Brown Dwarfs in the Era of WISE

Michael Cushing
University of Toledo

WISE at 5

2015-Feb-10

Brown dwarfs were baked into WISE

From the 1998 proposal for the
Next Generation Sky Survey (NGSS):

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The primary scientific objectives of NGSS are:
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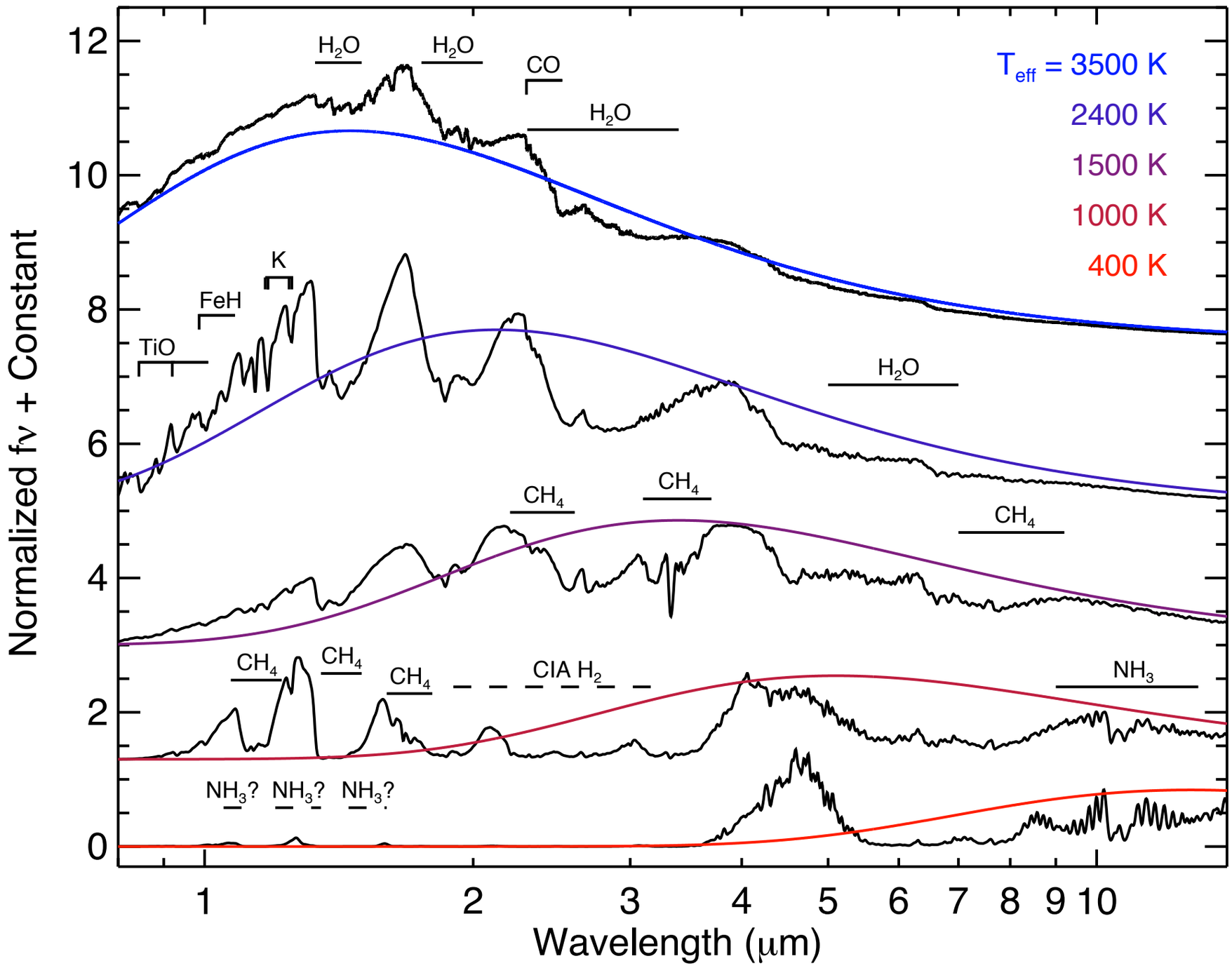
- The space density, mass function, and formation history of brown dwarf stars in the solar neighborhood. NGSS will be exceptionally sensitive to old, cold brown dwarf stars with T ~ 125 – 1000 K (Jupiter-Gliese 229B), among which is likely to be the nearest star to the sun (§A.1.2.5).

Not on the docket

- Daniella Bardalez Gagliuffi
  J-W2 colors and their utility on finding spectral binaries

- Chris Gelino
  Uncovering Faint Companions of WISE Brown Dwarfs

W1 & W2 were tuned to find cool brown dwarfs



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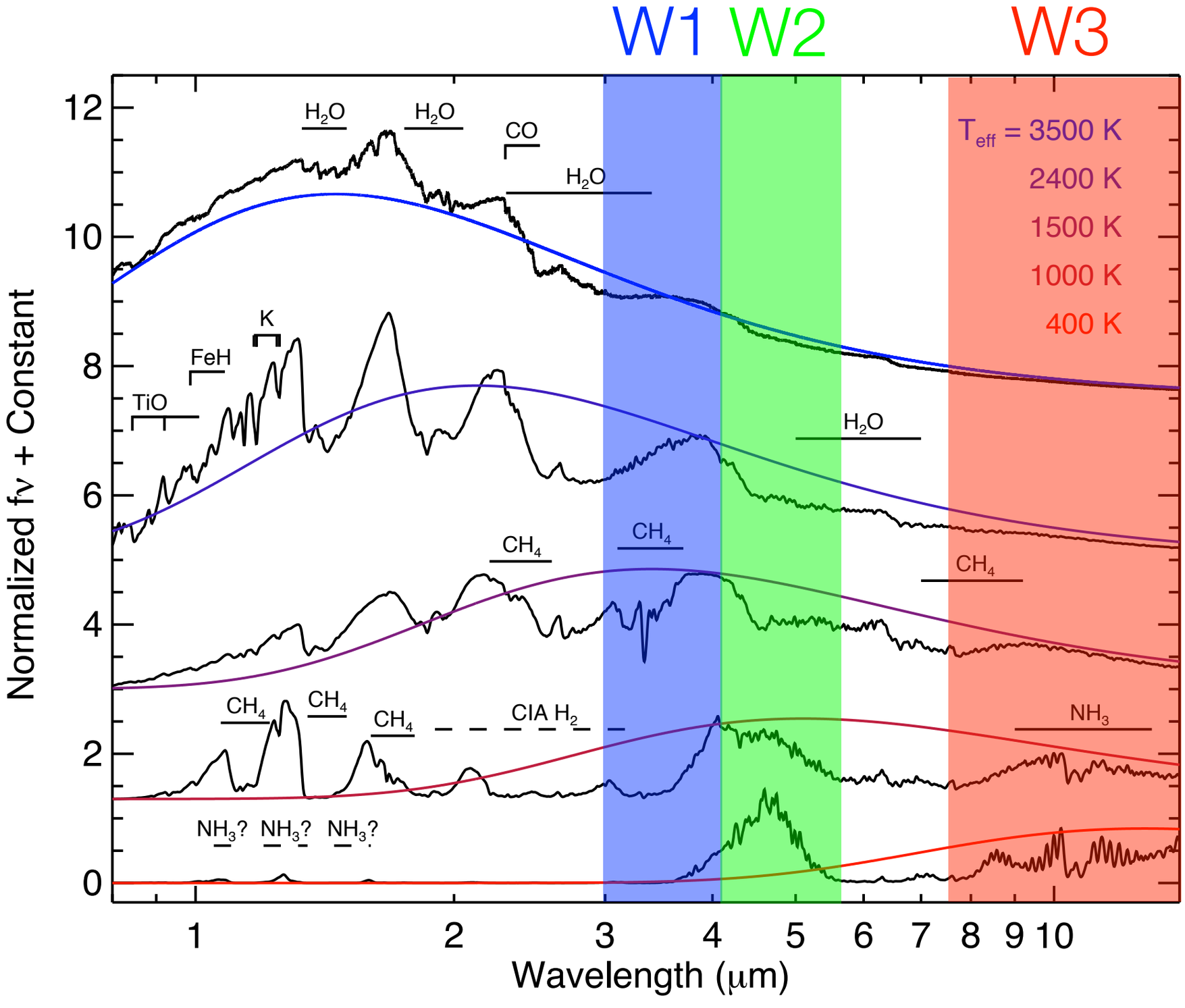
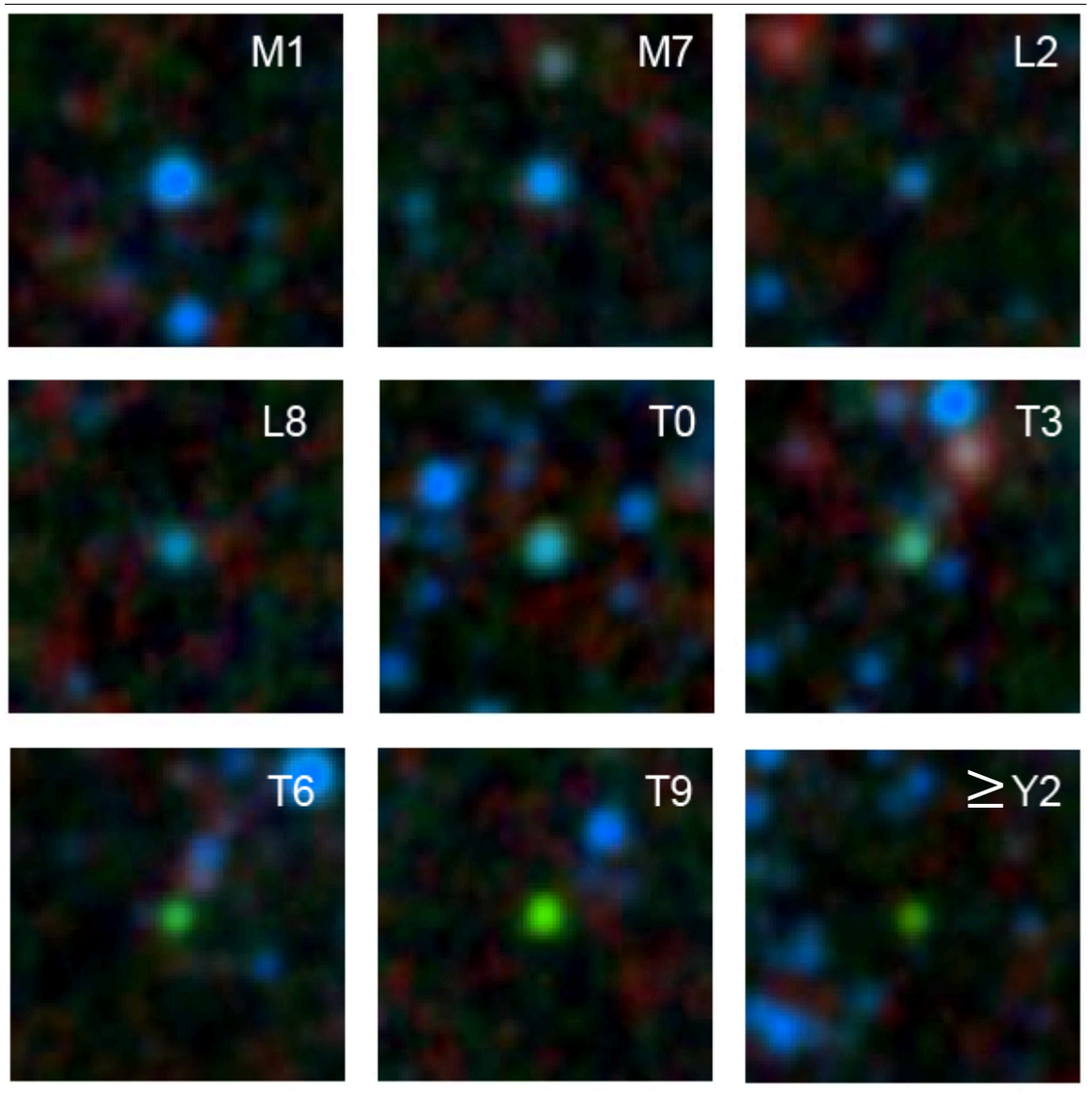
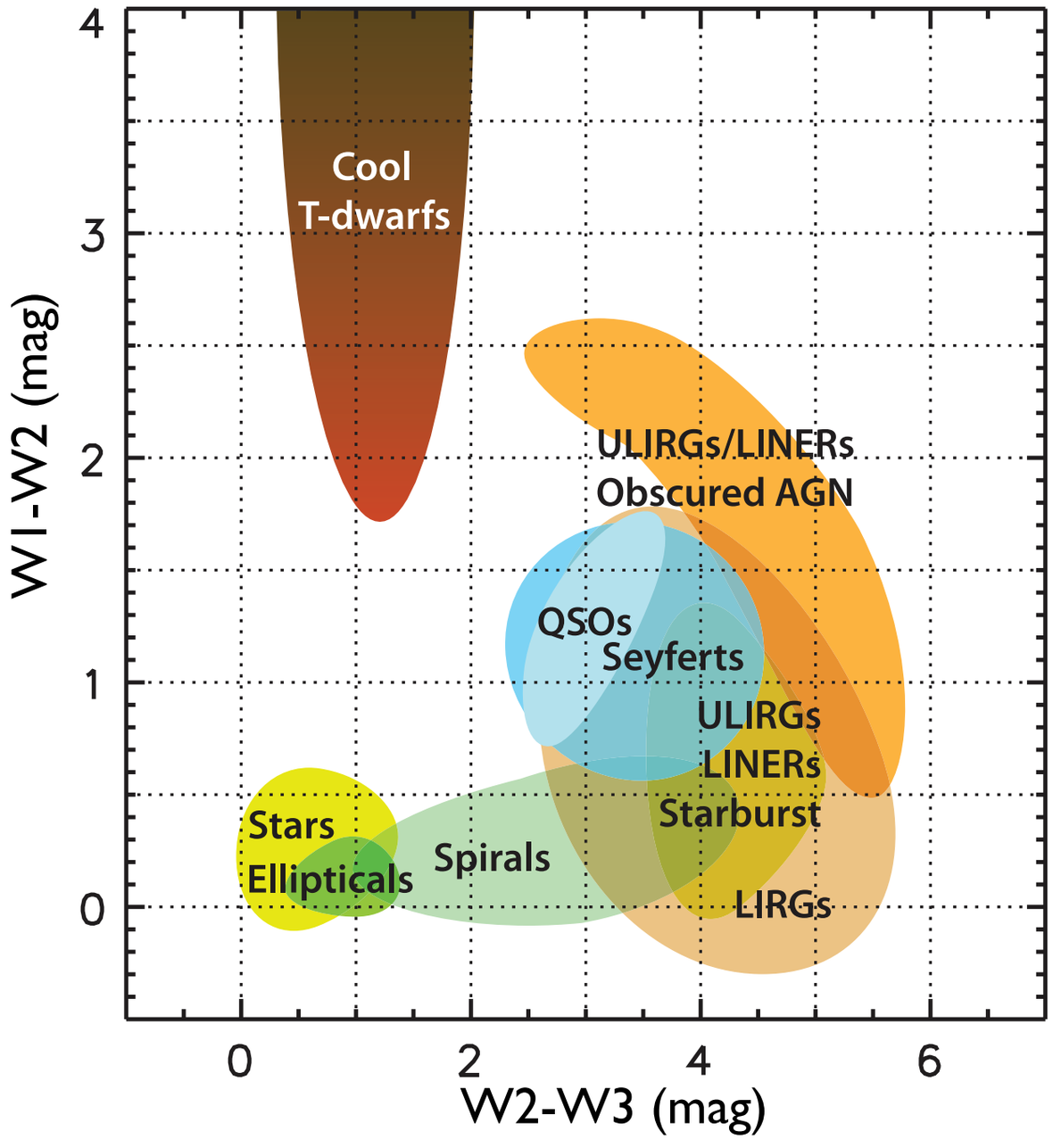


Cool brown dwarfs are red in W1-W2



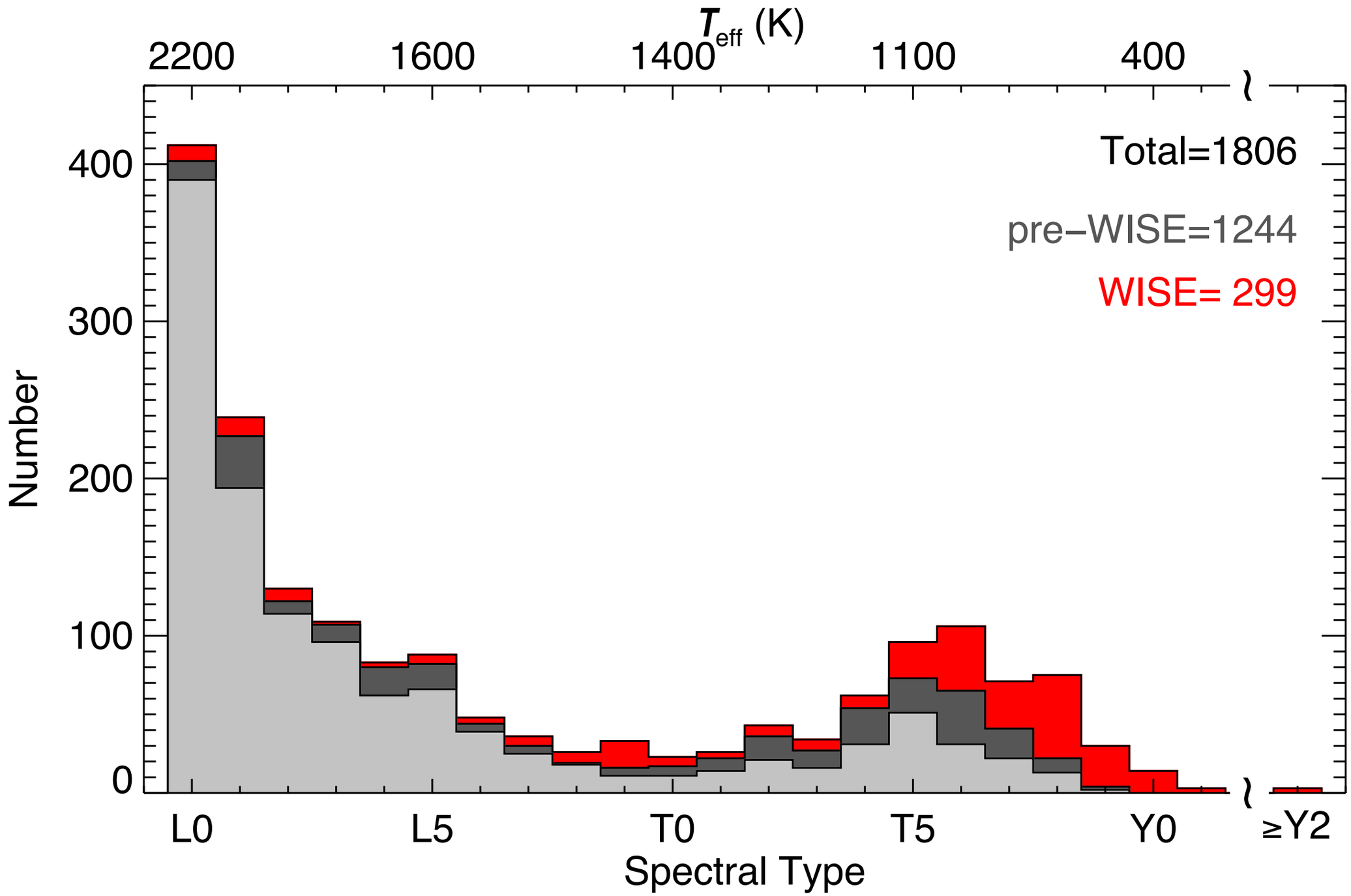
courtesy D. Kirkpatrick



Wright et al. (2011, AJ, 140, 1868)

Brown dwarf demographics and cartography

WISE has vastly increased the number of late-type brown dwarfs



DwarfArchives.org (updated)

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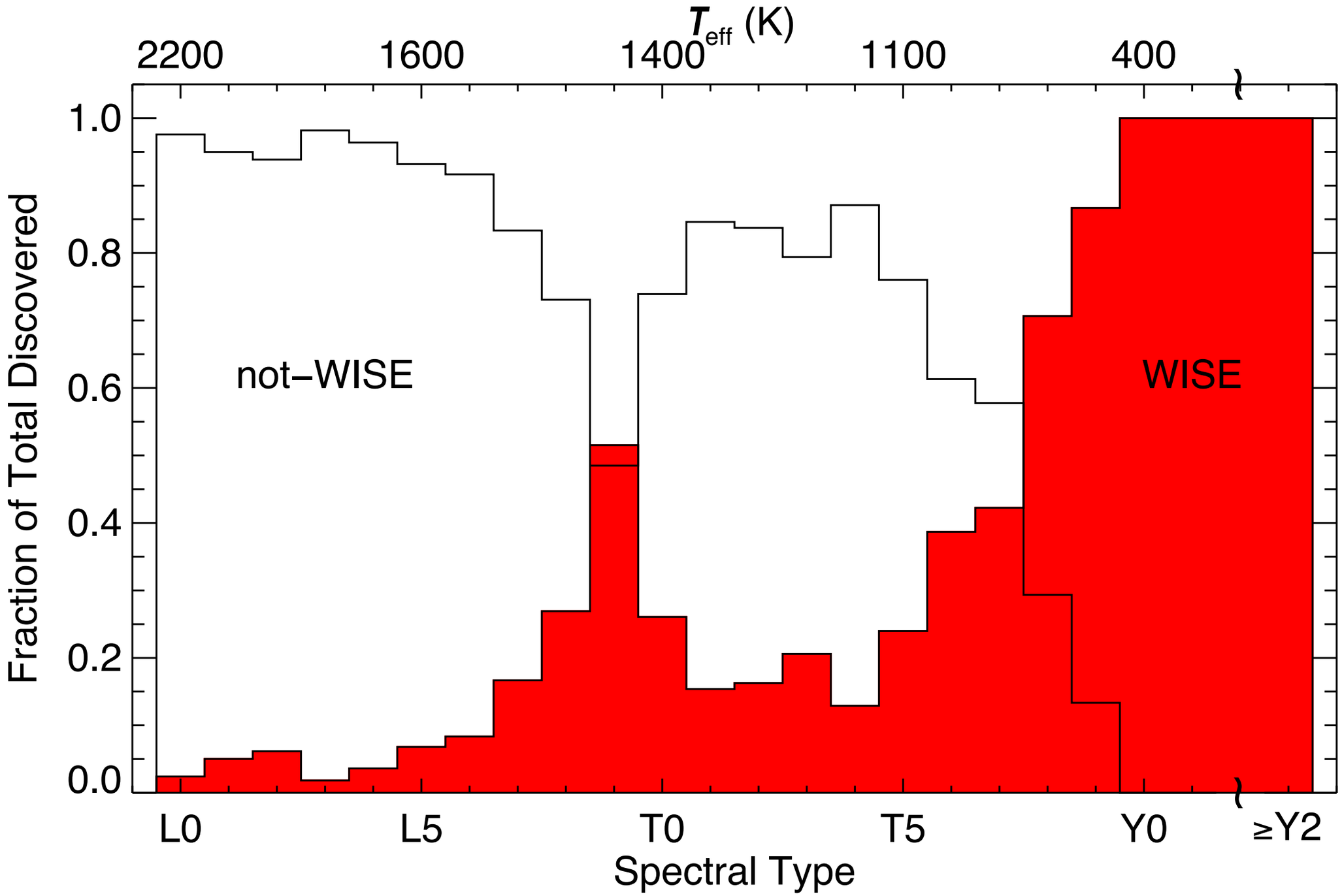

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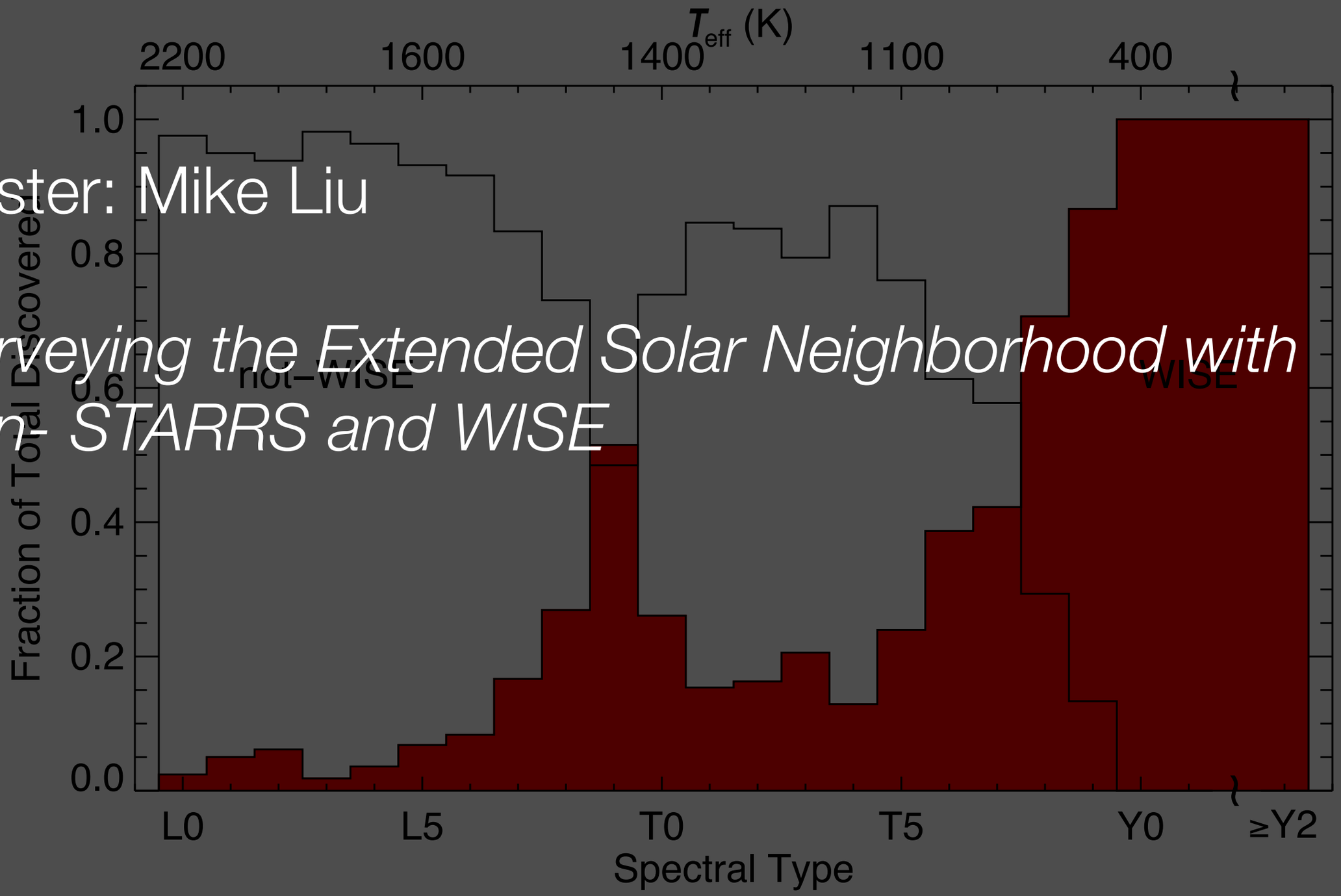
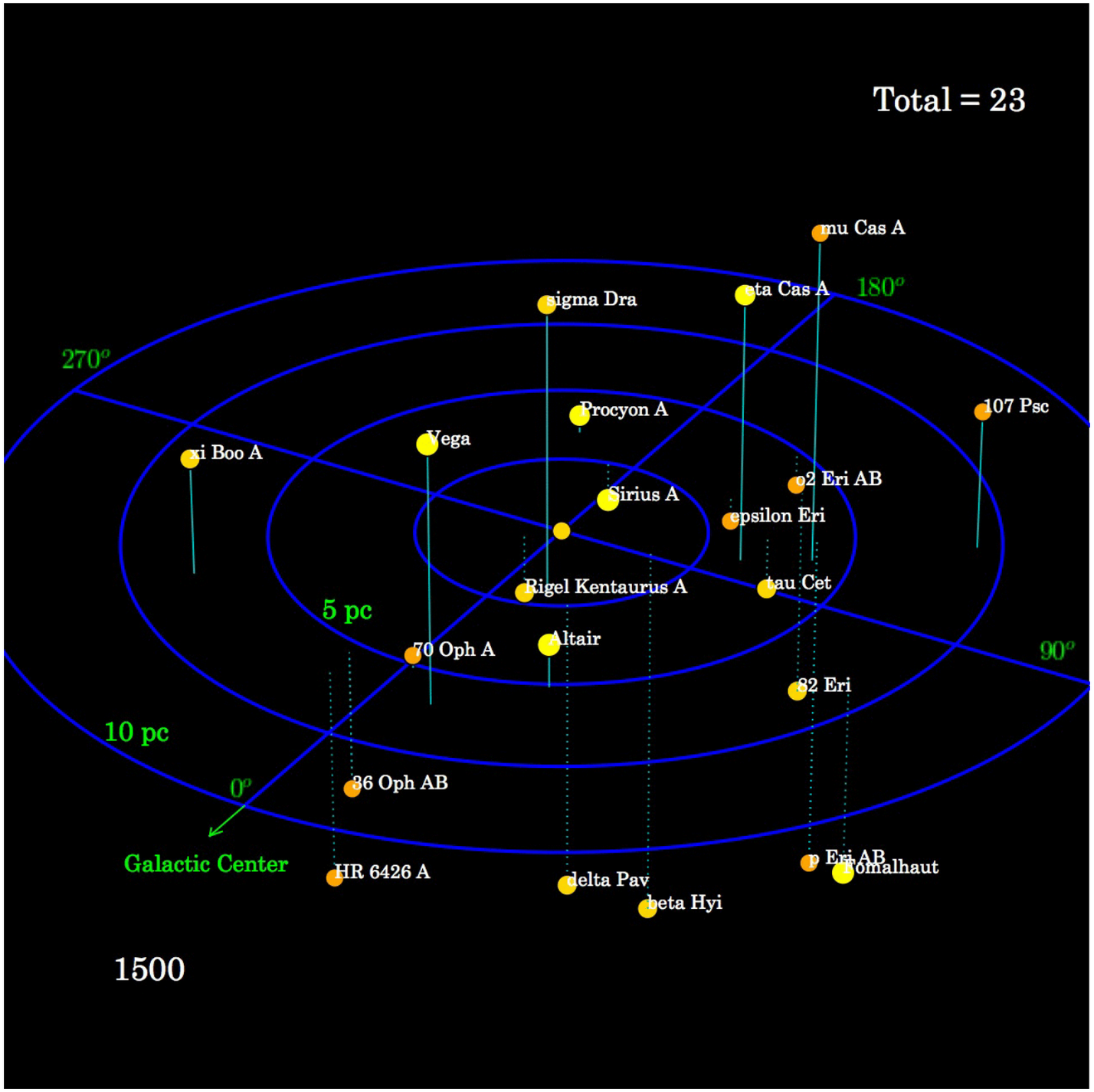
Poster: Mike Liu

Surveying the Extended Solar Neighborhood with Pan-STARRS and WISE



WISE is filling out the local 8 pc volume



data from Kirkpatrick et al. (2012, ApJ, 753, 156)
courtesy Adam Schneider

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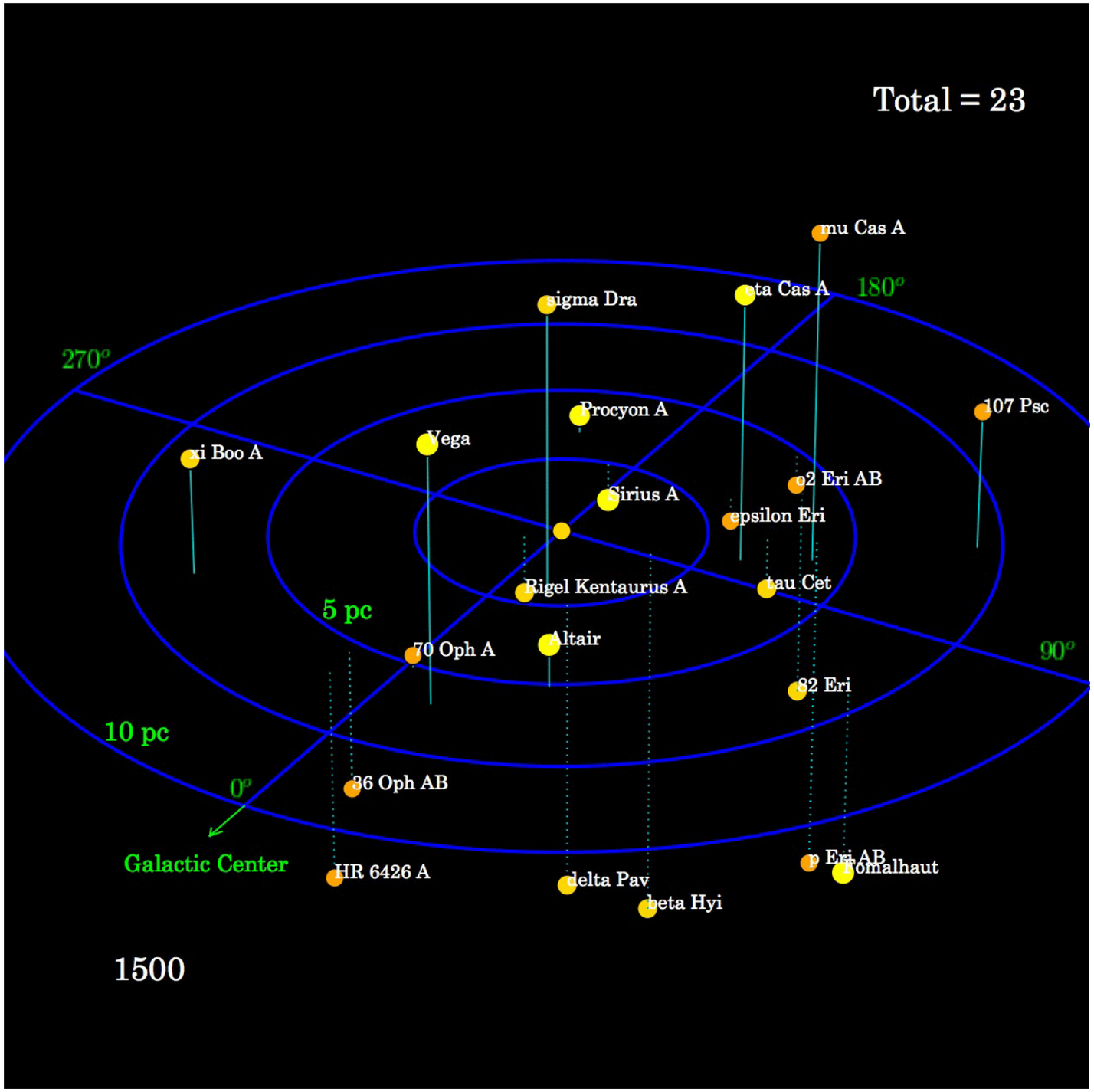

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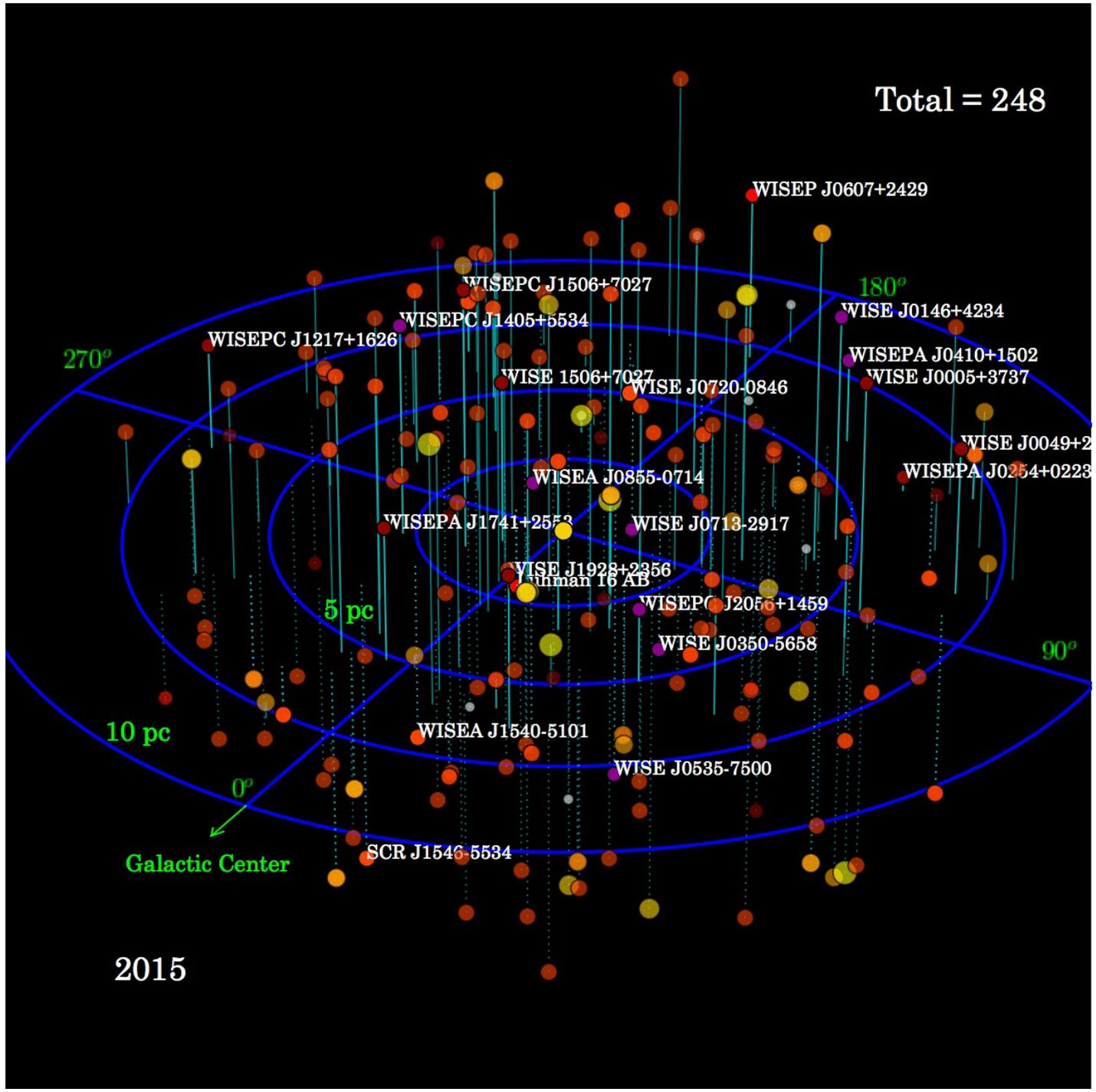

data from Kirkpatrick et al. (2012, ApJ, 753, 156)
courtesy Adam Schneider

Requires parallaxes

Dupuy et al. (2013, Sci, 341, 1492)

Marsch et al. (2013, ApJ, 762, 119)

Tinney et al. (2014, ApJ, 796, 39)

Kirkpatrick et al. (Spitzer Cycle 9)

Dupuy et al. (Spitzer Cycle 11)

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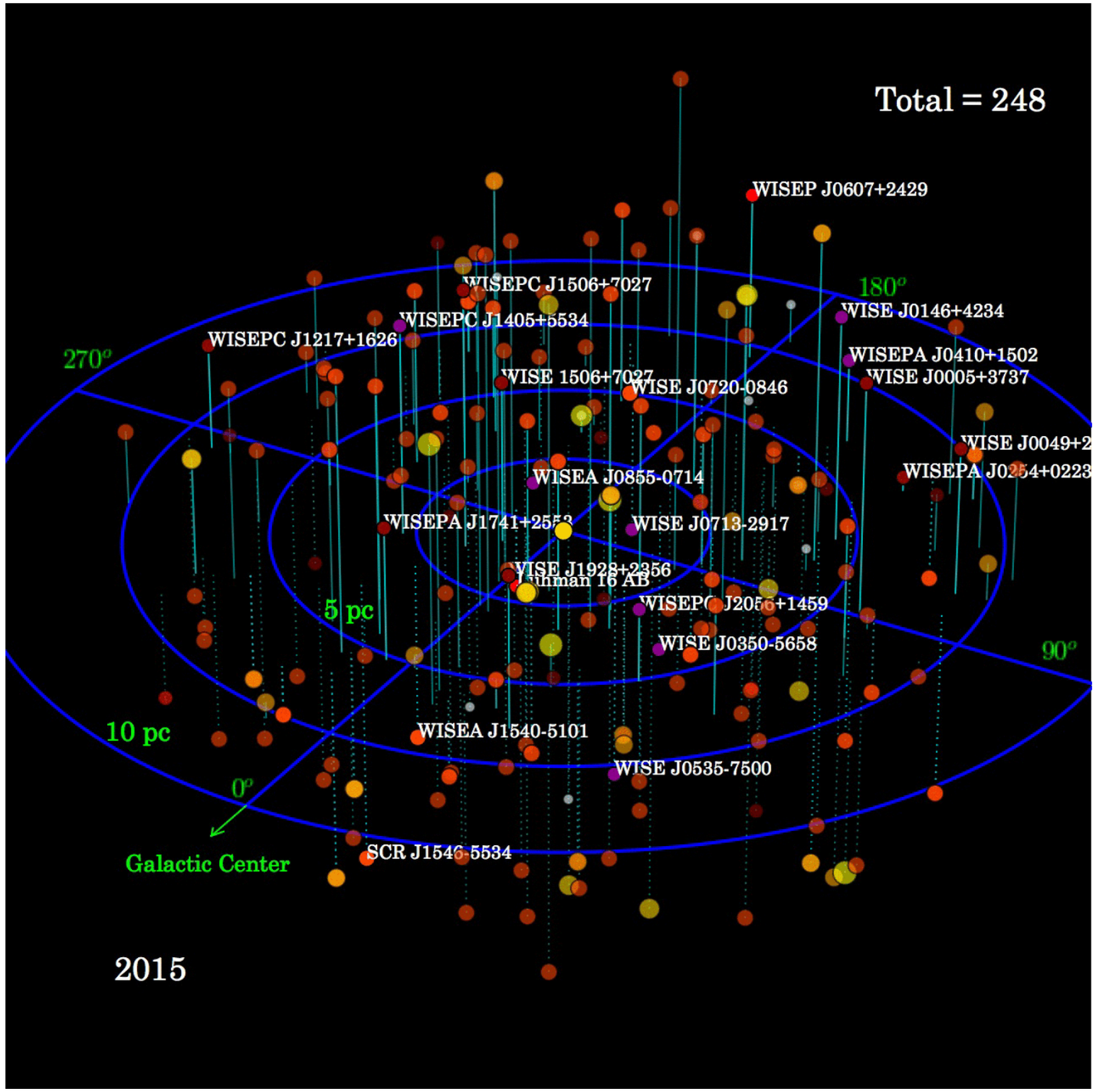

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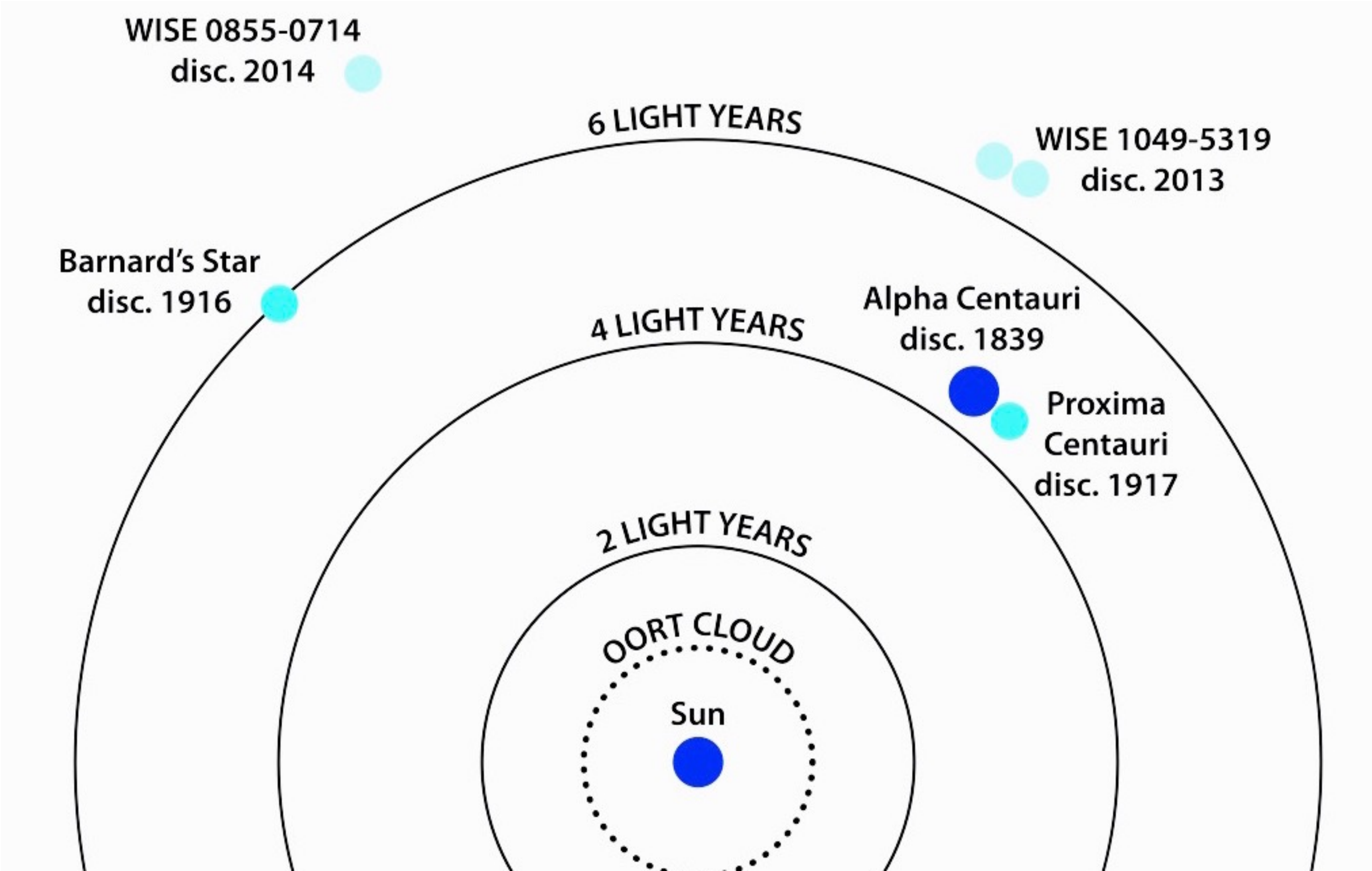
Luhman's binary and brown dwarf



Luhman's binary and star

Today, 1:30 pm: Kevin Luhman

Searching for Brown Dwarfs Near the Sun with WISE Proper Motions

WISE 1828+2650

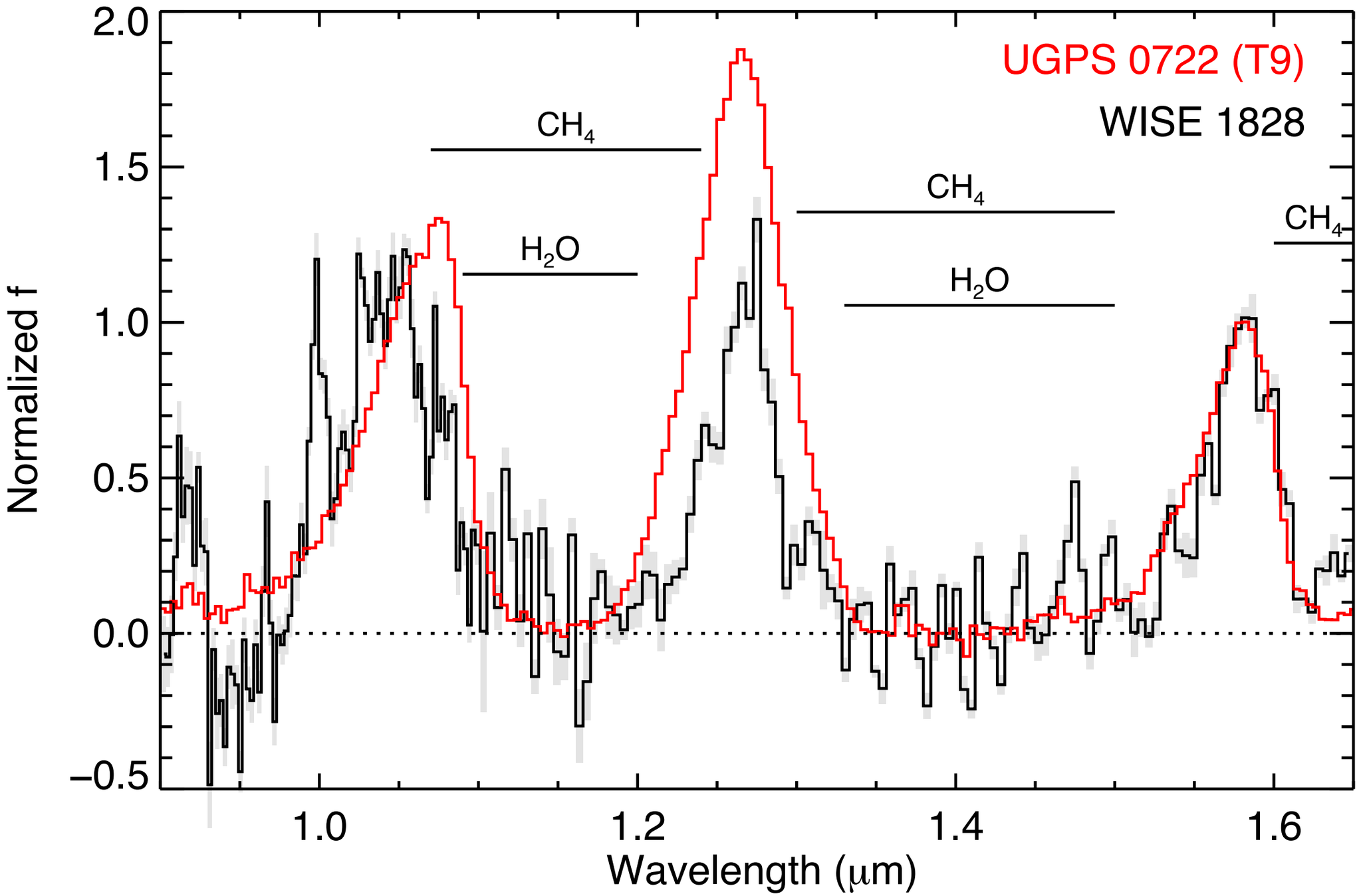
W1-W2 > 4.08

J-H = 0.7

J = 23.5 mag

d = 11-14 pc

WISE 1828+2650 is not a T dwarf

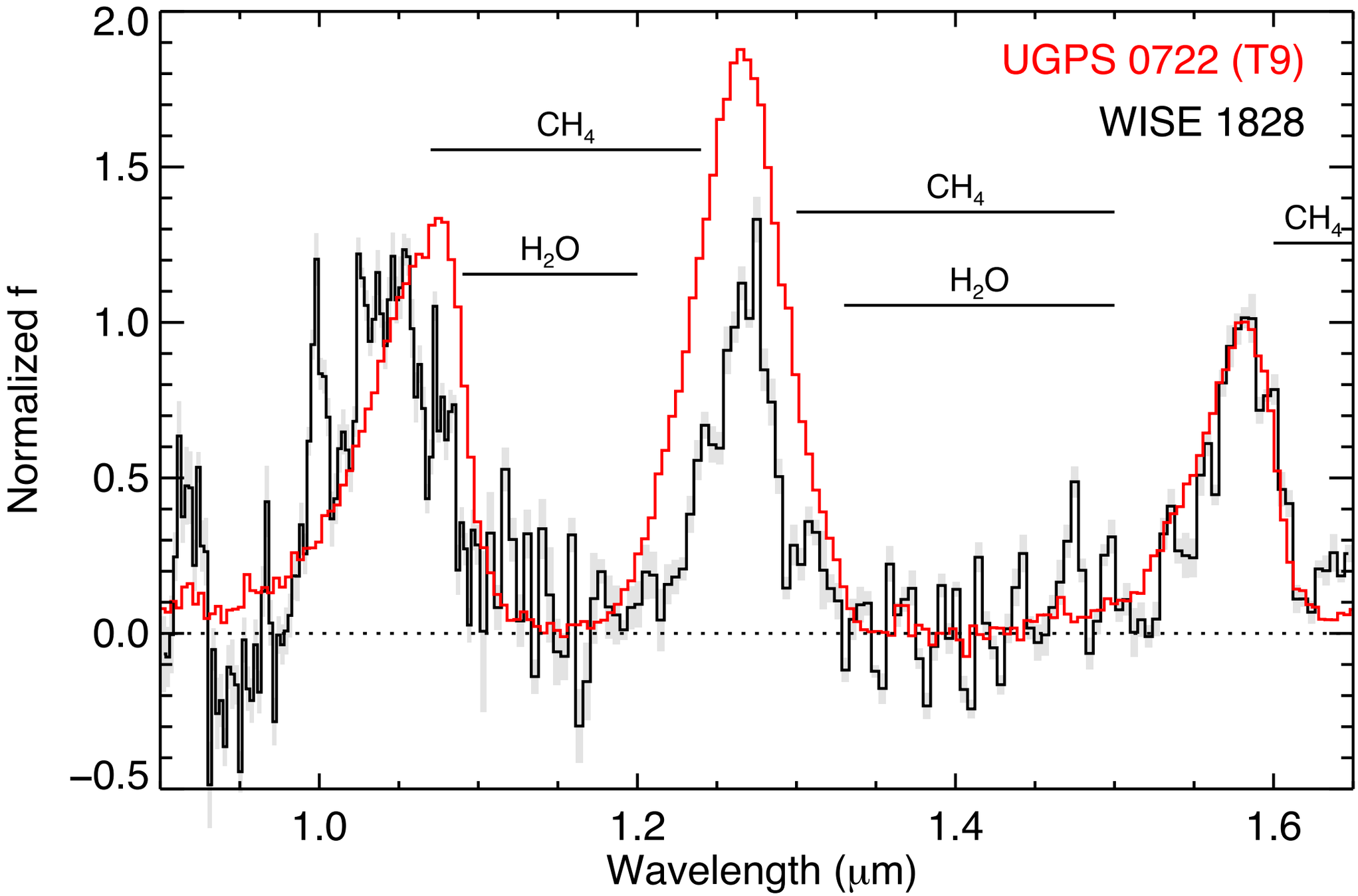


Cushing et al. (2011, ApJ, 743, 50)

Cushing et al. (in prep)

WISE 1828+2650 is not a T dwarf

$$f_\lambda(1.25\,\mu\mathrm{m}) \approx f_\lambda(1.6\,\mu\mathrm{m}),\ J-[4.5] \sim 9 \rightarrow T_{\mathrm{eff}} < 300\ \mathrm{K}$$



Cushing et al. (2011, ApJ, 743, 50)

Cushing et al. (in prep)

There are ~23 Y dwarfs known

Spectroscopic

6 Cushing et al. (2011, ApJ, 743 50)

7 Kirkpatrick et al. (2012, ApJ, 753, 156)

1 Liu et al. (2012, ApJ, 758, 57)

1 Tinney et al. (2012, ApJ, 759, 60)

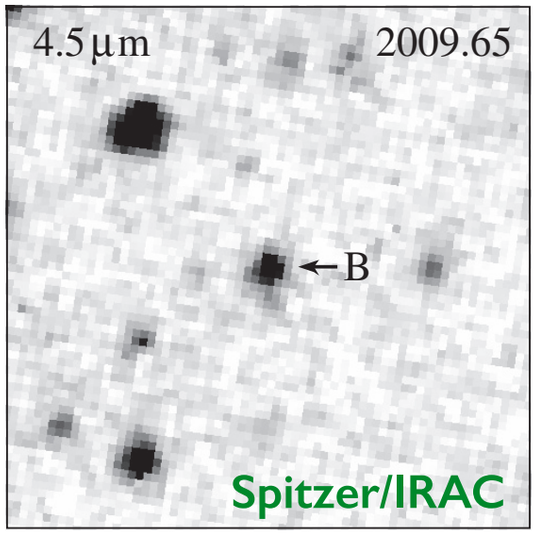
1 Kirkpatrick et al. (2013, ApJ, 776, 128)

1 Cushing et al. (2014, ApJ, 147, 113)

1 Pinfield et al. (2014, MNRAS, 444, 1931)

3 Schneider et al. (submitted)

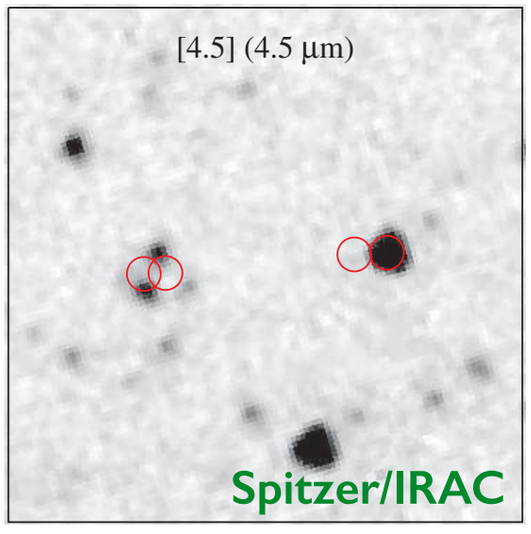
Photometric



WD 0806B

Luhman et al. (2011, ApJ, 730, L9)

J ~ 25 mag

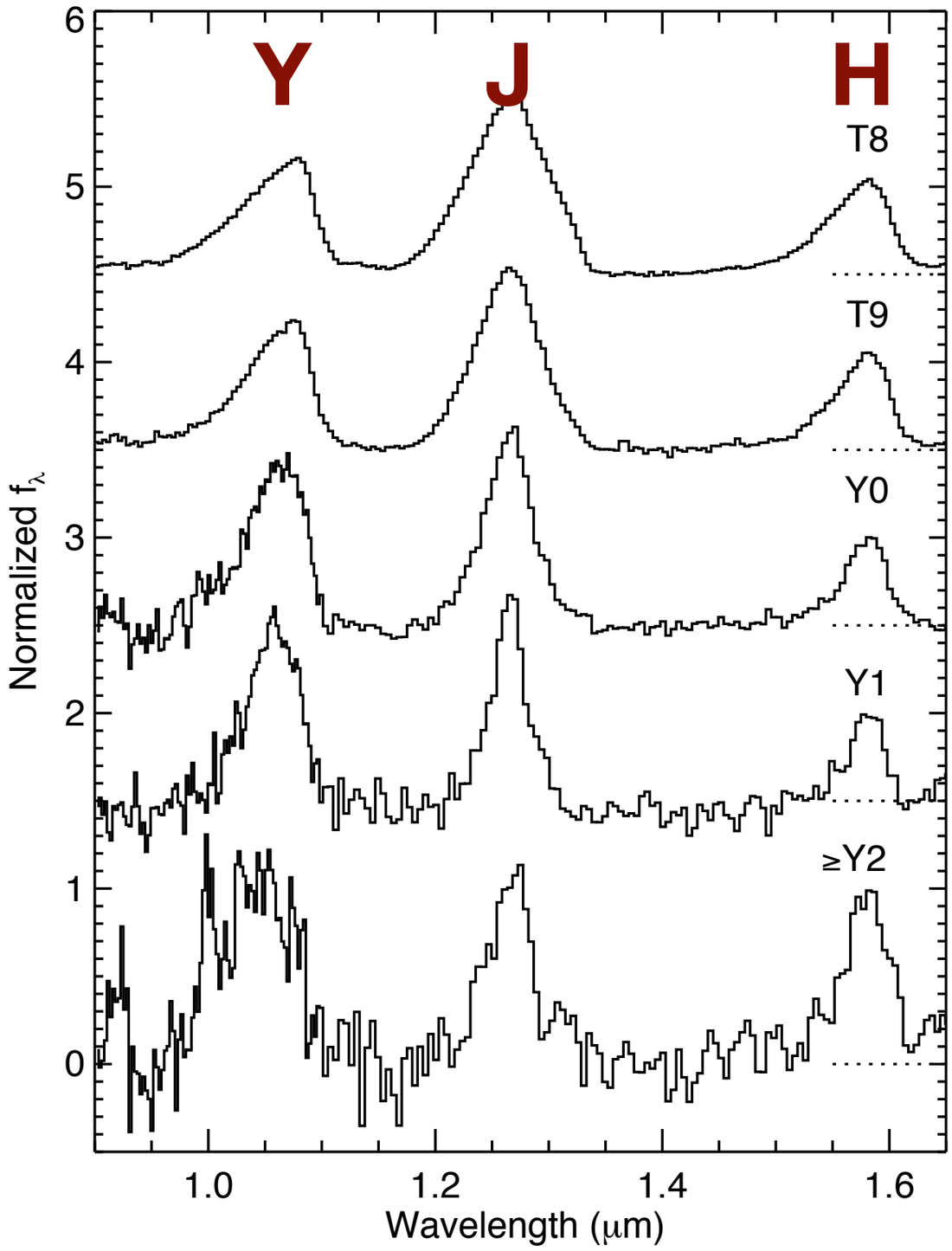


WISE 0855-0714

Luhman et al. (2014, ApJ, 786, L18)

J > 24 mag

The Y dwarf sequence

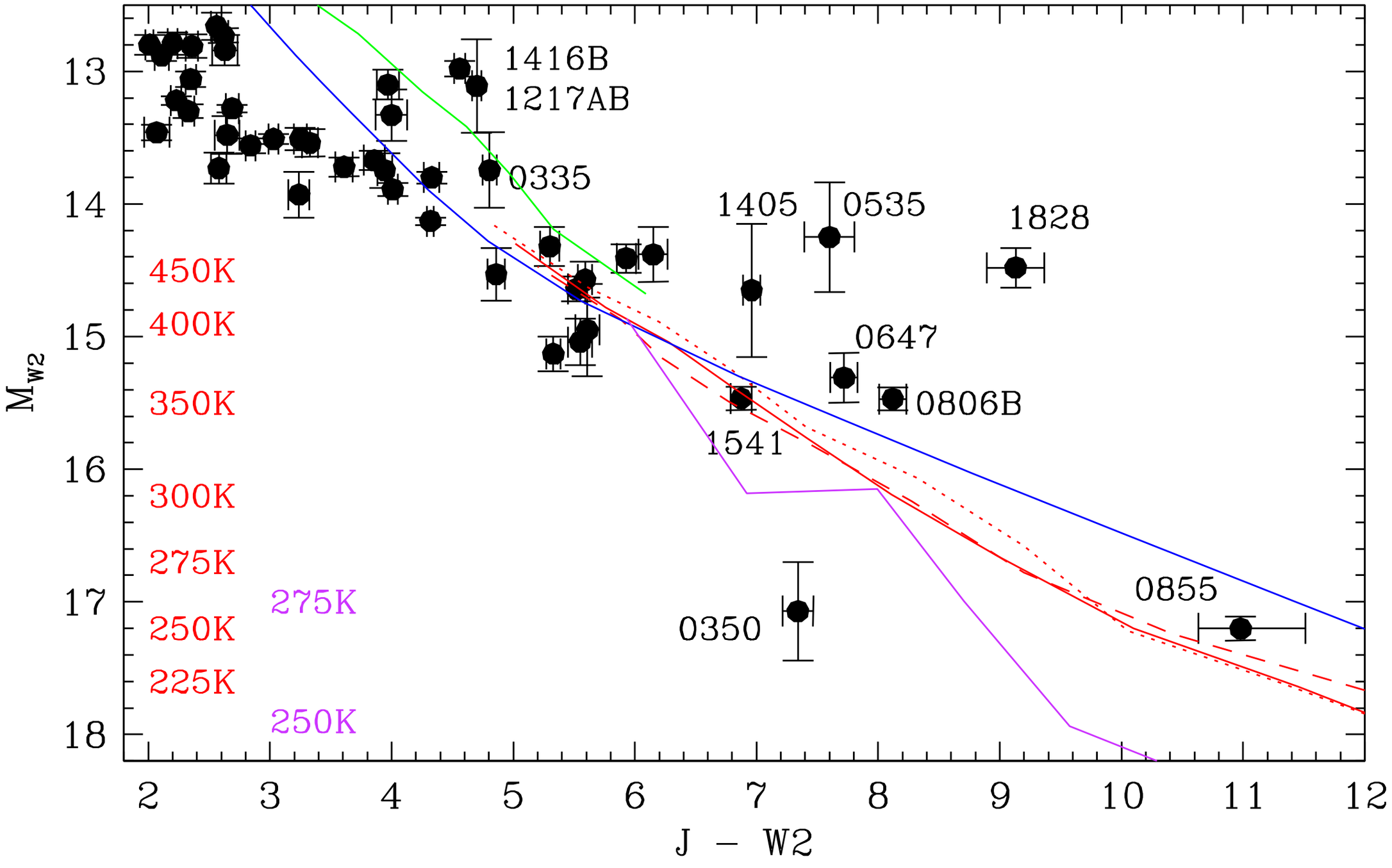


Schneider et al. (submitted)
Cushing et al. (in prep)

- The J-band narrows
- The Y/J/H peaks move towards unity ratios.
- The peak of the Y band shifts blueward.

Brown dwarf astrophysics enabled by WISE

Y dwarfs are cool, $T_{\rm eff} < 500$ K



Leggett et al. (2014, ApJ, 799, 37)

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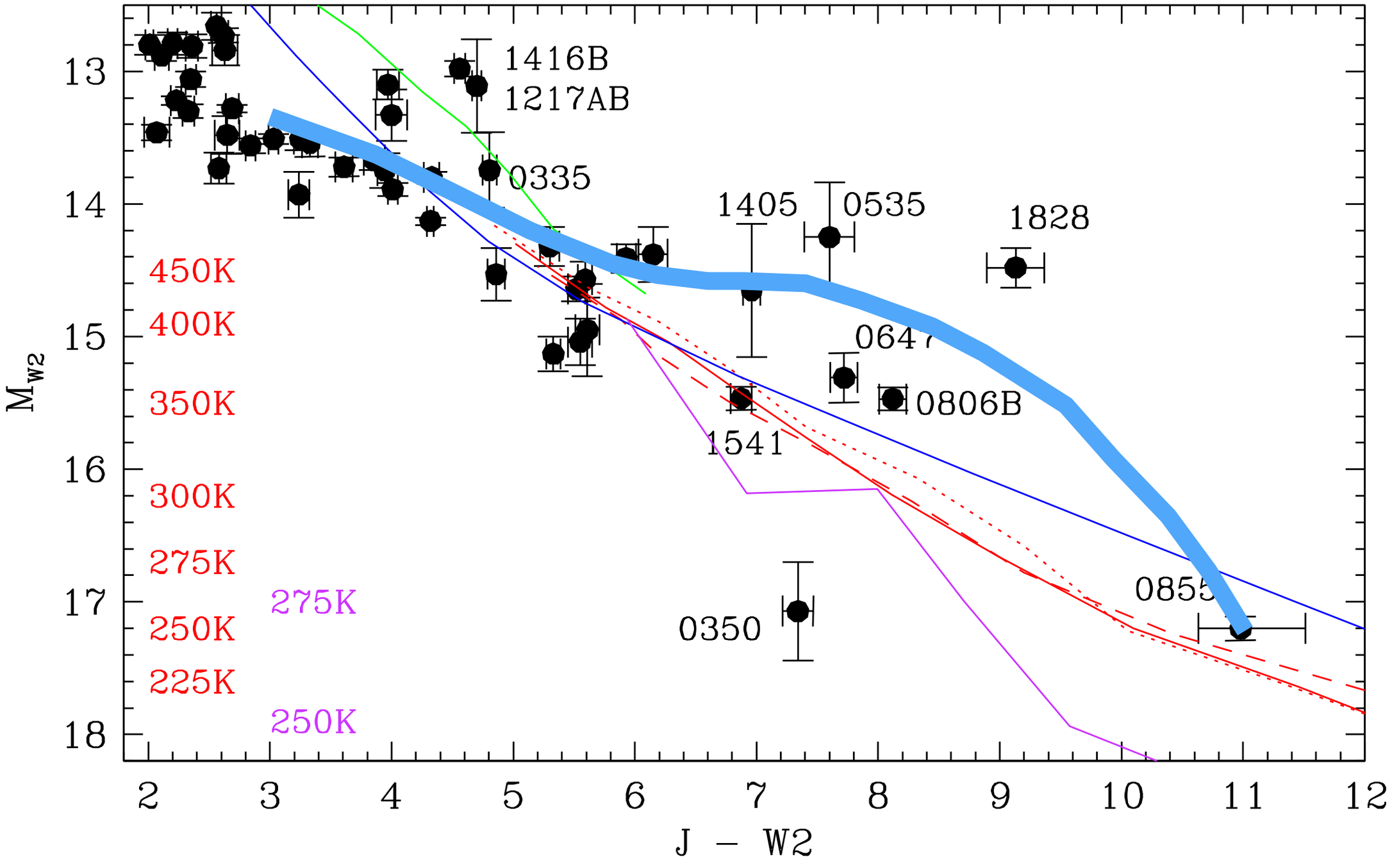
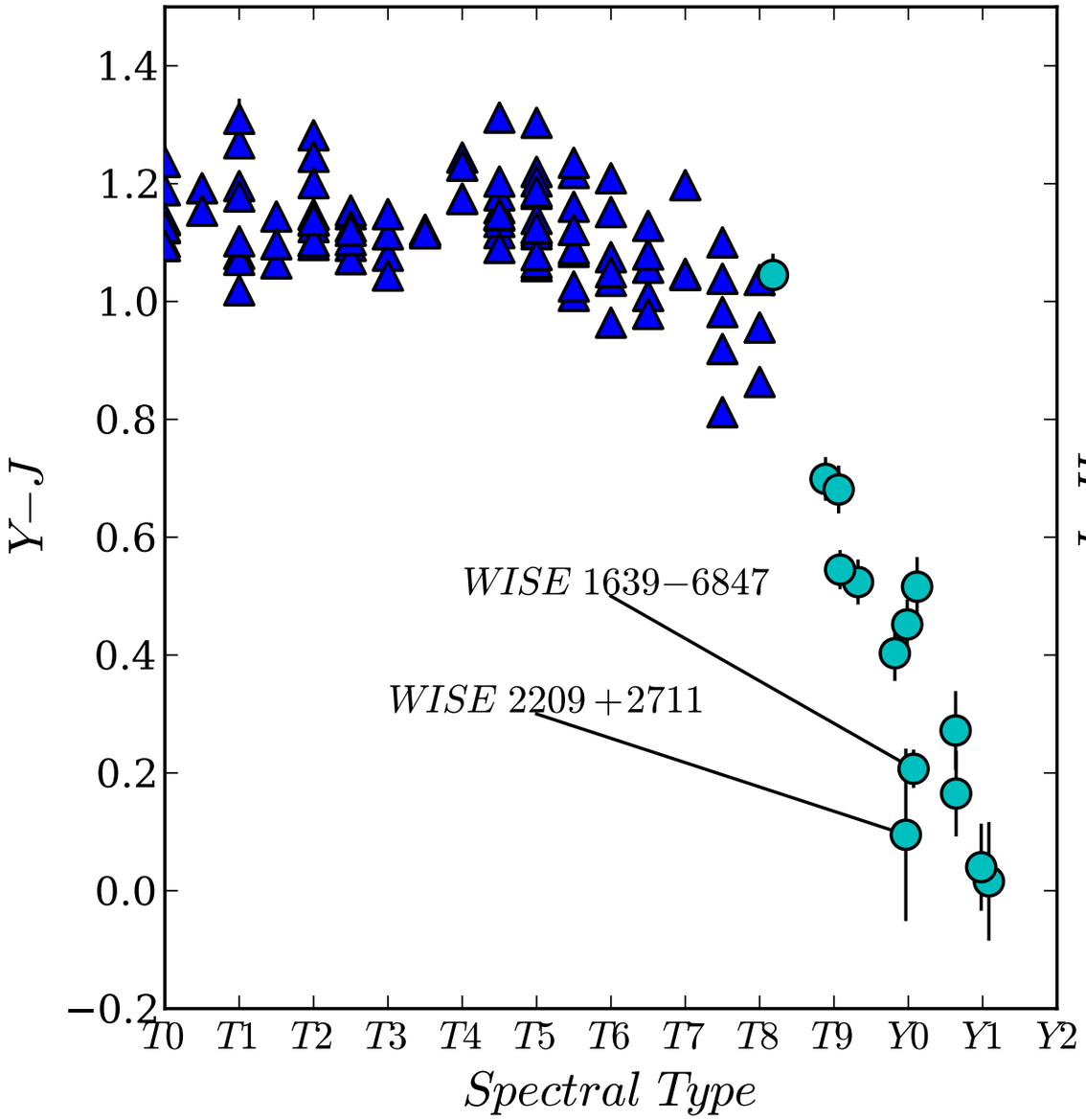


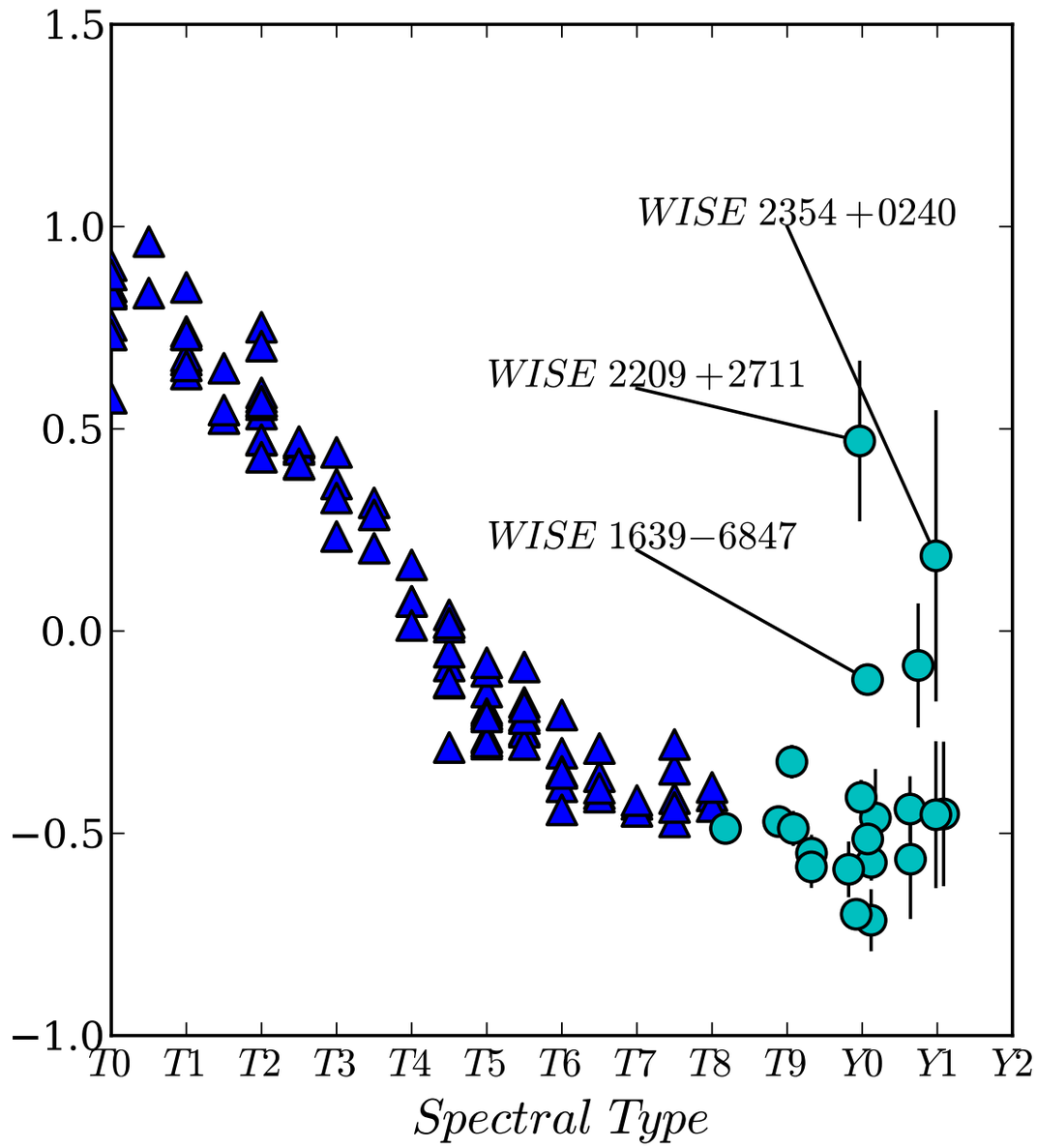
Leggett et al. (2014, ApJ, 799, 37)

Colors transition at the T/Y boundary



Schneider et al. (submitted)

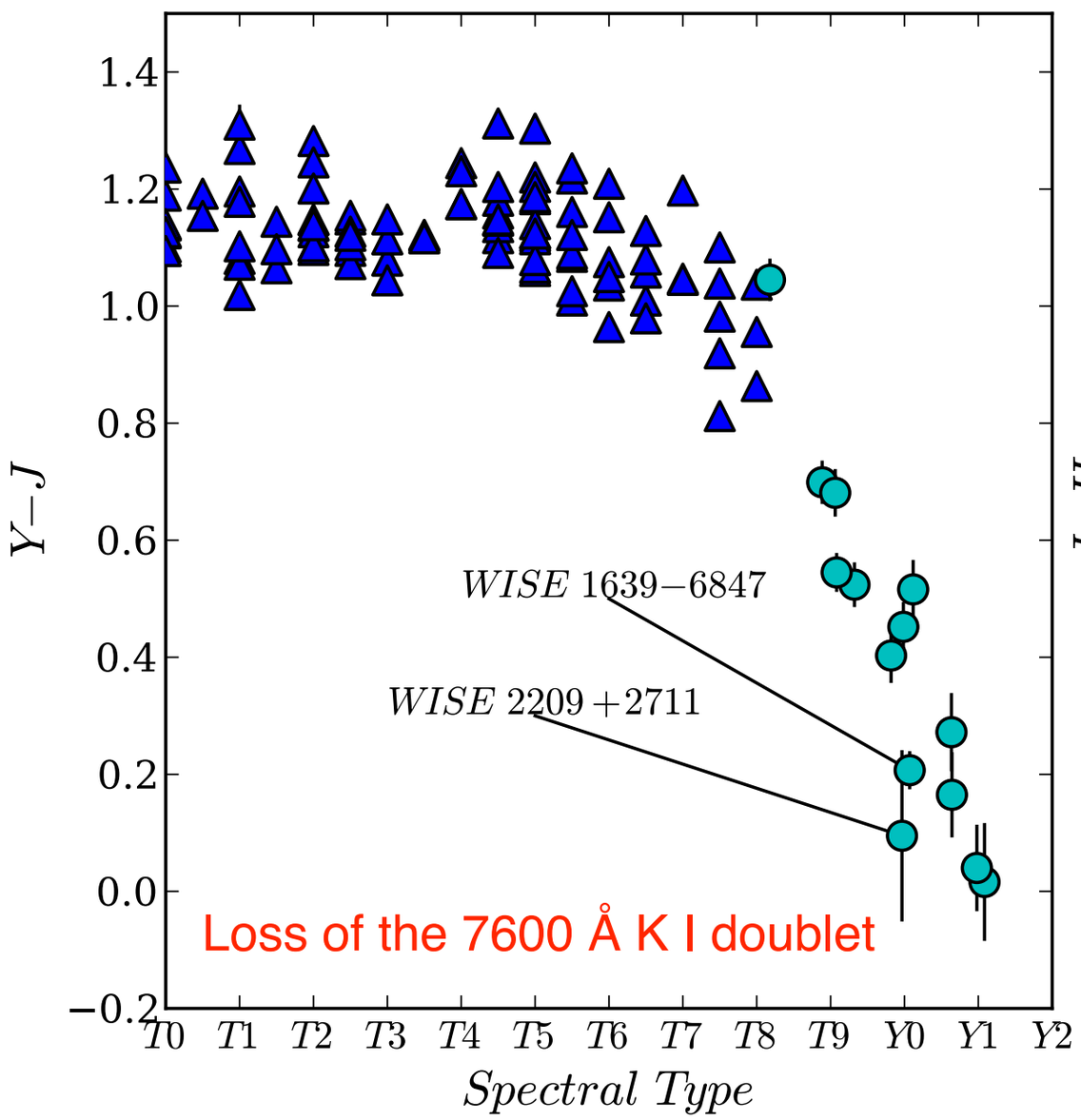
see also Liu et al. (2012, ApJ, 758, 57)
Lodieu et al. (2013, A&A, 550, L2)

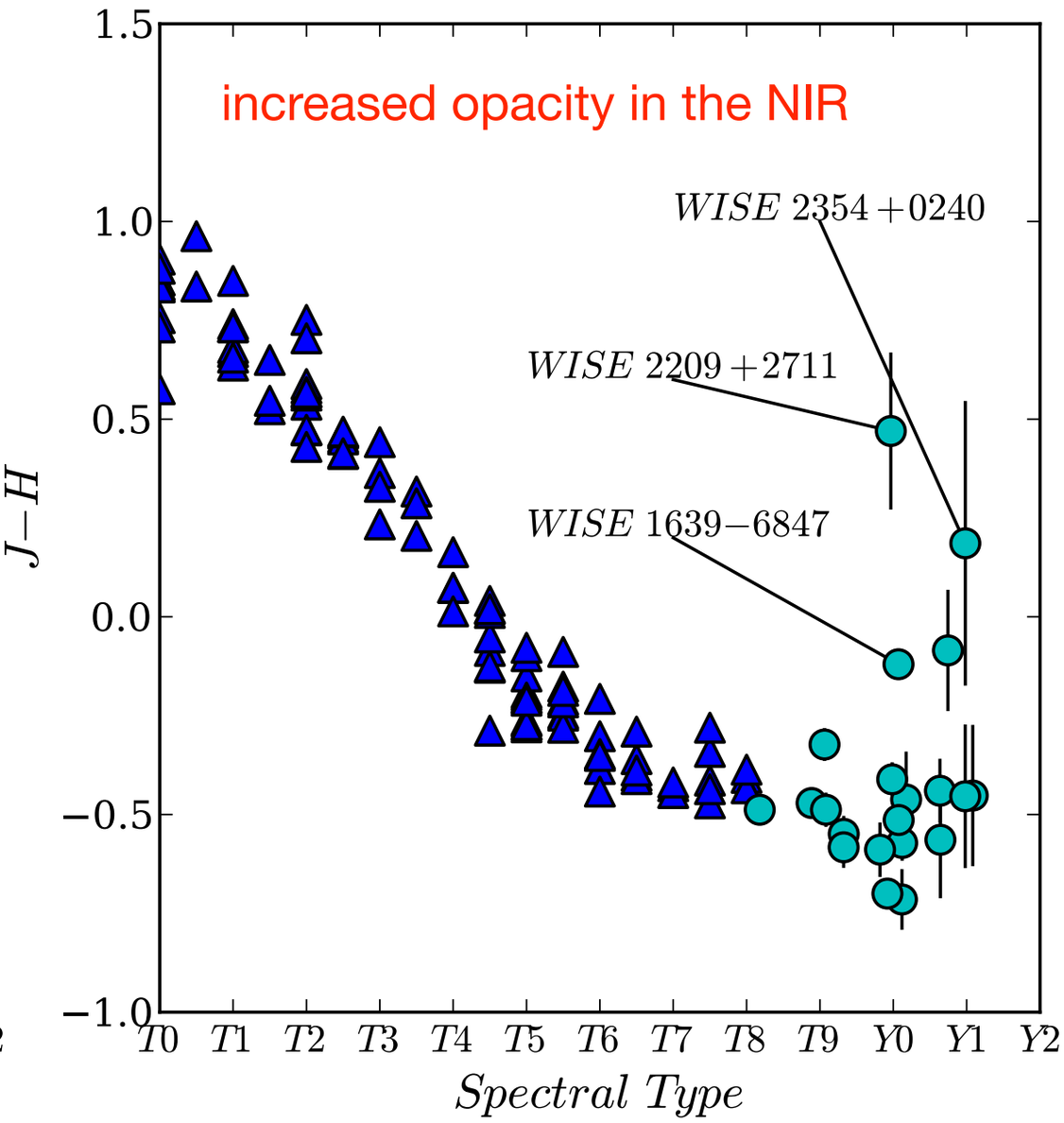


Schneider et al. (submitted)

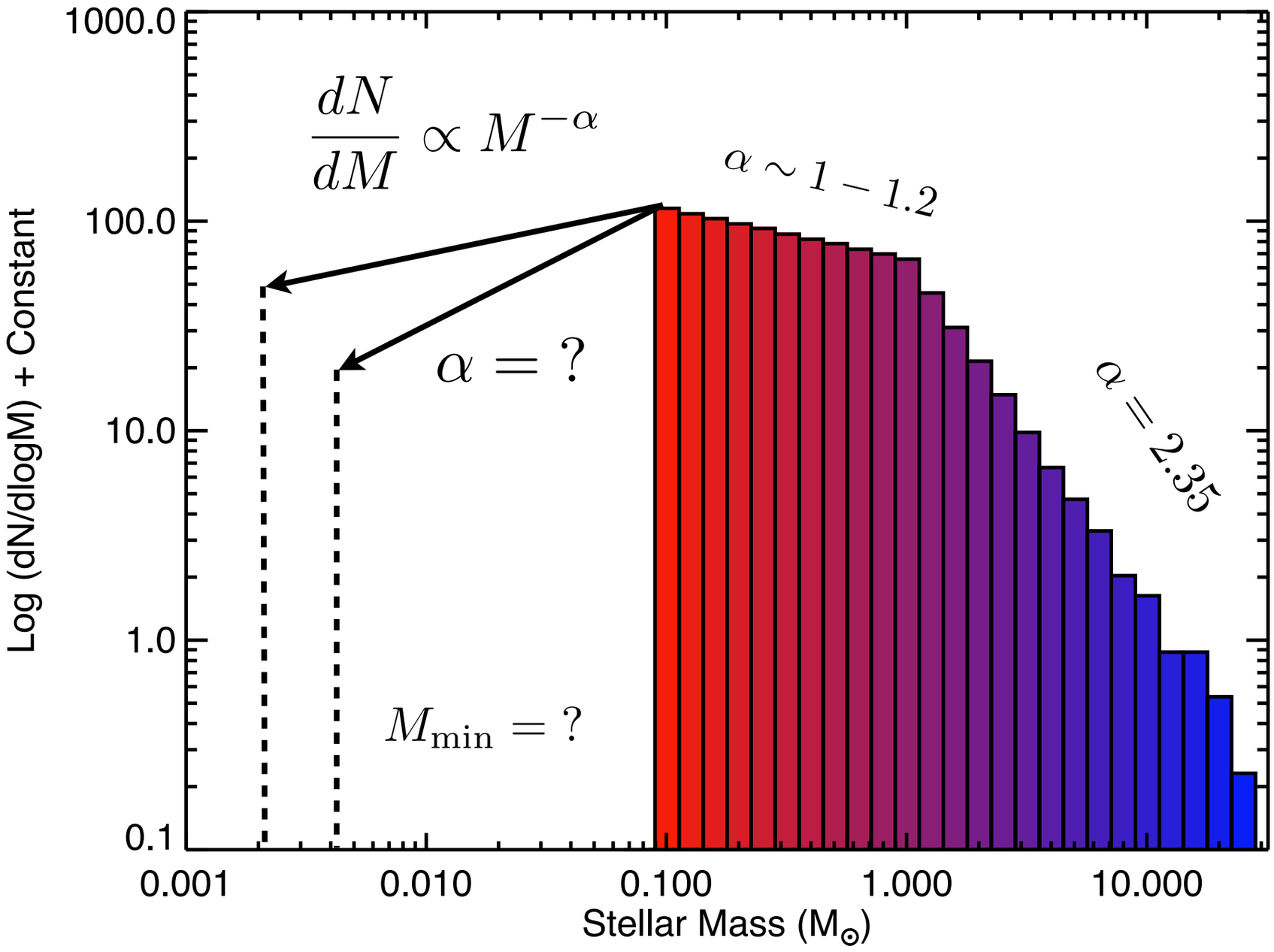
see also Mace et al. (2013, ApS, 205, 6)
Leggett et al. (2013, ApJ, 763, 130)

As a result of Na_2S and KCl formation

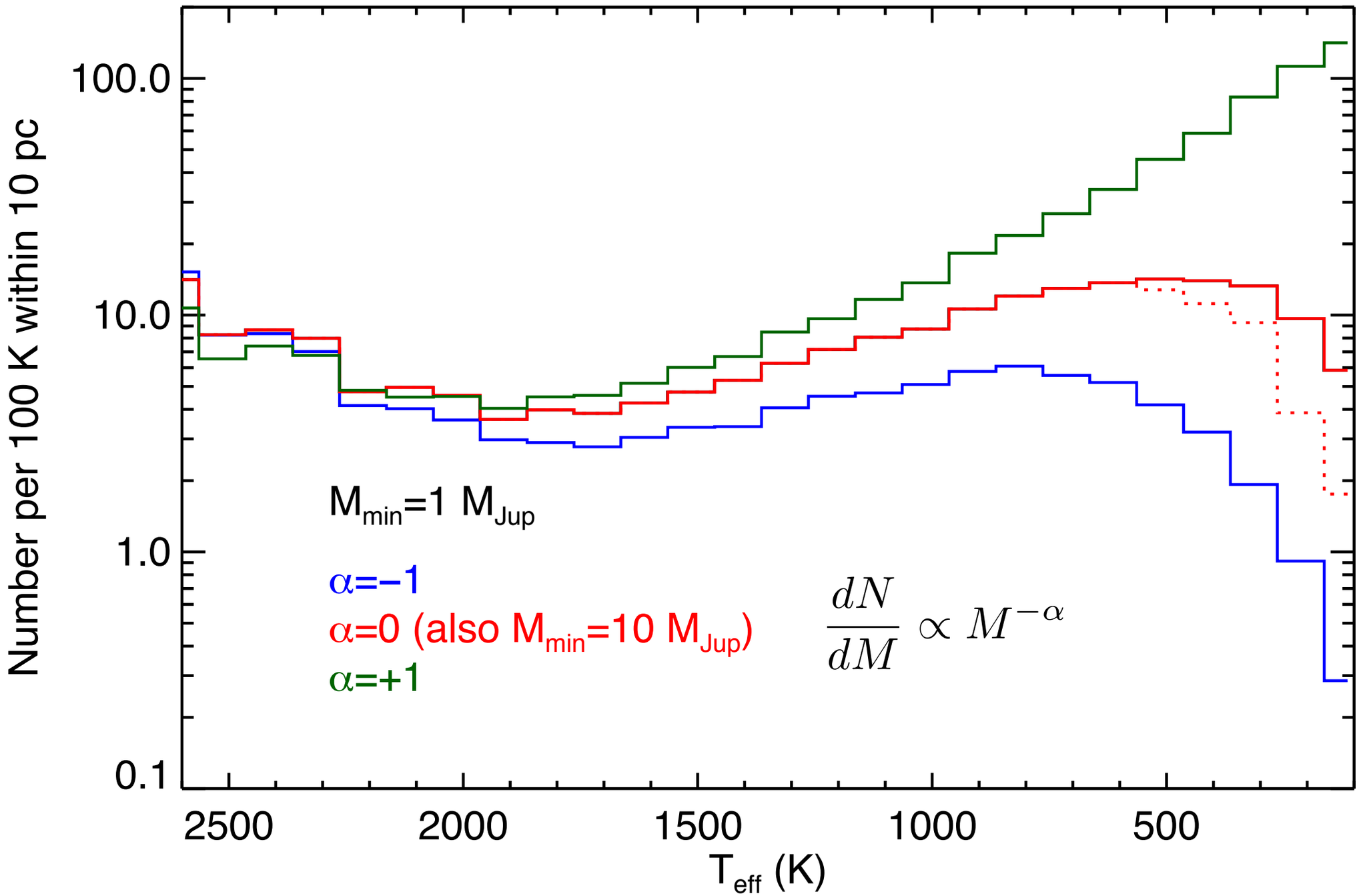




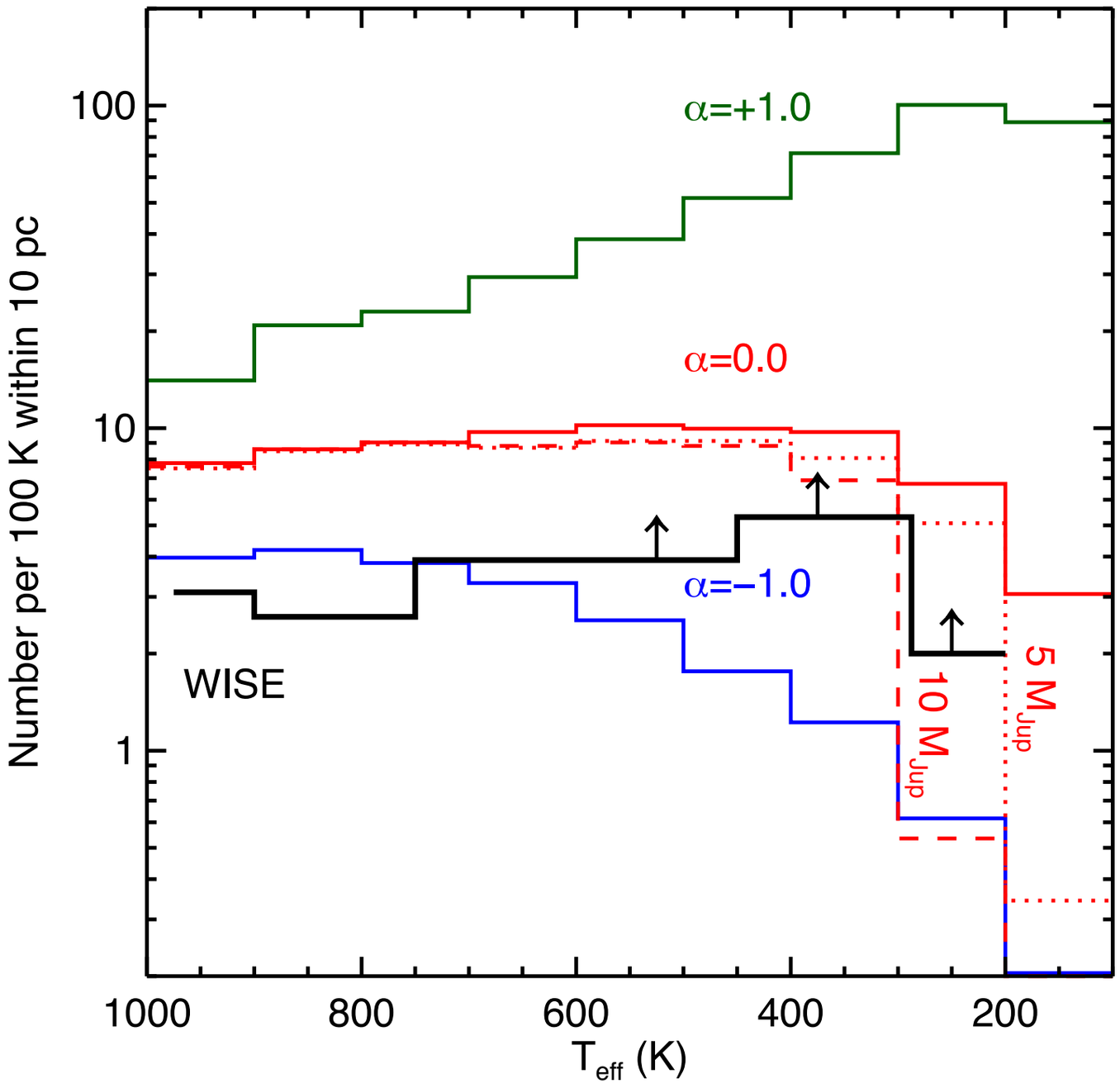
The mass function summarizes how molecular clouds turn gas into stars



The mass function is most sensitive to the coolest brown dwarfs



We can rule out α=+1



Kirkpatrick et al. (2012, ApJ, 753, 156)

And, a simple power law doesn't appear to match the data well.

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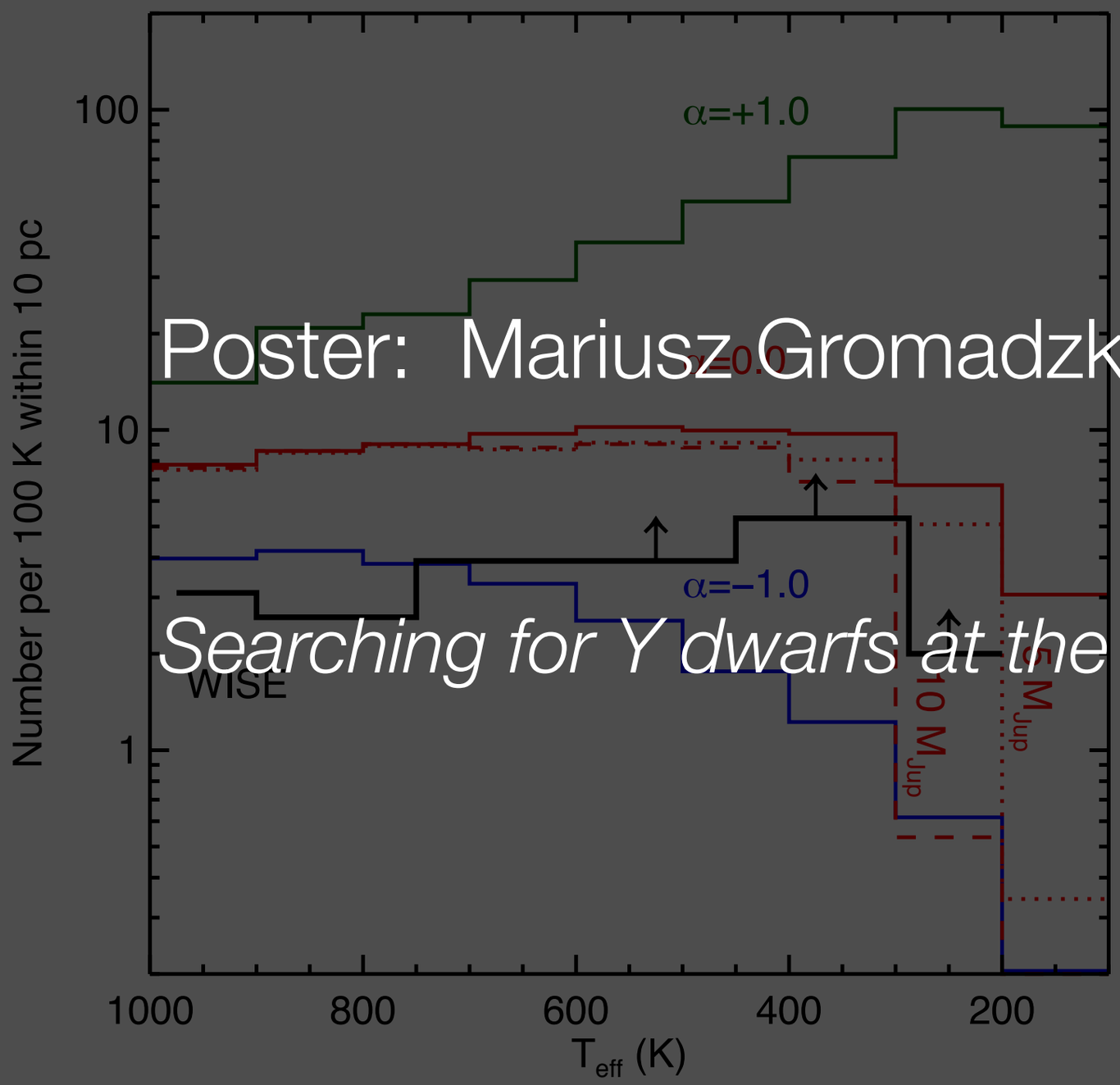

Poster: Mariusz Gromadzki

Searching for Y dwarfs at the faint limits of WISE

And, a simple power law doesn't appear to match the data at all!

Kirkpatrick et al. (2012, ApJ, 753, 156)

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(Next Generation Sky Survey):

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- The nature and evolutionary history of ultra-luminous infrared galaxies (ULIRGs), and the identification of the single most luminous galaxy in the universe (§A.1.2.4).

- The space density, mass function, and formation history of brown dwarf stars in the solar neighborhood. NGSS will be exceptionally sensitive to old, cold brown dwarf stars with T ~ 125 – 1000 K (Jupiter-Gliese 229B), among which is likely to be the nearest star to the sun (§A.1.2.5).

Kinematic searches with WISE

- Today, 1:30 pm: Kevin Luhman
  Searching for Brown Dwarfs Near the Sun with WISE Proper Motions

- Today, 4:35 pm: Adam Schneider
  The NEOWISE-Reactivation Proper Motion Survey - Methods and Initial Result

- Thursday, 4:20 pm: Kendra Kellogg
  Searching for Ultracool Subdwarfs Using the AllWISE Motion Survey

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WISE