

**EPSC-DPS Joint Meeting 2011**

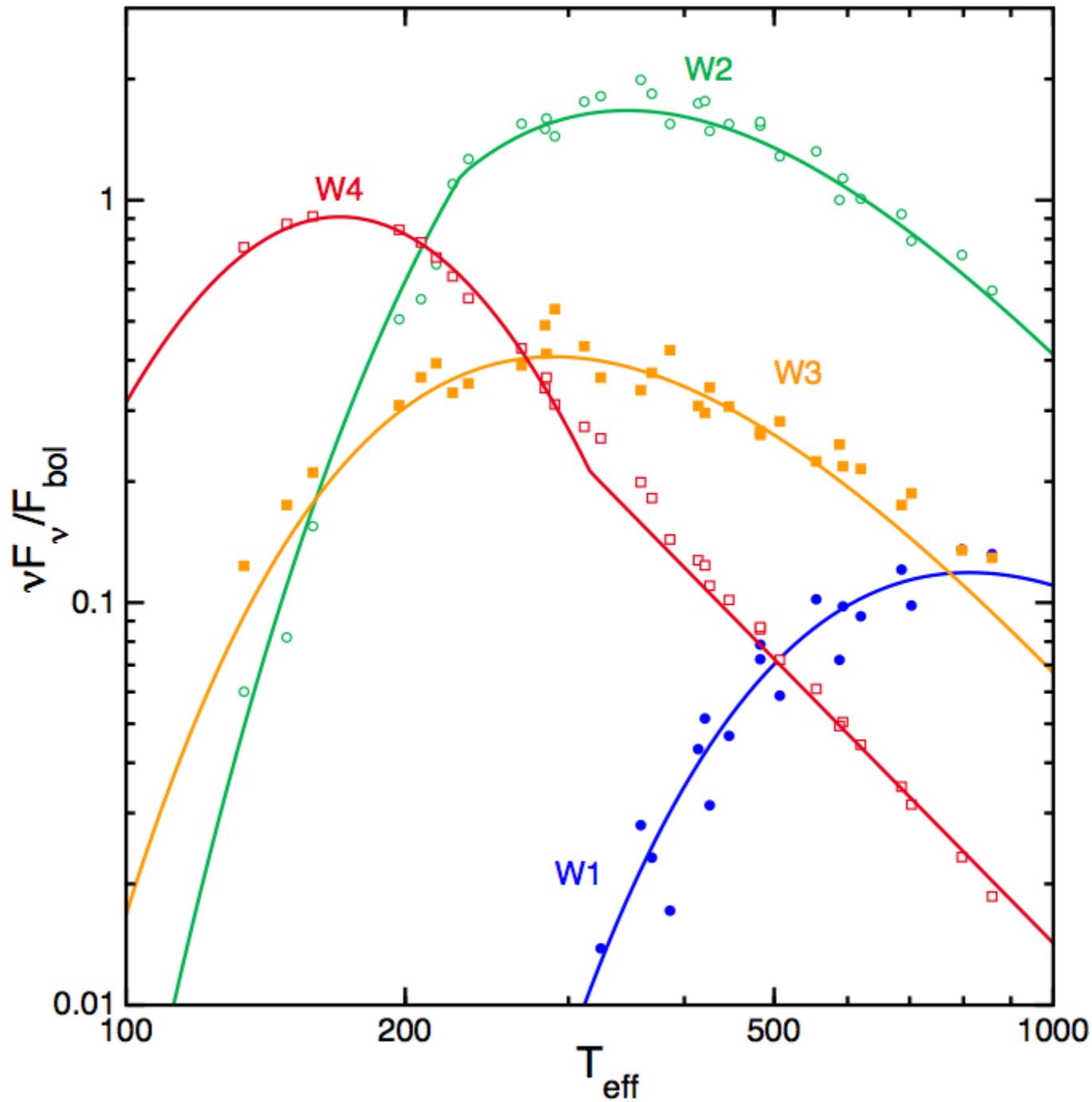
**La Cité Internationale des Congrès Nantes Métropole  
02 – 07 October 2011, Nantes, France**

## ***Searching the WISE preliminary catalog for massive planets in the Oort cloud***

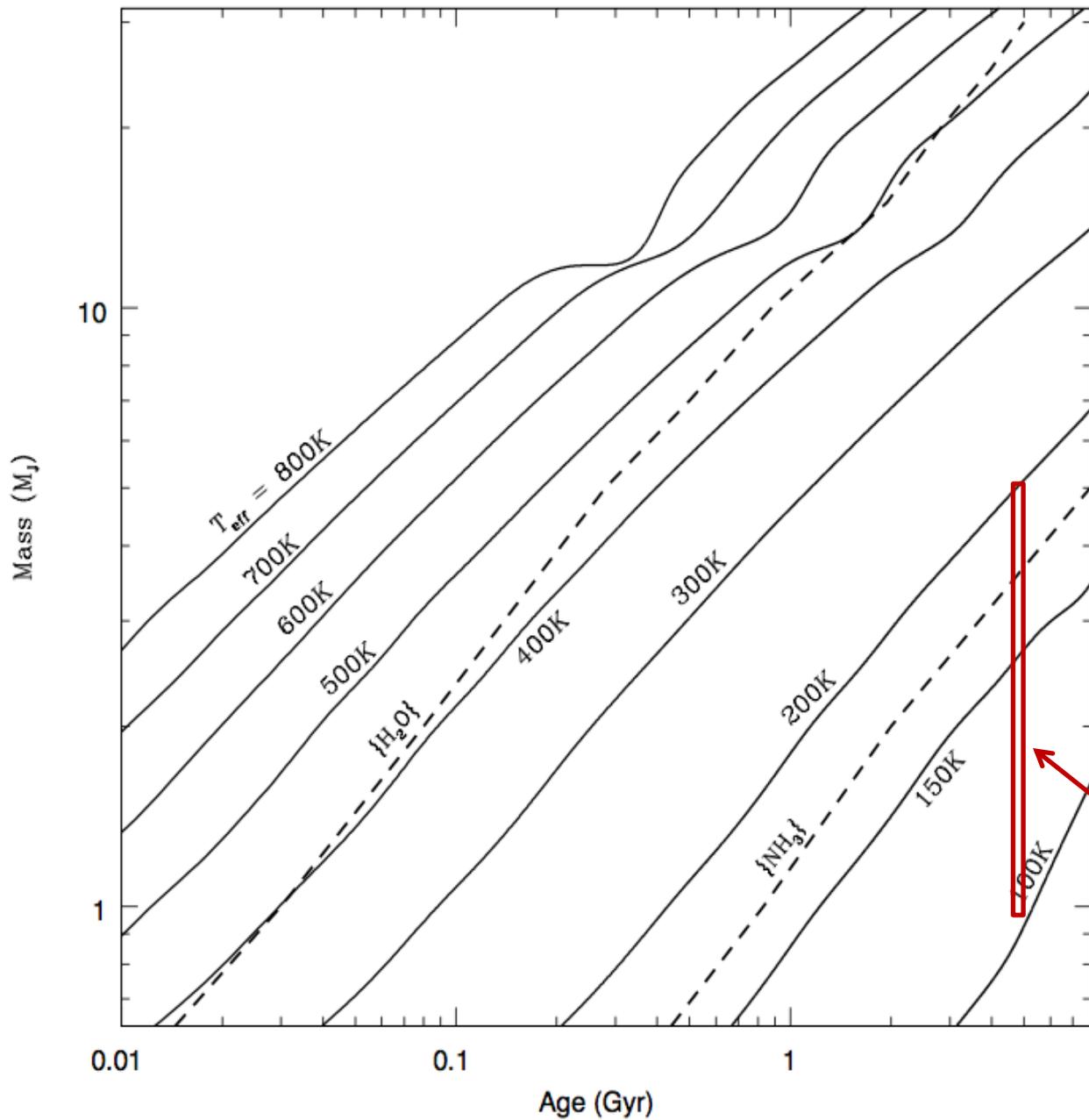
### ***Goals:***

- 1) Develop an efficient procedure for searching the catalog for nearby ultracold planet candidates.**
- 2) Determine if any candidates are consistent with a conjectured Jupiter mass planet in the Oort comet cloud (Matese & Whitmire, 2011)**

**John J. Matese & Daniel P. Whitmire  
University of Louisiana-Lafayette**

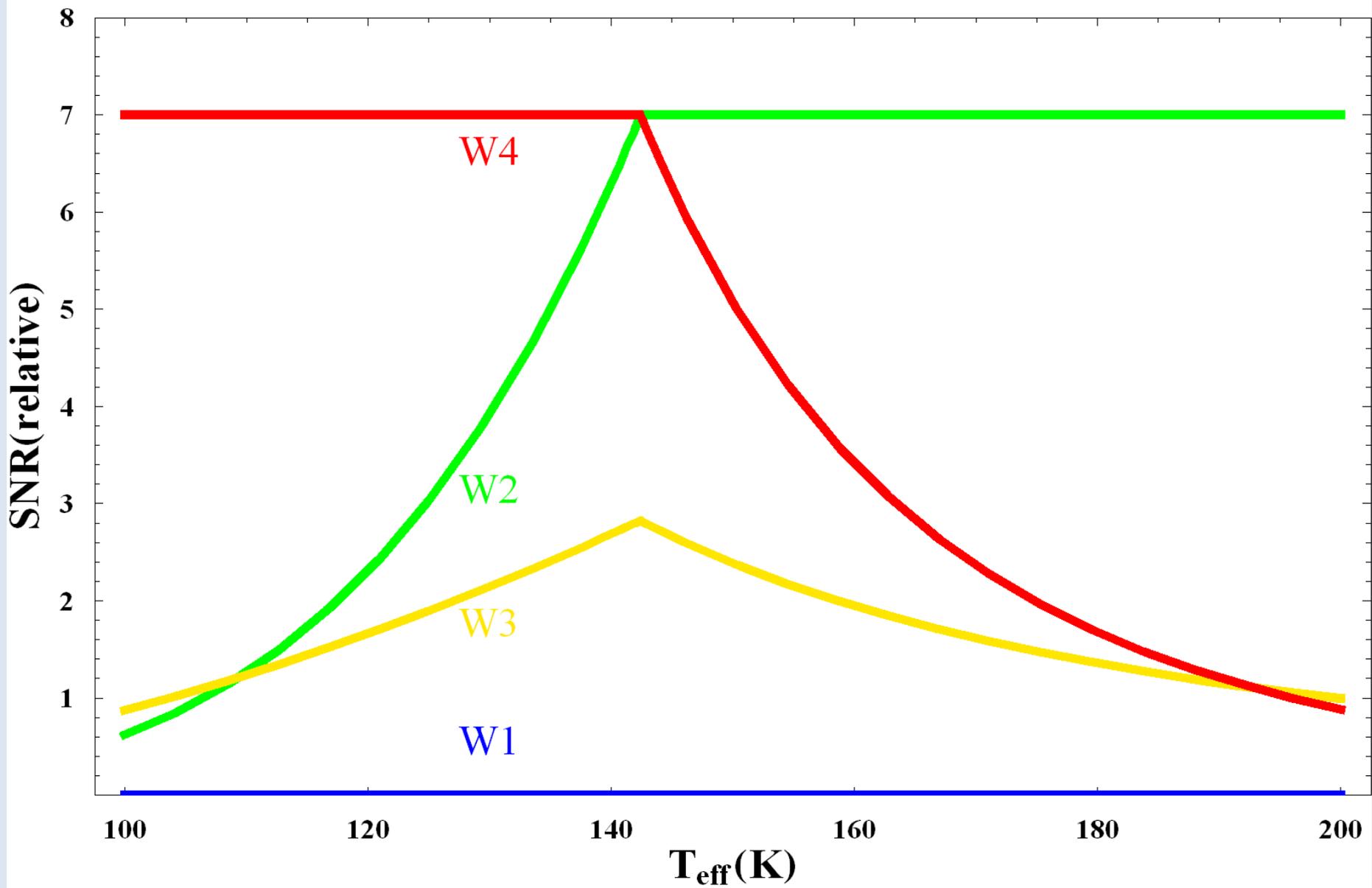


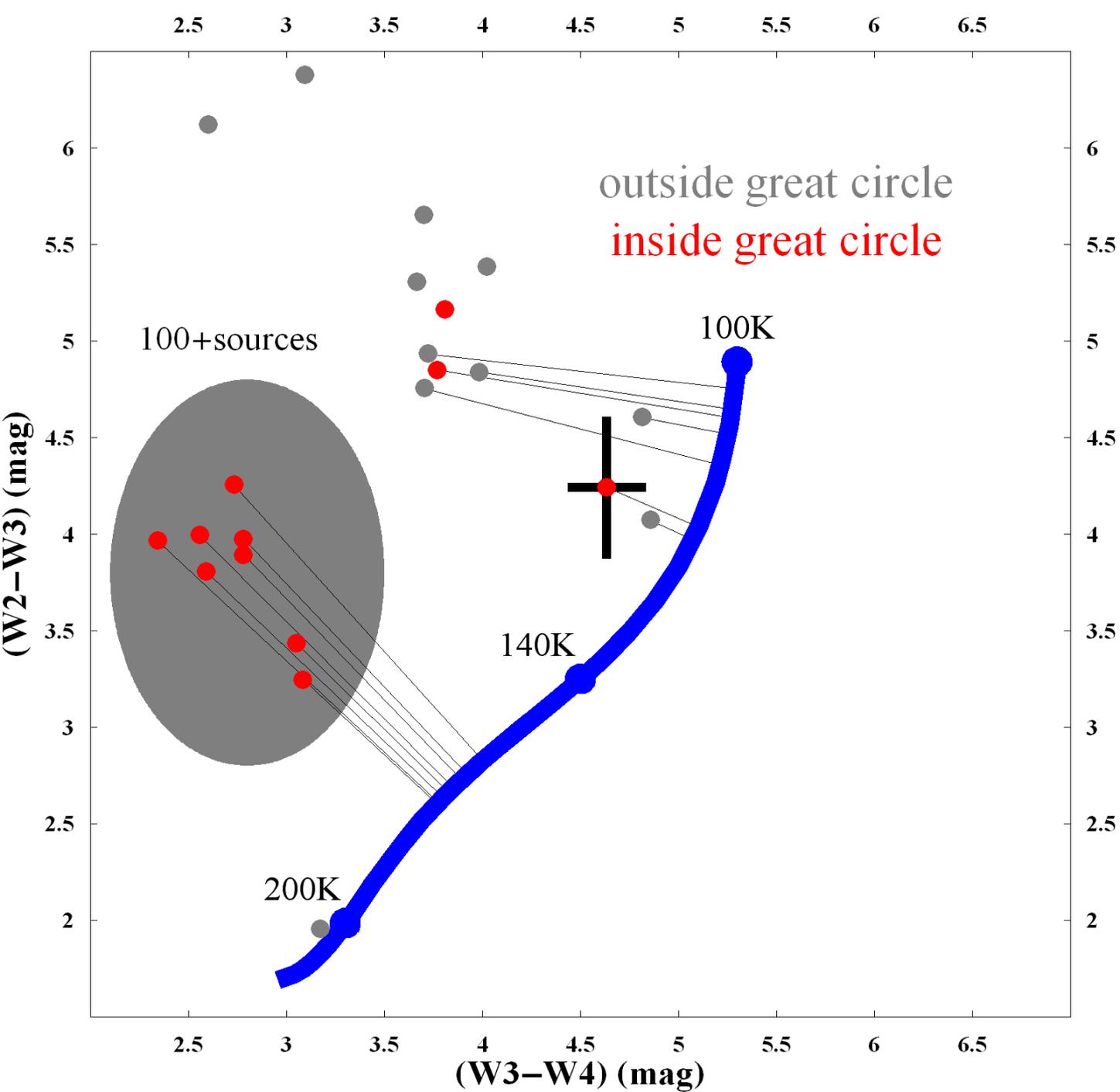
Wright *et al.*, (2010)  
Burrows *et al.*, (2003)



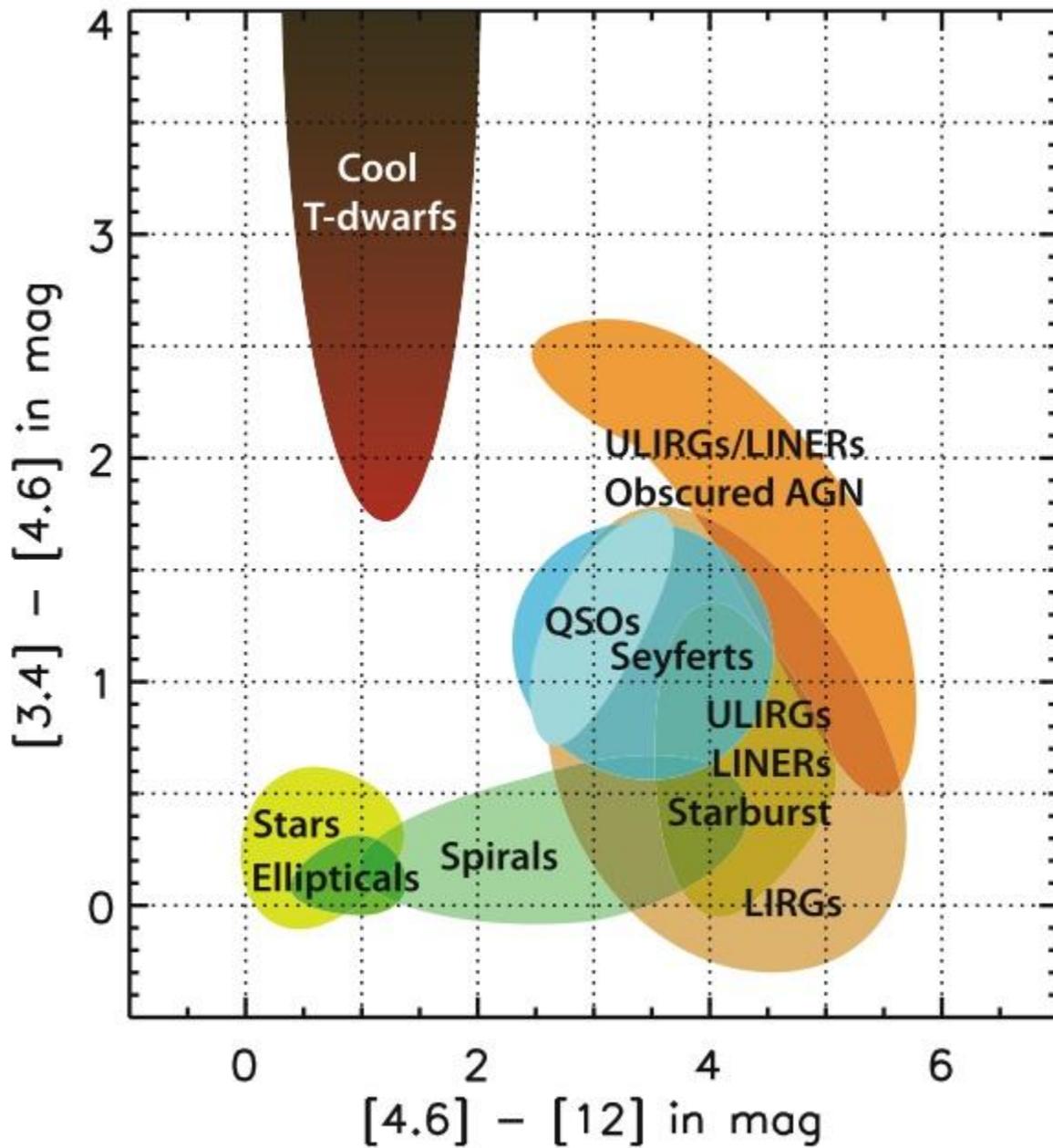
Burrows *et al.*, (2003)

Mass-Teff-Age  
Range of interest



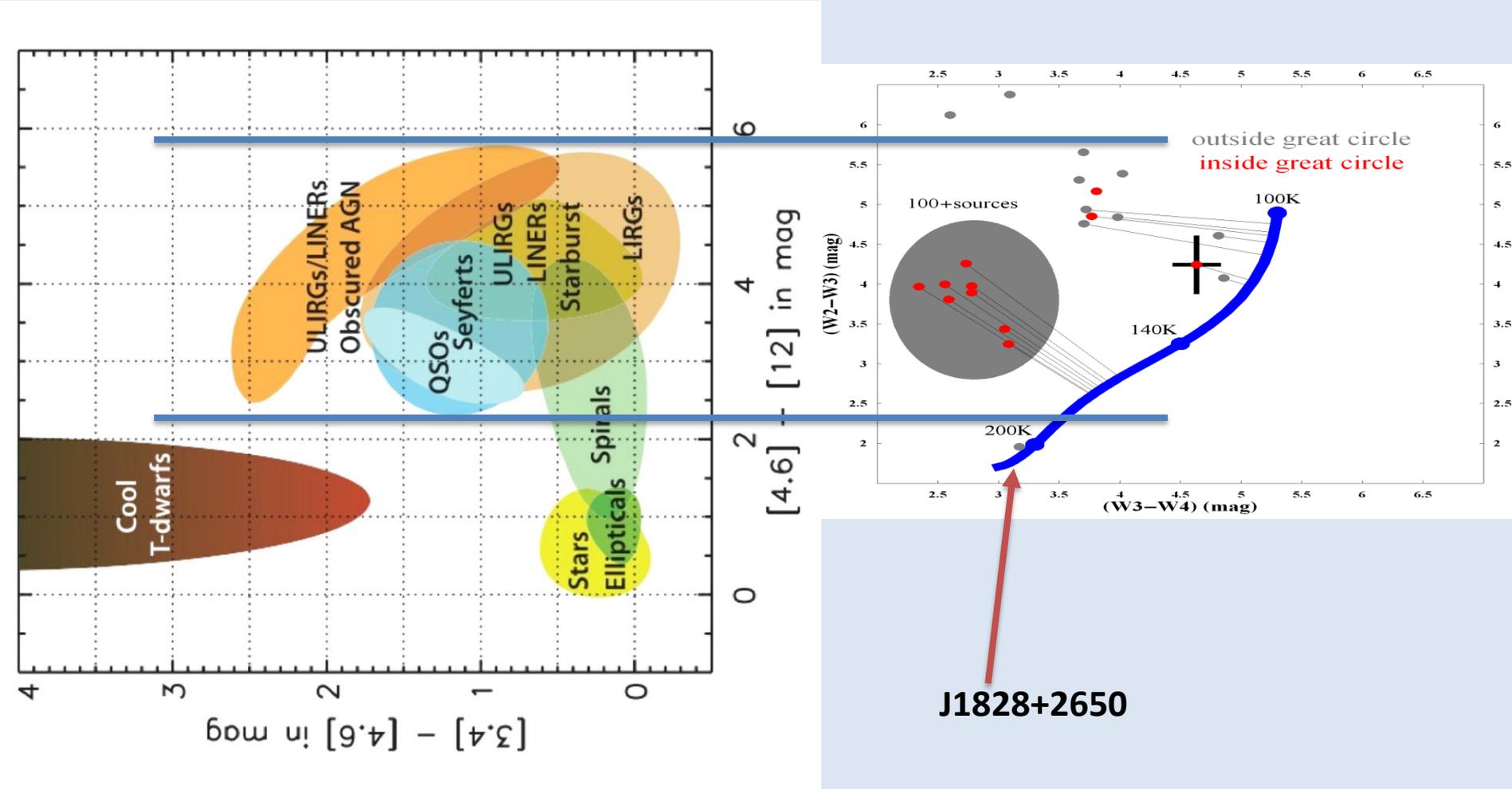


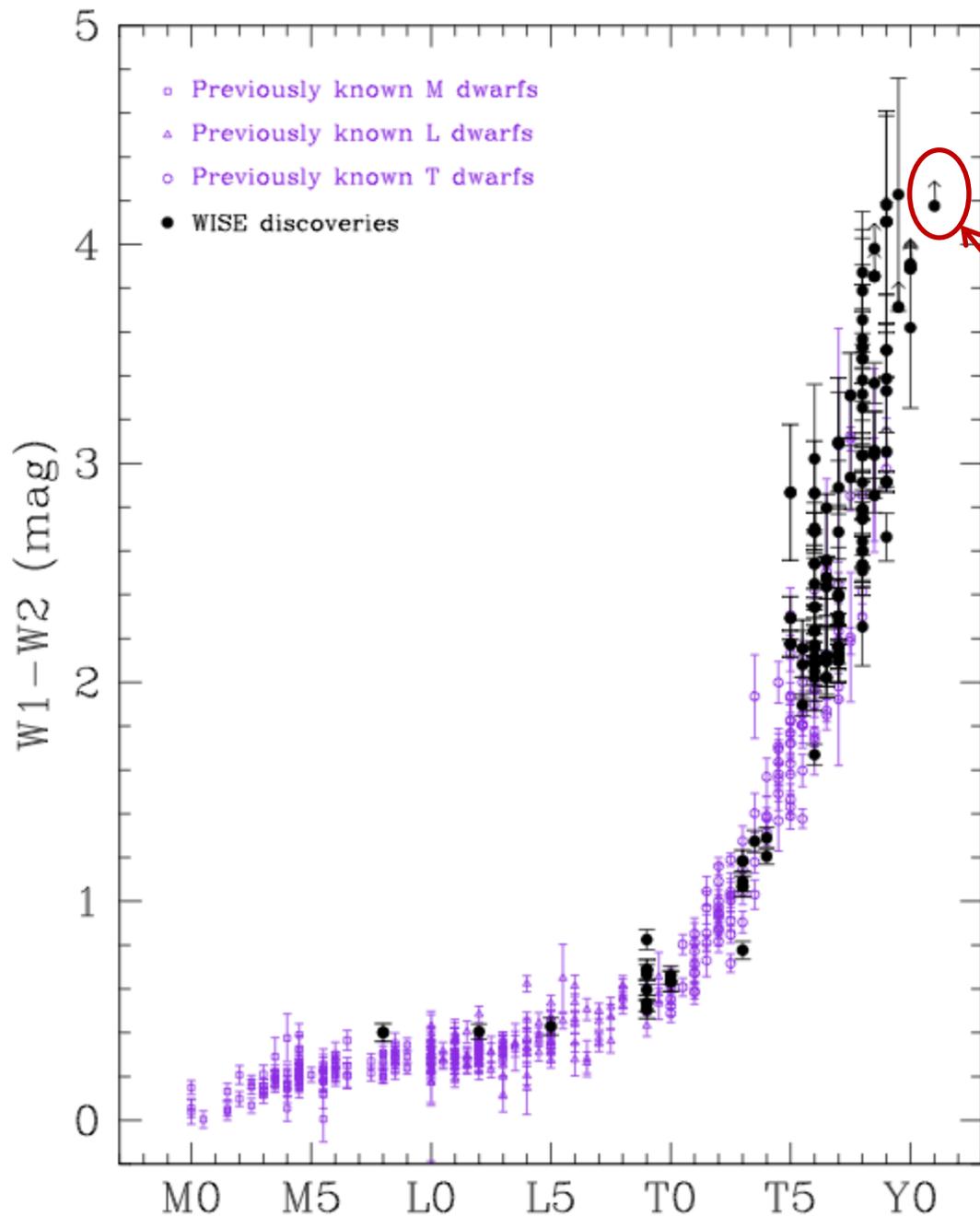
Color-color curve based on slide 2.



Wright *et al.*, (2010)

With one exception, the newly discovered J1828+2650, all sources are consistent with being extra-galactic objects if the W1 magnitude limit is taken as the actual magnitude





"... First 100 Brown Dwarfs..."  
 Kirkpatrick et al., 2011

J1828+2650  
 coldest of the discoveries

# Candidate ultracold planets:

Fits based on models of Burrows *et al.*

for the WISE bands only

Name	Temperature (K)	4.5 Gyr Mass ( $M_J$ )	Distance (AU)	Inside great circle?	Comments
J070812.58-524259.9	105	1.0	30 000	No	Extra-galactic ?
J132419.54-111021.2	115	1.2	40 000	Yes	Extra-galactic ?
J030520.35-154651.1	115	1.2	40 000	No	Extra-galactic ?
J182831.08+265037.8	200	5.2	350 000	No	Freefloater: Coldest discovered Y dwarf Kirkpatrick <i>et al.</i> (2011) Younger --> smaller M Older --> larger M

# Conclusions

- We have developed search criteria for the WISE database that yields a manageable number of ultracold (<200K) planet candidates for follow-up study.
- The criteria have been used in the preliminary catalog and we find four candidate sources.
- Three of them may be bound 1 MJ planets in the Oort cloud, but are possibly extra-galactic objects. VizieR does not list any associations. To determine the nature of the sources requires further observations, including trigonometric parallax determinations.
- Based on the modeling of Burrows et al., in the WISE bands only, we find that one recently identified candidate, J1828+2650, is a ~200K free floater at a distance of ~1.7 pc. The NIR spectroscopic parallax is <9.4 pc.

A copy of the slideshow can be found at  
<http://www.ucs.louisiana.edu/~jjm9638/Nantes.pdf>

# Comments on the slides

- (1) An Oort cloud anomaly leads us to conjecture that there exists a Jupiter mass object in the cloud orbiting in a well-determined “great circle” band. If it exists, its IR flux should be listed in the WISE point source catalog.
- (2) Wright et al., (2010) Fig. 12. Our focus is on  $T_{\text{eff}} < 200\text{K}$ , where W1 is negligible and the dominant snr is in W2 or W4. Note that Burrows et al., (2003) do not calculate below 134K, so that lower temperatures are uncertain extrapolations as given in Wright.
- (3) Burrows et al. (2003), Fig. 2 is used to infer Mass-Temperature-Age relations.
- (4) From slide 2, assume  $F_{\text{bol}}$  scales as  $T_{\text{eff}}^4$ , determine the spectral flux  $F_{\nu}$ , divide by the WISE band sensitivity and scale the signal-to-noise ratios to a maximum of 7. If the maximum  $\text{snr} < 7$  it will not be listed as a point source in the catalog. For example, band 4 is predicted to have the largest snr for temperatures  $< 140\text{K}$ . We use this to guide our search of the preliminary catalog for ultracold planet candidates.
- (5) Take the band spectral flux functions inferred from slide 2 and determine the theoretical temperature-dependent colors (blue curve). The uncertainties in this process are much wider than the curve in the figure suggests when  $T_{\text{eff}} < 140\text{K}$ . The result of our search includes 13 sources with W4 snr as the largest (3 of which are in the great circle band inferred from the Oort cloud anomaly), and  $> 100$  sources with W2 snr as the largest. W1 is given only as a limiting magnitude in the catalog. We indicate the 1 sigma observational uncertainties for a single case. The single observation near 200K in the color/color curve is the coldest object (J1828-2650,  $> Y0$ ) among the first 100 brown dwarf discoveries (Kirkpatrick et al., 2011).
- (6) Wright et al., (2010) shows the  $(W1-W2)\text{color}/(W2-W3)$  color diagram locating the regions for various interesting classes. The sources in slide 5 have only an upper-limit flux in band 1 and show the  $(W2-W3)\text{color}/(W3-W4)\text{color}$ .
- (7) Rotating to compare the  $(W2-W3)$  colors of the various groups with that of the observed sources. Only the newly discovered case of J1828-2650 is clearly distinct as its  $(W1-W2)$  color is  $> 4.2$ . For the 3 low temperature candidate planets,  $(W1-W2) > (0.5, 1.8, 1.7)$ , and they may be extra-galactic objects. They are unlikely to be free floaters.
- (8) Kirkpatrick et al., (2011), Fig 1. First WISE brown dwarf discoveries
- (9) For the four sources whose color/color point is closer to the theoretical curve than 0.5 magnitudes, we list the best fit temperature and distance, the mass fit if the object is an ultracold planet of 4.5 Gyr age, and whether the source is located in the great circle band of the Oort cloud anomaly. The 3 low temperature objects are possibly extra-galactic (and unlikely to be free floaters). They should be checked for trigonometric parallax to exclude the possibility that they are bound. J1828-2650 is the coldest object ( $> Y0$ ) among the first 100 brown dwarf discoveries (Kirkpatrick et al., 2011). The NIR spectroscopic parallax inferred there for this object ( $< 9.4$  pc) is larger than the WISE parallax inferred here (1.7 pc). For the next coldest object found, J1541-2250 (spectral class Y0), the spectroscopic parallax was 8.2 pc and the trigonometric parallax was 2.8 pc.
- (10) A summary of conclusions.