A *Spitzer* Search For Disks Around Young Planetary Mass Objects

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Outline

- Allers et al (2006) found young BDs from combined *Spitzer c2d* data and deep IJHK imaging
- Lower mass limit set by *c2d* sensitivity at 5.8 and 8μm to confirm youth via CS disks
- Our new program selected a 0.5 deg^2 sub-region of the original program for deep *Spitzer* IRAC imaging (missed MIPS due to LHe end!)

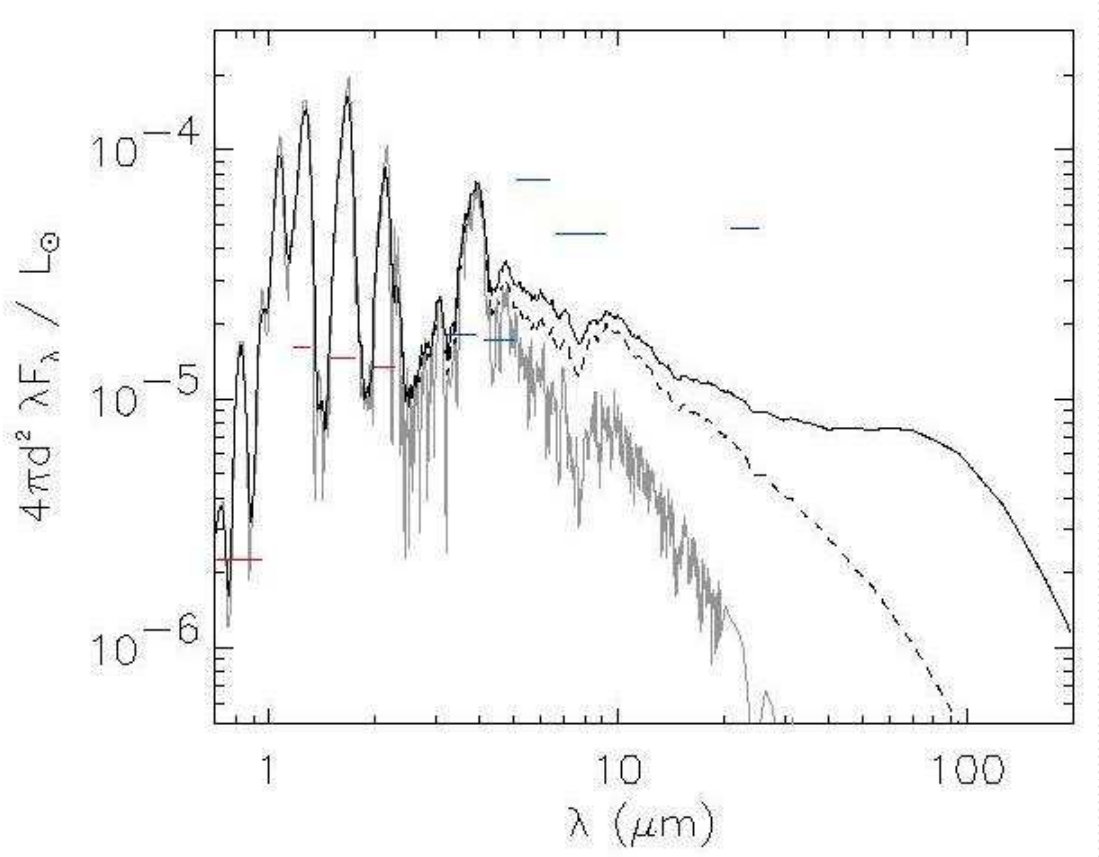
Motivation

- What are the lowest mass objects that can form like stars? And how do they form?
- What is the shape of the IMF past the currently observed likely turnover at low mass?
- What are the observational characteristics of young, planetary mass brown dwarfs? And what do their atmospheres look like?

Motivation (cont'd)

- How do disks evolve and possibly form planets around very low mass central objects?
- What are the physical properties of disks around very low luminosity objects?
- Are the "stars" cool enough that the dust extends all the way in to the stellar surface?

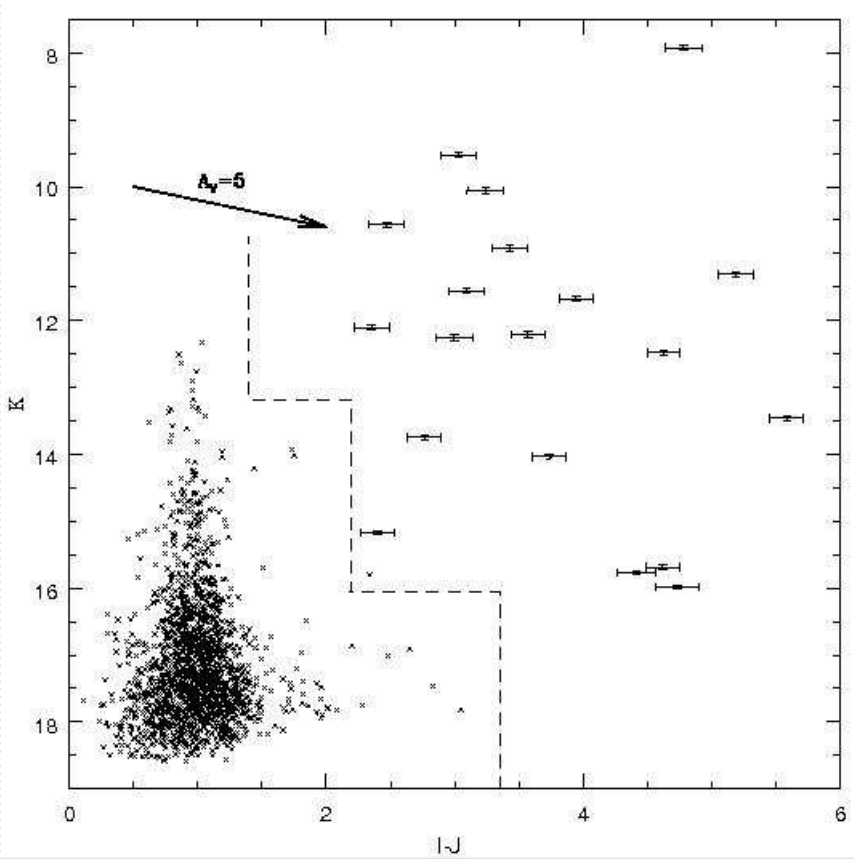
Motivation – $2M_J$ Model Plus Disk

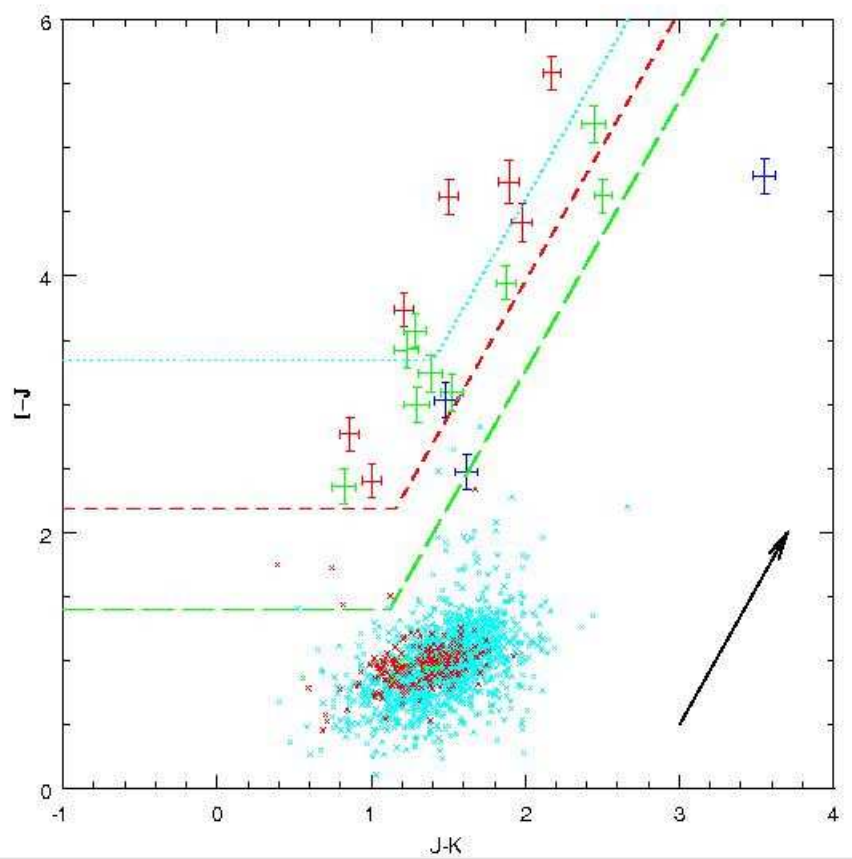


Program Design

- Allers et al (2006) were able to find criteria that resulted in a 18/19 success rate for finding young, low-mass dwarfs and BDs in nearby star-forming regions
- They chose parts of 3 clouds where extinction was moderate in order to be able to use I band data
- Used colors/magnitudes plus careful examination of images

Allers et al Selection Criteria





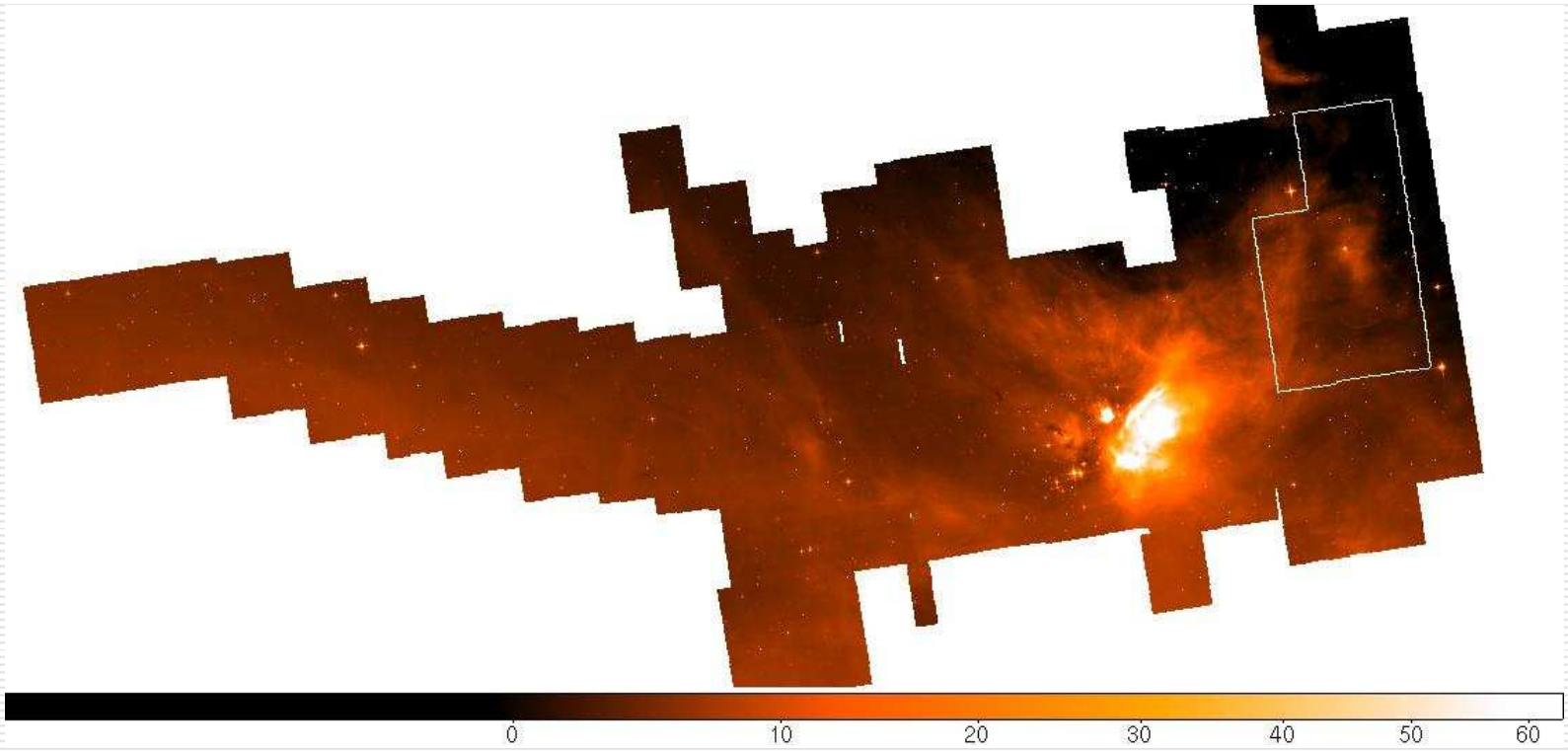
Program Design

- We extended this concept with much deeper 5.8/8μm photometry with *Spitzer* and improved S/N at 3.6/4.5μm
- We used the existing IJHK photometry from the original Allers study since it already went deep enough in all those bands to be a good match to *Spitzer's* sensitivity

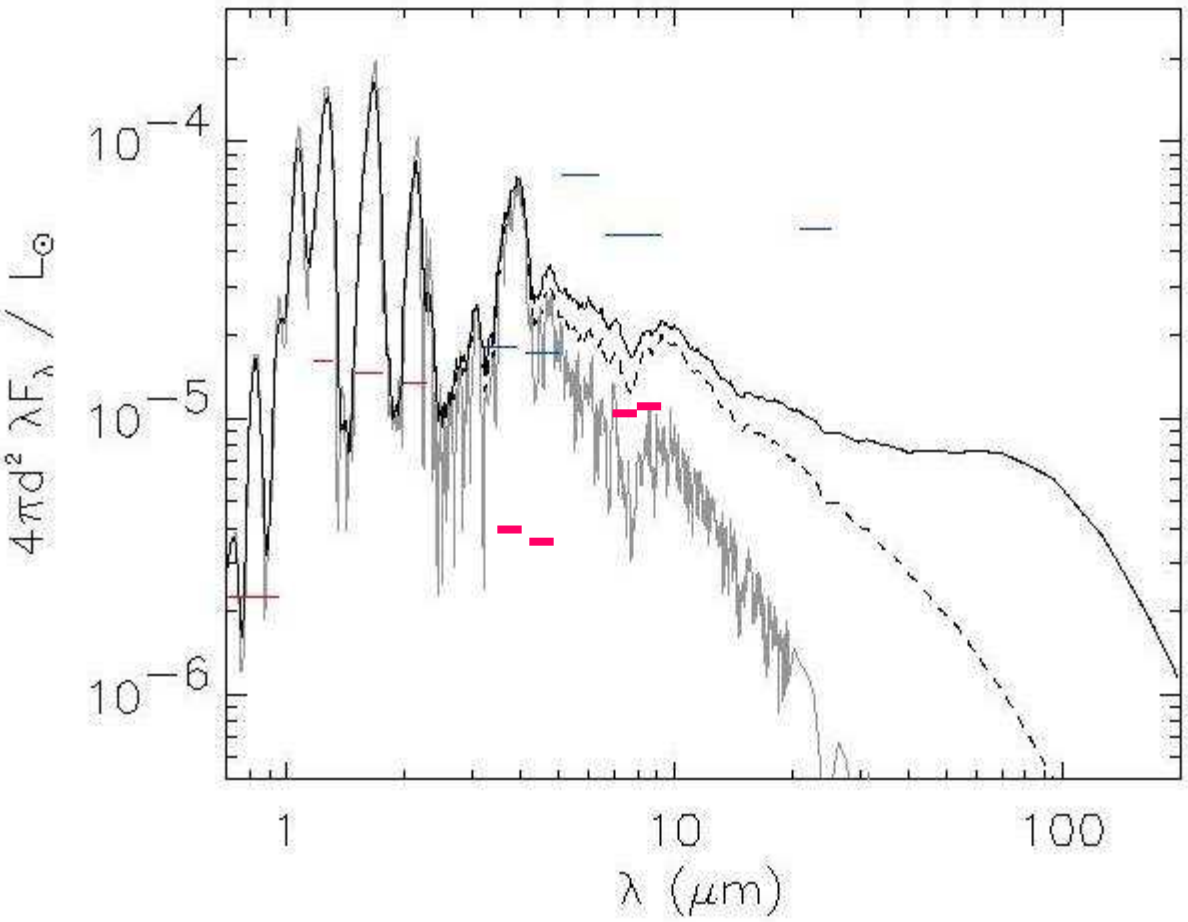
Program Design (cont'd)

- Used IRAC with 100 sec frame times and 9 dithers for total intg time of 900 sec, ~20 X *c2d*
- Chose area containing sources from original study and with lower background and few bright sources, 0.5 square degrees

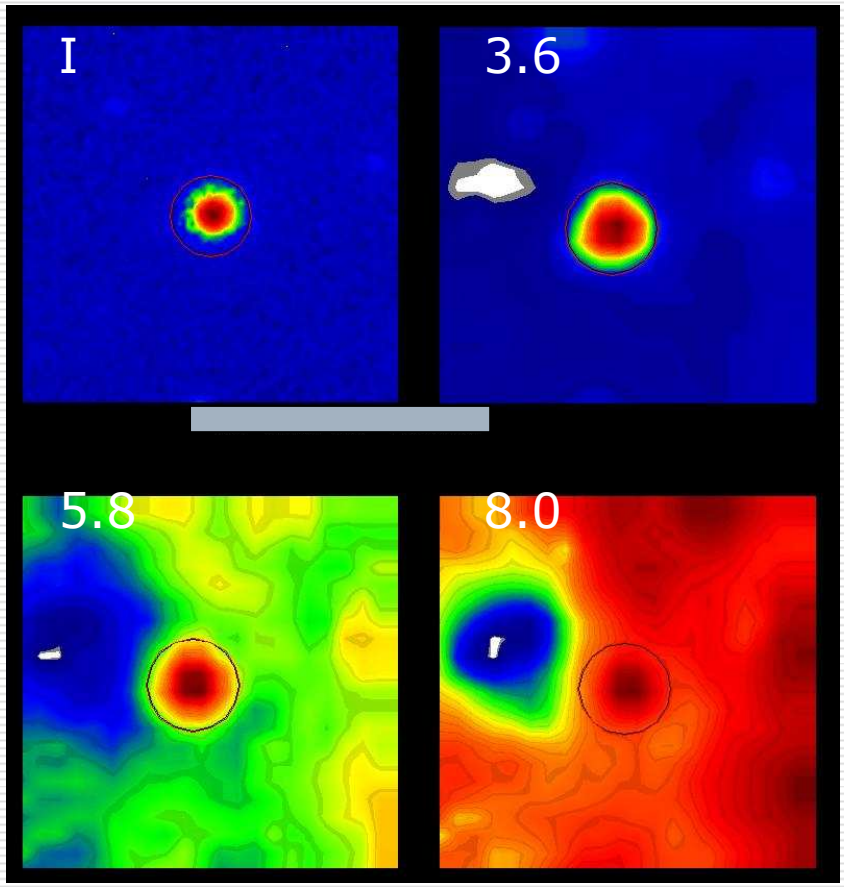
Observed Area



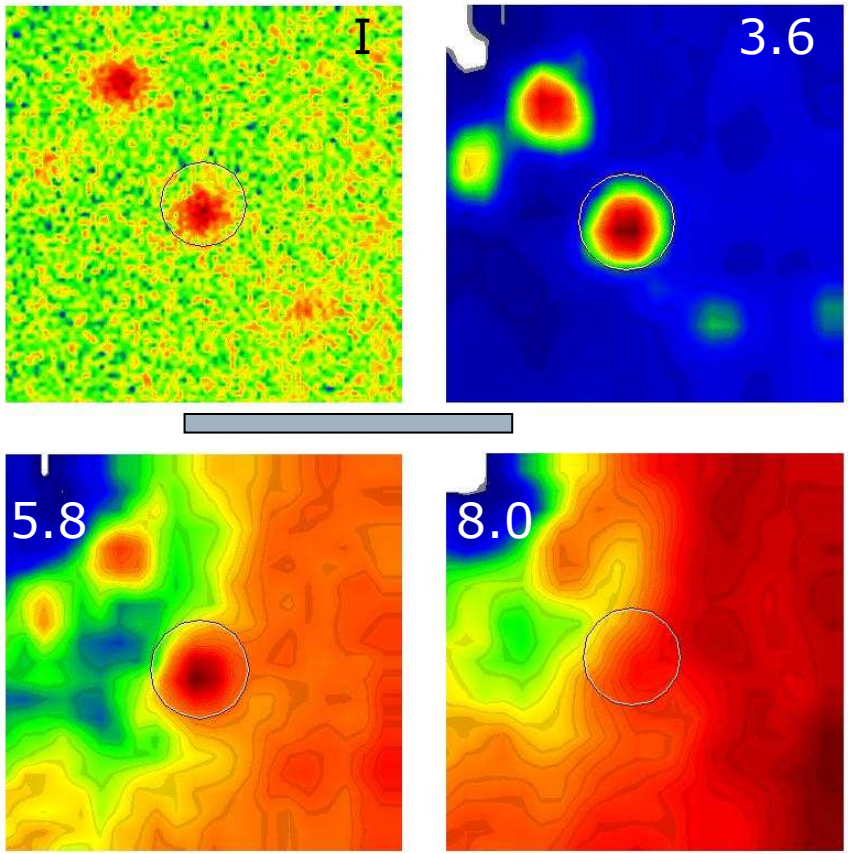
New Sensitivity Limits



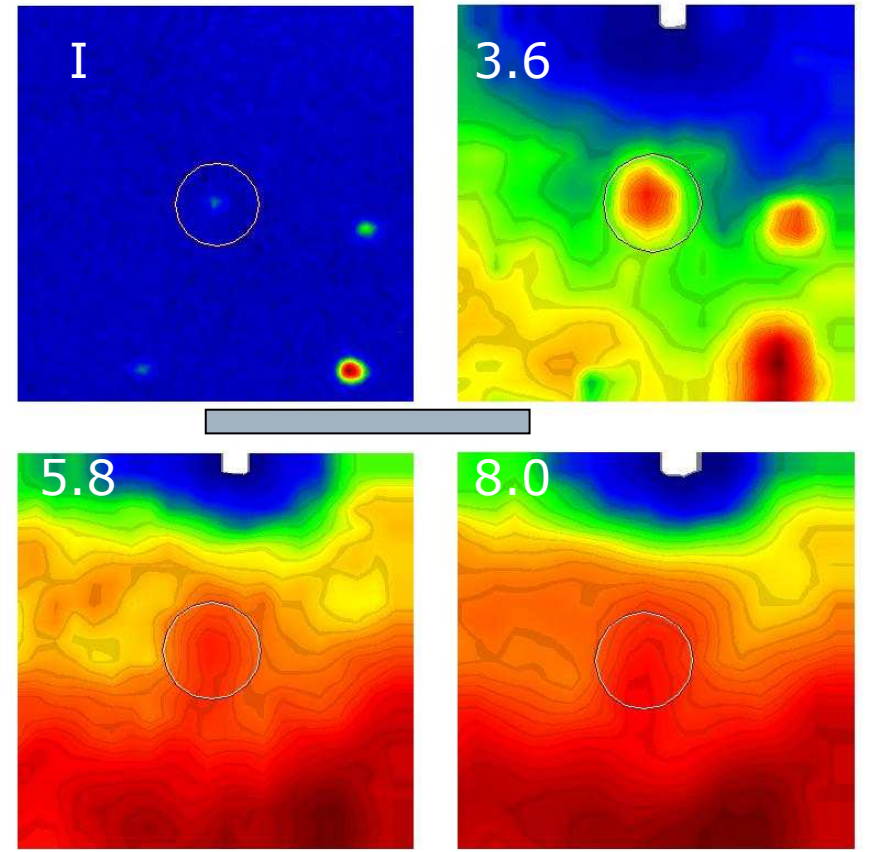
Results – A High Probability Source



Results – High Probability But No Band 4 (8μm)

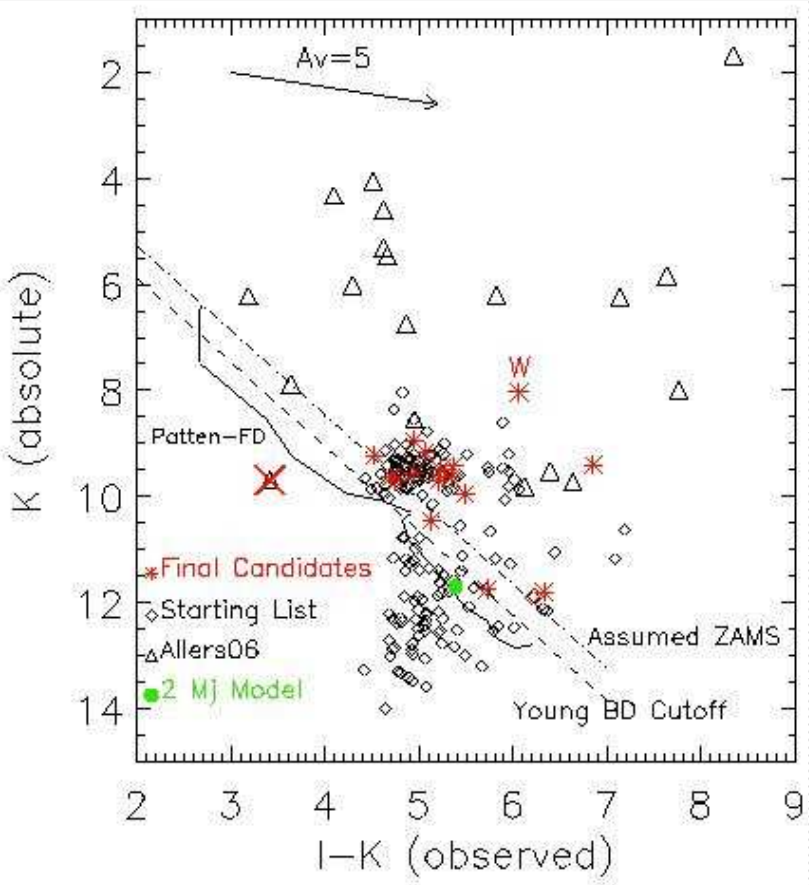


Results - A Possible Candidate

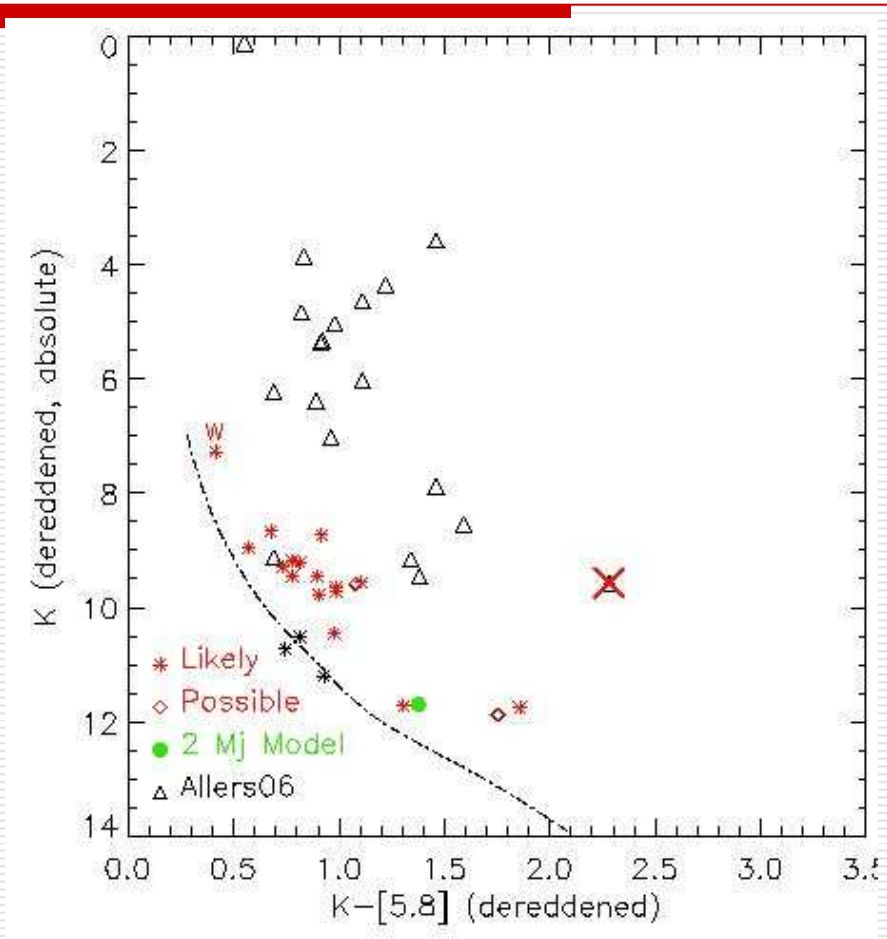


Results – Select Relative to FD's

- FD contamination?
- Caballero et al (2008) estimate ~ 1 foreground field dwarf
- Background giants? No, ℓ~18



Results – Select For Disk Excess

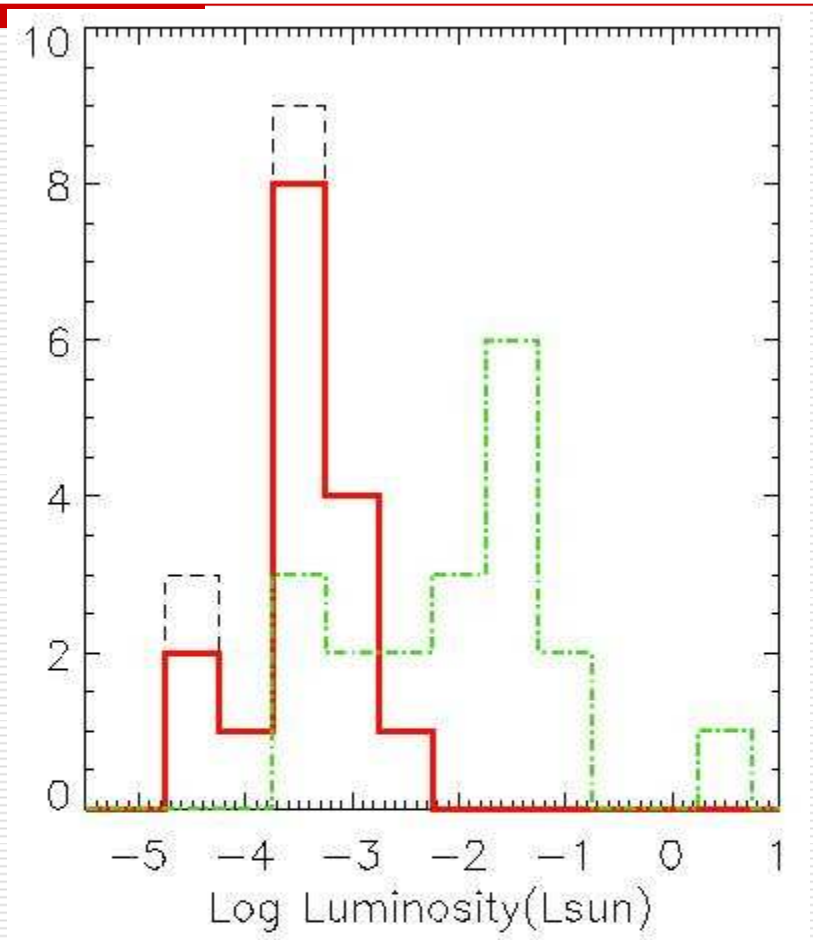


Luminosities of Candidates

Allers ’06 objects

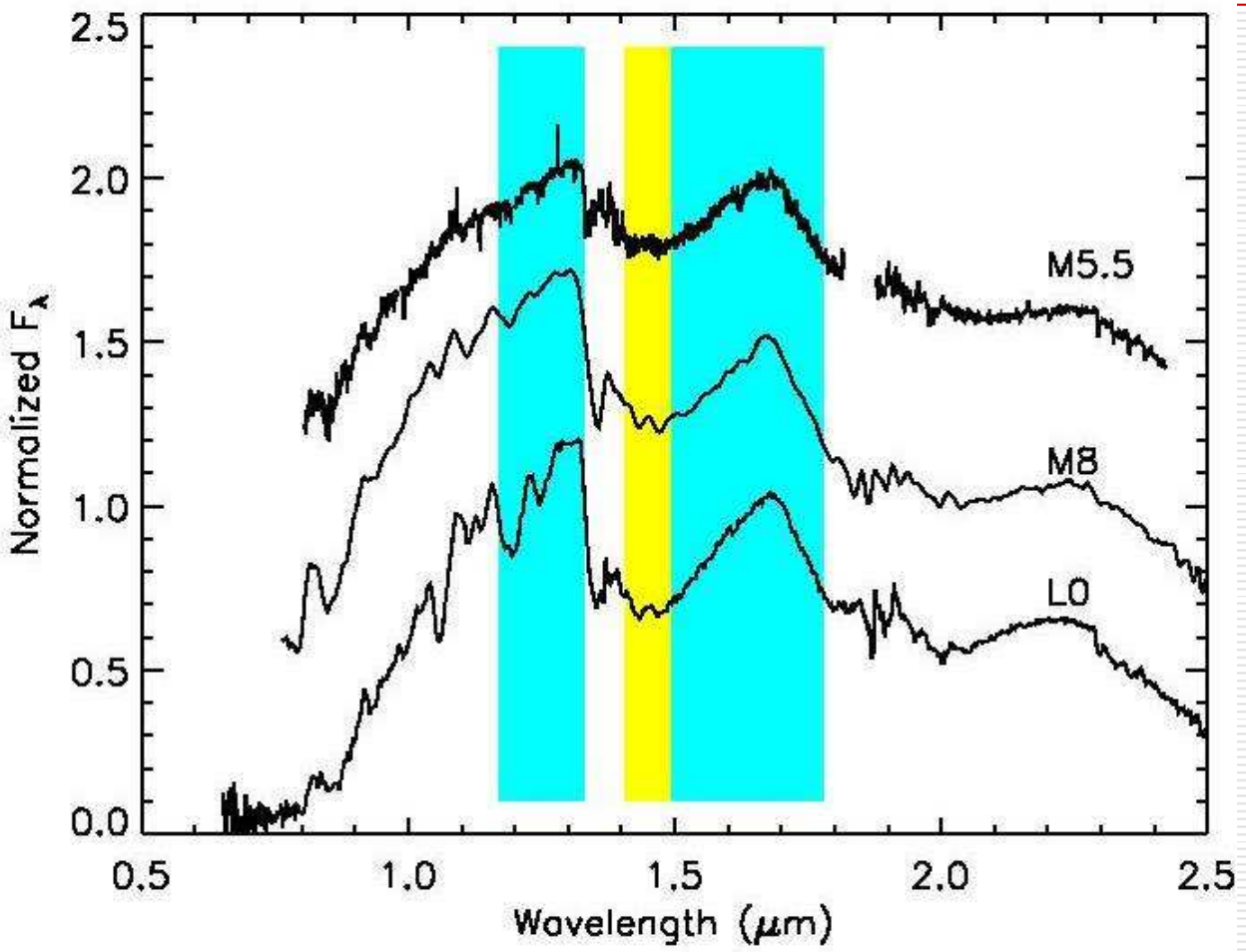
Likely New

Possible New



Next Steps – W Filter at UH 2.2m

(Allers and Liu)



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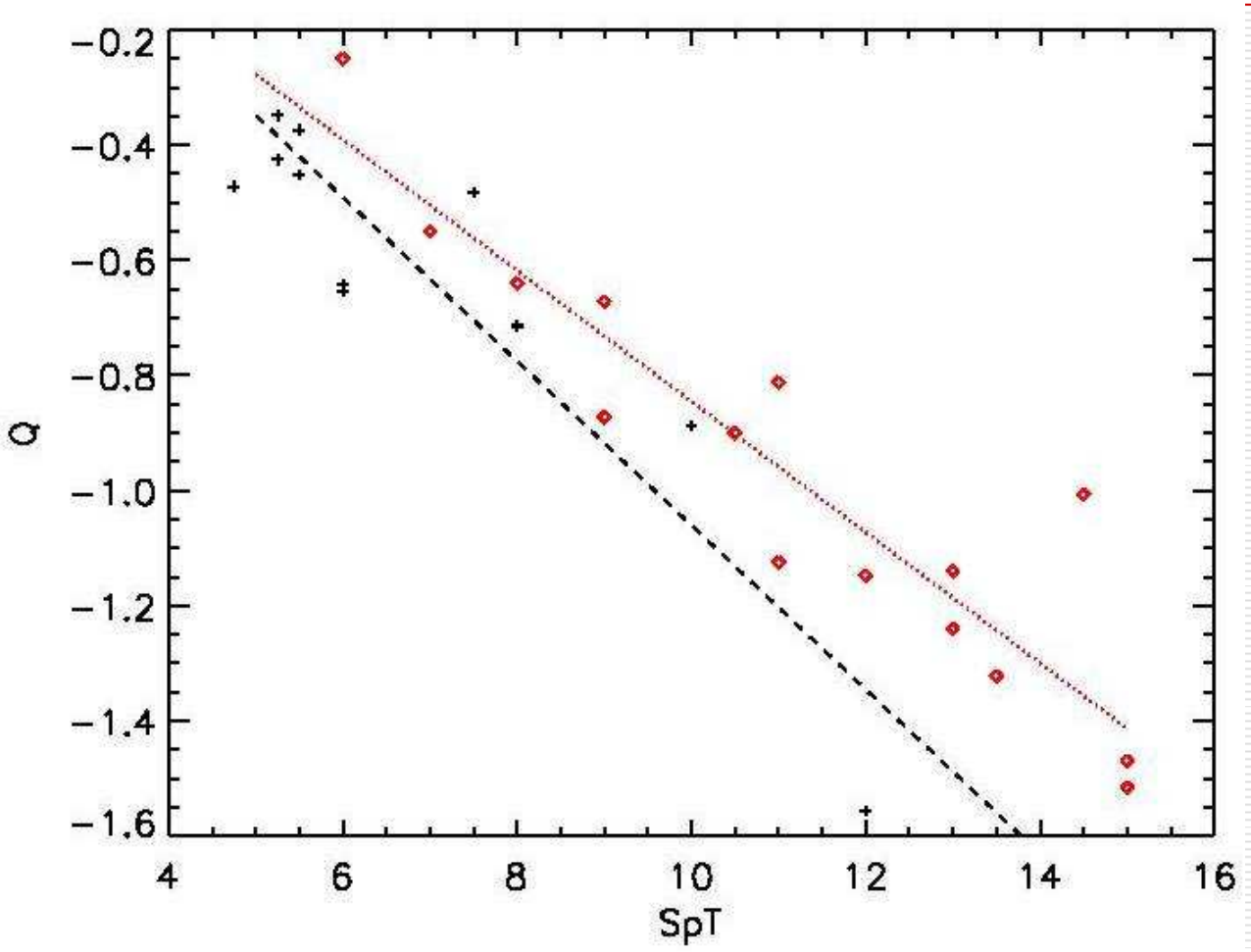
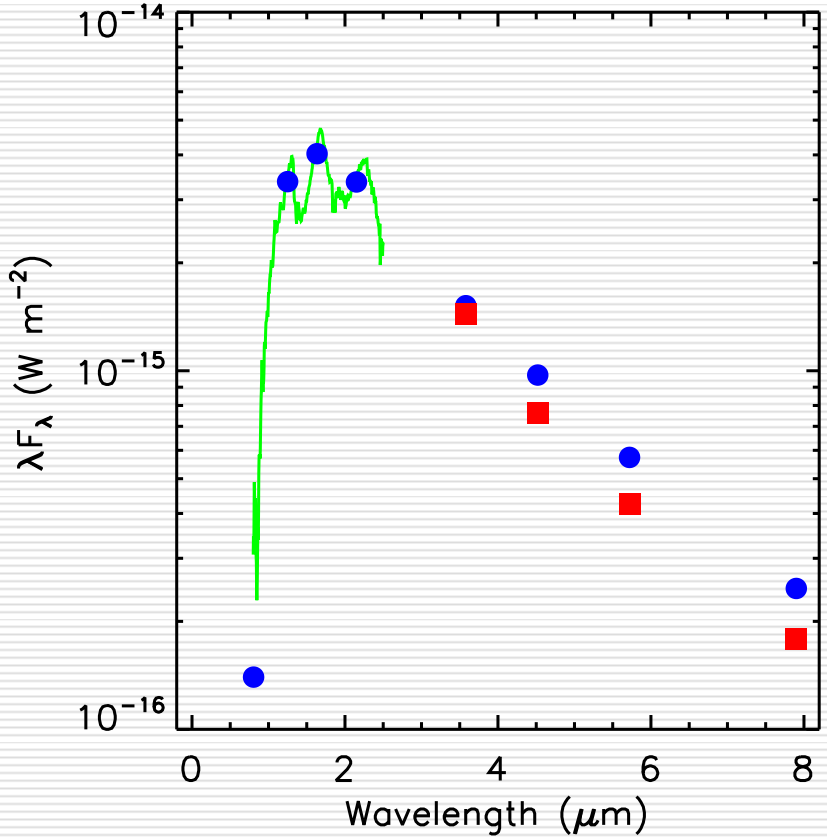


One Source Already Confirmed

- W-filter
- IRTF Spex



Next Steps – Followup Spectra

- Multi-object I band spectra
- For faintest few objects considering VLT X-Shooter?
- Future – JWST? ALMA?

Summary

- We have identified 18 candidates
- Colors/Magnitudes consistent with down to1MYr 2M_J Brown Dwarf (Models)
- Narrowband photometry being used to provide further confirmation
- Next step to obtain near-IR spectra
- Further analysis of data set may find more candidates