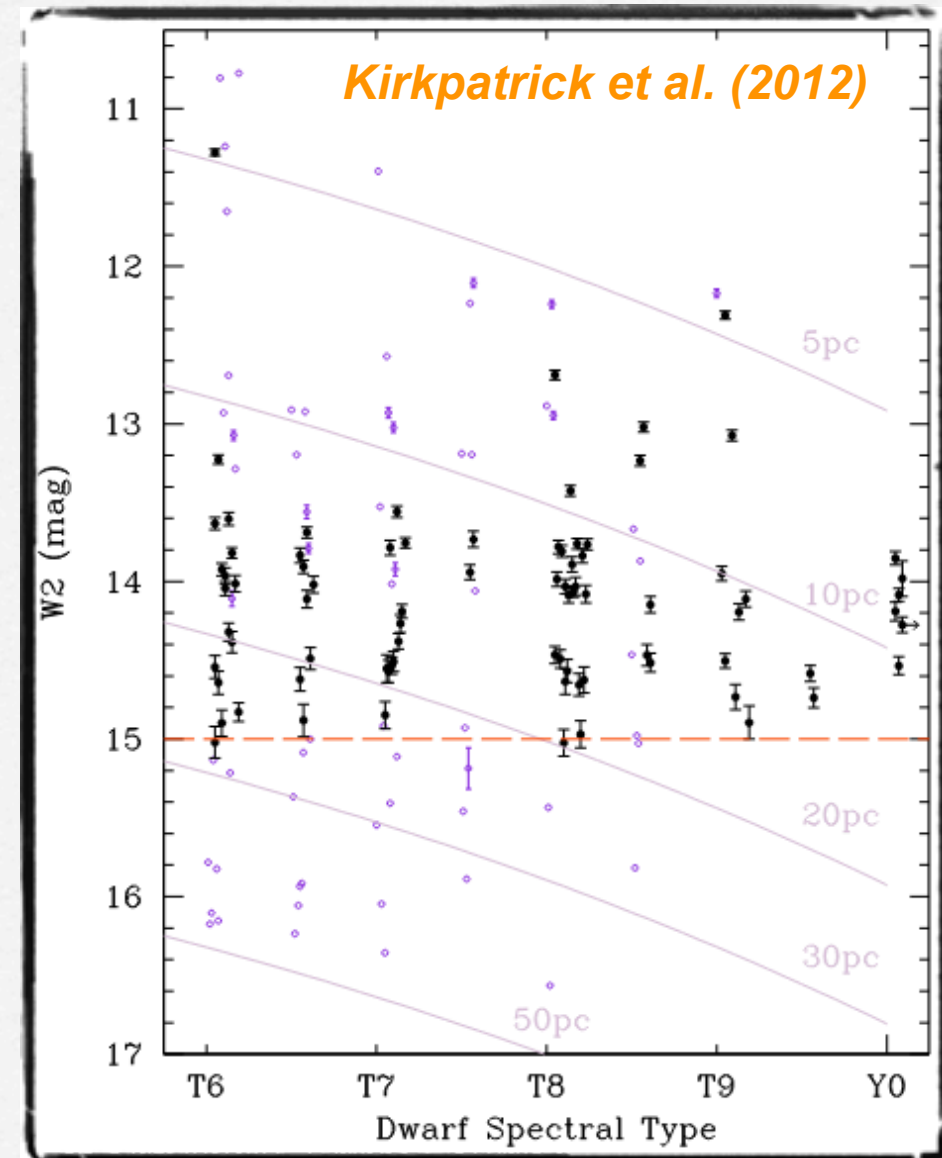
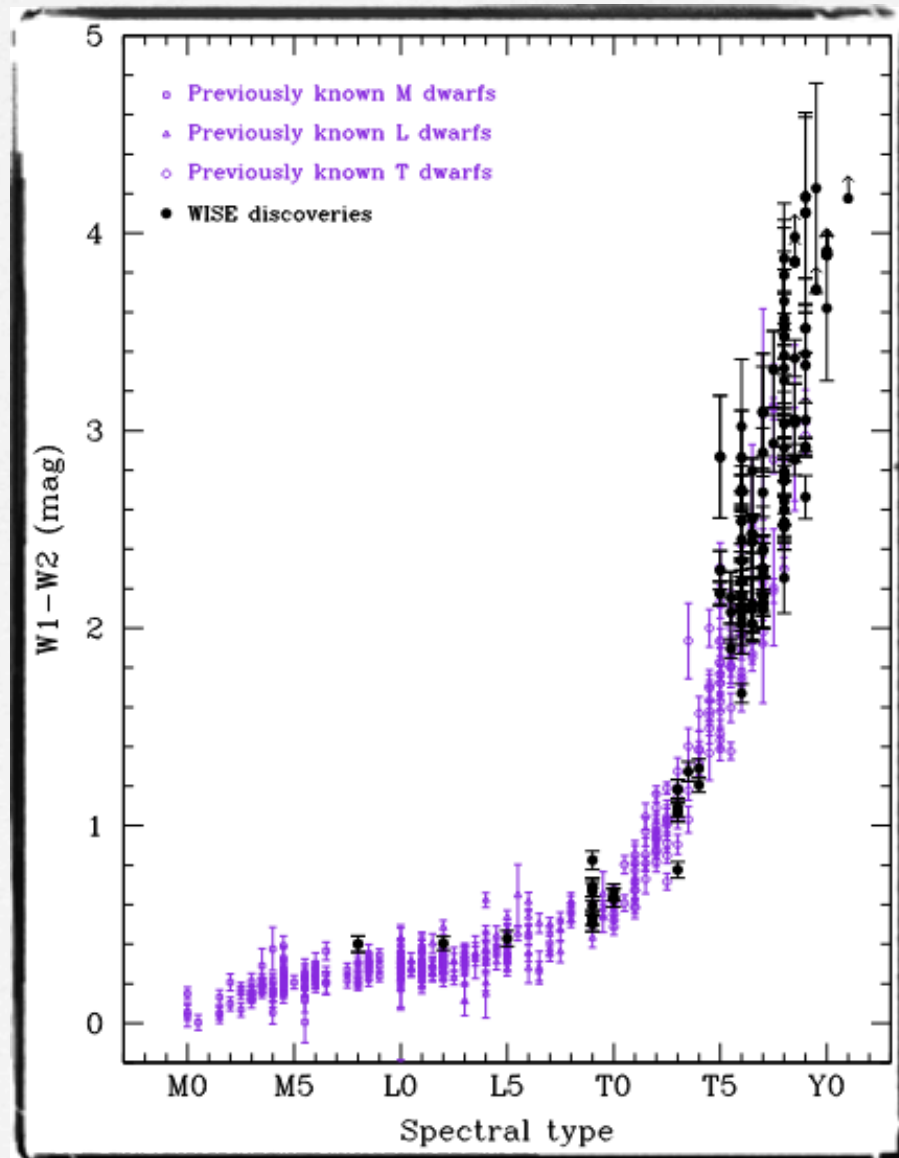
Best et al. (2018)

WISE

The First Hundred Brown Dwarfs Discovered by the Wide-field Infrared Survey Explorer (WISE)

Show affiliations Show all authors

Kirkpatrick, J. Davy  ; Cushing, Michael C. ; Gelino, Christopher R.  ; Griffith, Roger L. ; Skrutskie, Michael F. ; Marsh, Kenneth A. ; Wright, Edward L. ; Mainzer, A. ; Eisenhardt, Peter R. ; McLean, Ian S. ; Thompson, Maggie A.  ; Bauer, James M. ; Benford, Dominic J. ; Bridge, Carrie R. ; Lake, Sean E.  ; Petty, Sara M. ; Stanford, S. A. ; Tsai, Chao-Wei  ; Bailey, Vanessa  ; Beichman, Charles A. ; ...





WISE

The Discovery of Y Dwarfs using Data from the Wide-field Infrared Survey Explorer (WISE)

Cushing et al. (2011)

Show affiliations

Cushing, Michael C. ; Kirkpatrick, J. Davy  ; Gelino, Christopher R.  ; Griffith, Roger L. ;
Skrutskie, Michael F. ; Mainzer, A. ; Marsh, Kenneth A. ; Beichman, Charles A. ; Burgasser, Adam J.  ;
Prato, Lisa A. ; Simcoe, Robert A. ; Marley, Mark S.  ; Saumon, D. ; Freedman, Richard S. ;
Eisenhardt, Peter R. ; Wright, Edward L.

WISE 1828+2650

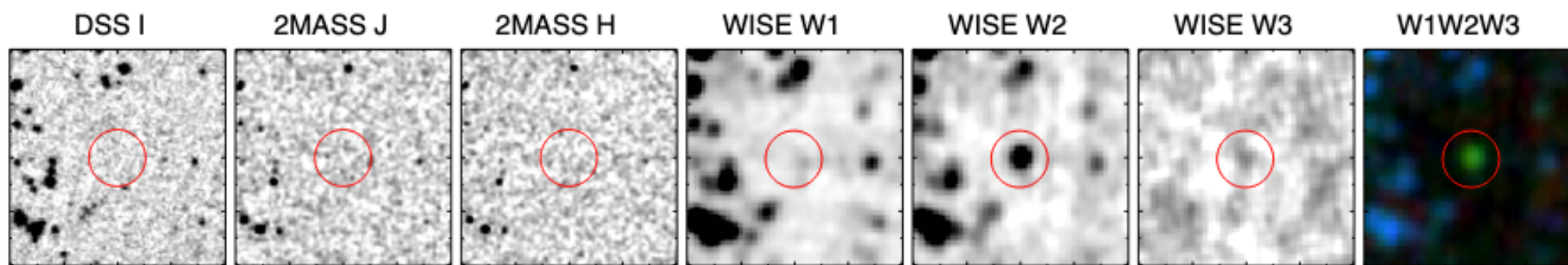
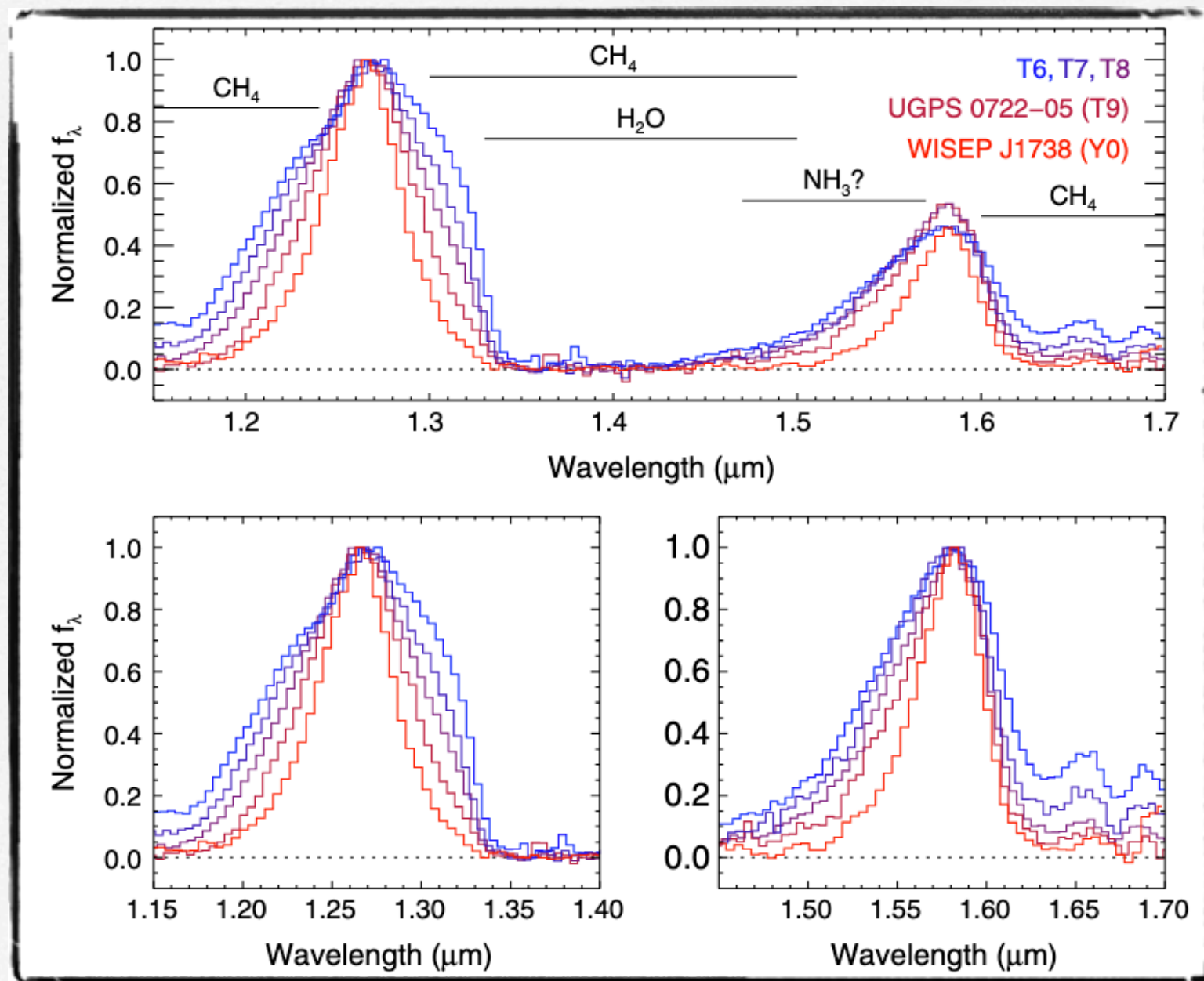


Table 1
WISE Photometry

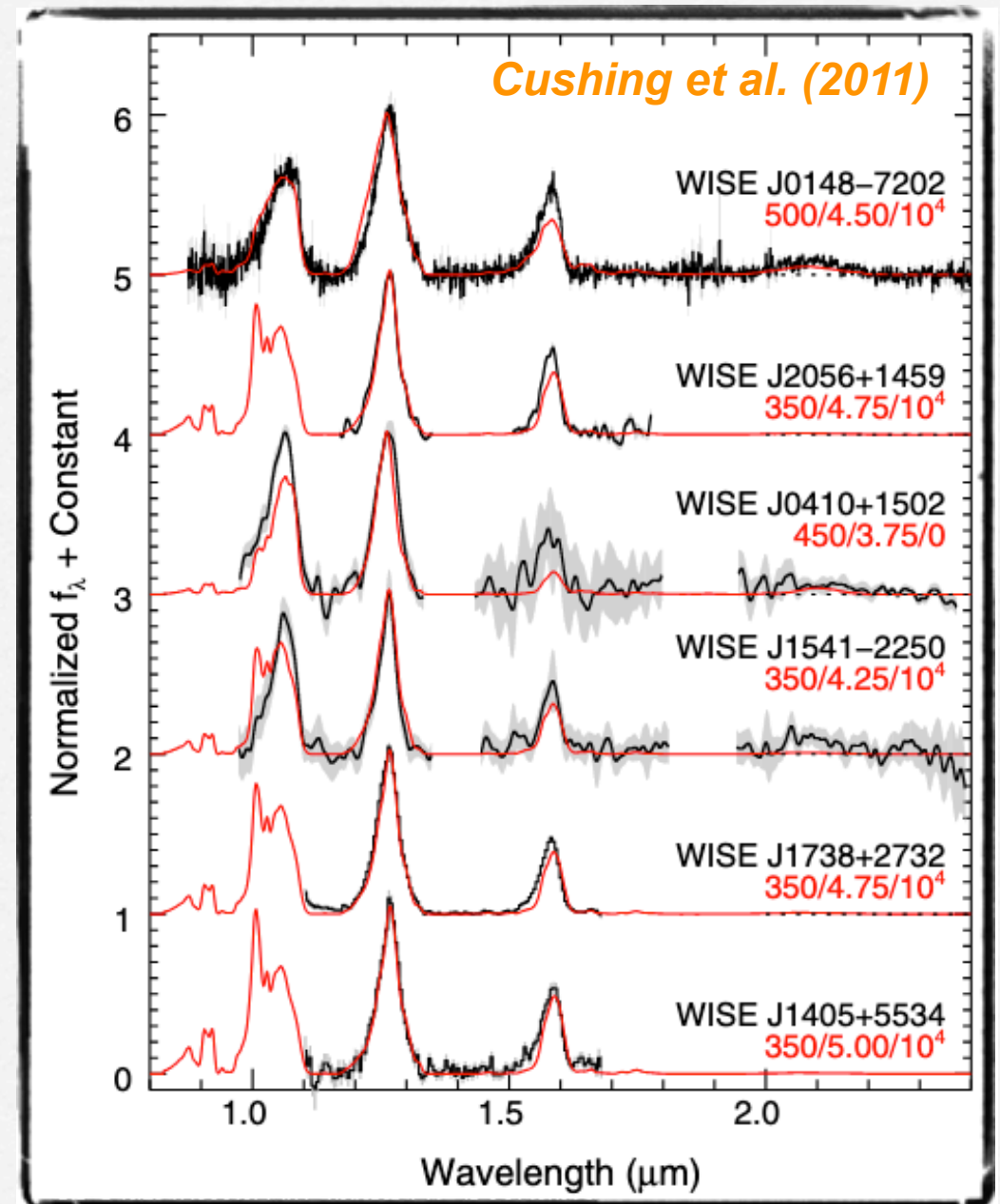
Object	W1 (mag)	W2 (mag)	W3 (mag)	W4 (mag)	W1-W2 (mag)
WISEPC J014807.25-720258.8	18.812 ± 0.529^a	14.584 ± 0.052	> 12.579	> 9.521	4.228 ± 0.532
WISEP J041022.71+150248.5	> 18.101	14.190 ± 0.059	12.472 ± 0.482^a	> 8.923	$> 3.911 \pm 0.059$
WISEPC J140518.40+553421.5	> 17.989	14.085 ± 0.041	12.312 ± 0.252	> 9.115	$> 3.904 \pm 0.041$
WISEP J154151.65-225025.2	> 17.018	13.982 ± 0.112	12.134 ± 0.443^a	> 9.064	$> 3.036 \pm 0.112$
WISEP J173835.52+273258.9	18.155 ± 0.362	14.535 ± 0.057	12.536 ± 0.350	> 9.182	3.620 ± 0.366
WISEP J182831.08+265037.8	> 18.452	14.276 ± 0.050	12.320 ± 0.291	9.147 ± 0.438^a	$> 4.176 \pm 0.050$
WISEPC J205628.90+145953.3	> 17.742	13.852 ± 0.043	11.791 ± 0.222	> 8.646	$> 3.890 \pm 0.043$

Y dwarf classification

Distinct spectral features in *J* and *H*



Temperature derivation



Conclusions

Best-effort estimates:

- Spectral type \geq M7 (spectroscopically confirmed all-sky): $\sim 4,000 - 8,000$
- L dwarfs (spectroscopically confirmed): $\sim 1,500 - 3,500$
- T dwarfs (spectroscopically confirmed): $\sim 1,100$
- Y dwarfs (confirmed): ~ 40

Estimated numbers within 100 pc:

- \geq M7: a few $\times 10^3$ — $\sim 10^4$
- L dwarfs within 100 pc: $\sim 2,000 - 5,000$
- T dwarfs within 100 pc: $\sim 800 - 2,000$
- Y dwarfs within 100 pc: a few dozen

Thank you

Brown Dwarfs Keep Their Cool

30 Years of Substellar Science

1-5 September 2025
La Gomera
Canary Islands
Spain

