



# $\rho$ Ophiuchi molecular cloud

Probing the low-mass end of the IMF in star-forming regions

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# How do brown dwarfs form?

WIRCam/CFHT

## The substellar IMF

Complete census of brown dwarfs down to  $M_{Jup}$

ISAAC/VLT

NIRI/Gemini

Osiris/GTC

NICS/TNG

Sofi/NTT

Accretion

Discs geometry and masses

Multiplicity

Kinematics

X-rays

Herschel

Disc mass + mass accretion rate  $\rightarrow$  disc survival time

# Where can planets form?

# $\rho$ Ophiuchi molecular cloud

Alves de Oliveira & Casali 2008, A&A, 485, 155

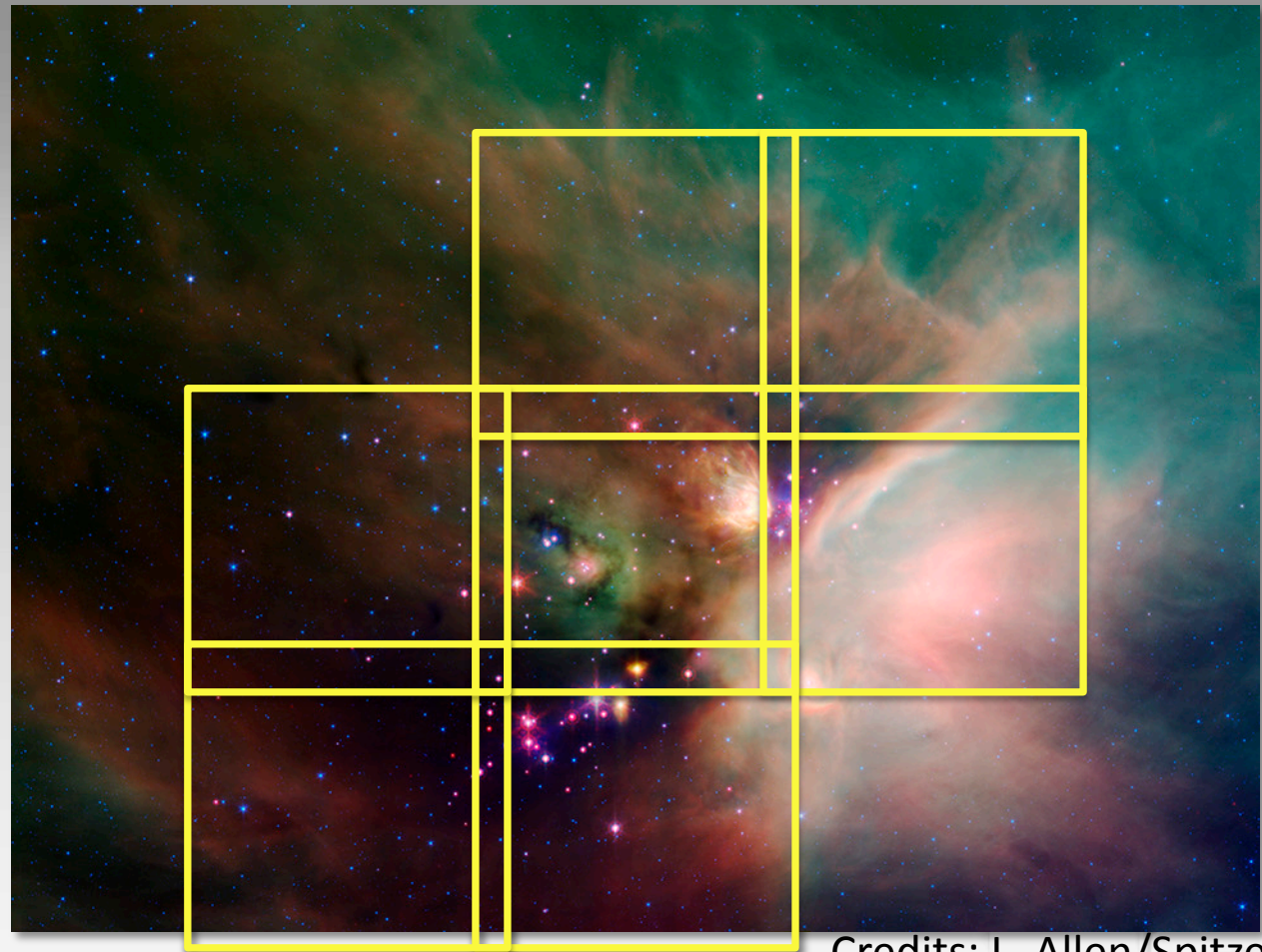
1 Myr,  
~250 members  
d ~ 120-140 pc  
 $A_v = 50-100$

Optical

Credits: M. Bate

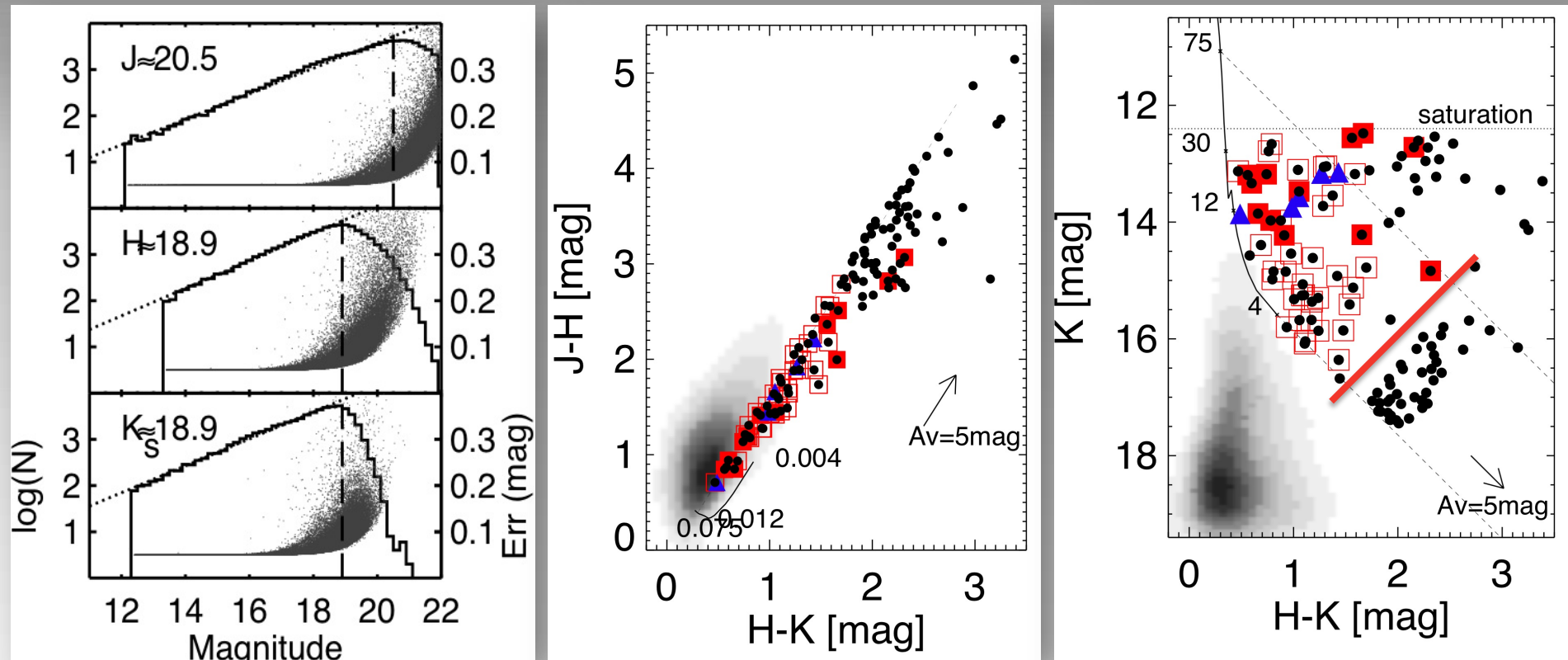
WIRCAM/CFHT:  
deep JHKs ( $\sim 1 \text{ deg}^2$ )

- Archival data:
- \_ Subaru: optical
  - \_ Spitzer: mid-IR

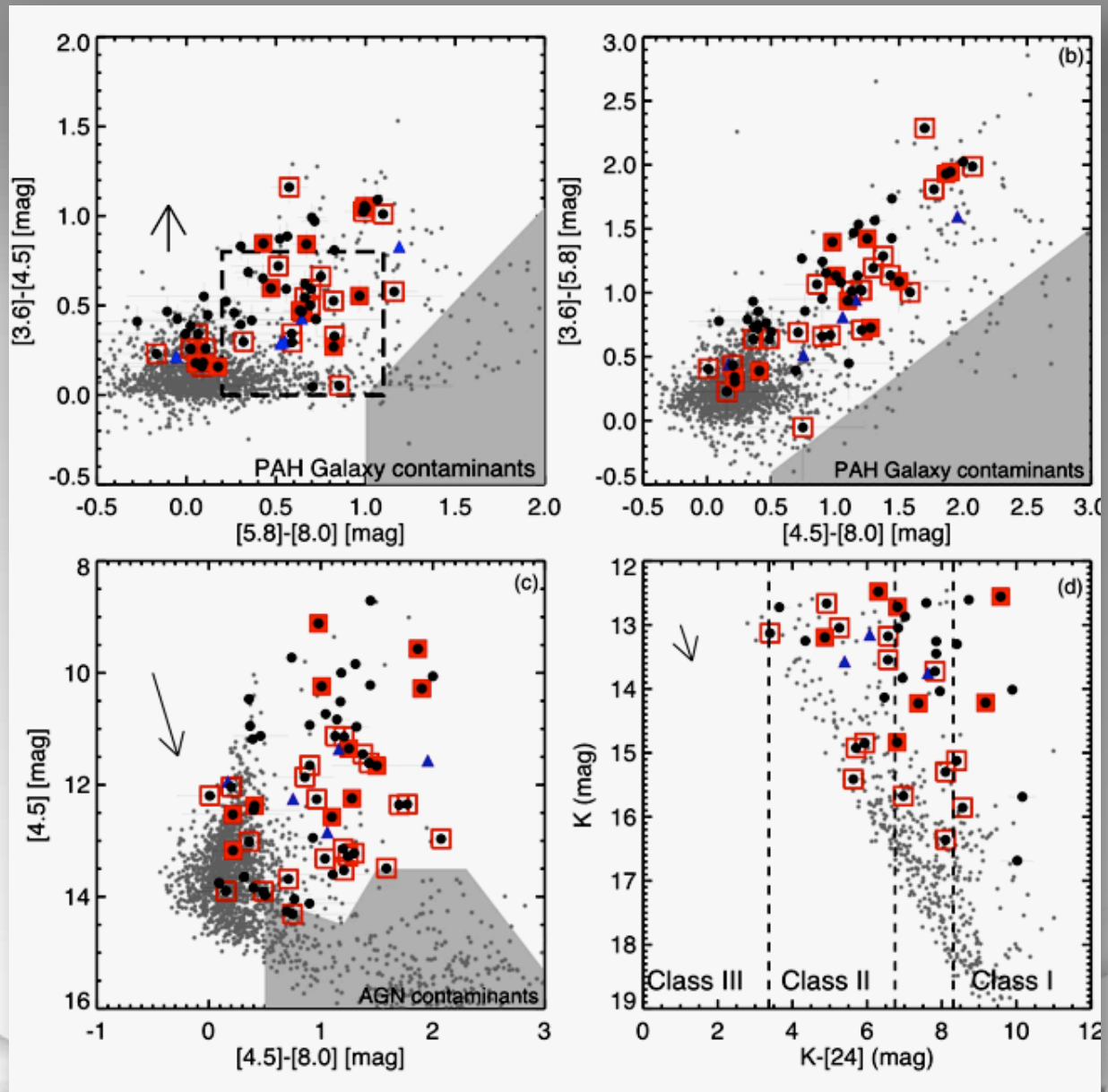


Credits: L. Allen/Spitzer

# Candidate selection: 110 substellar candidates (57,000)

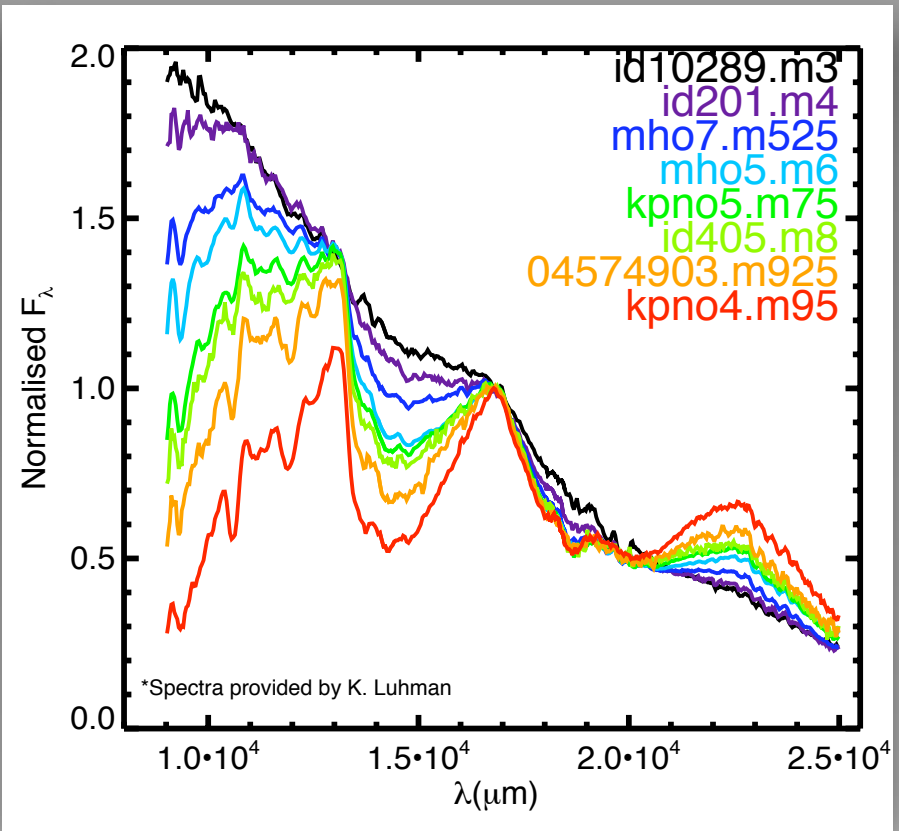
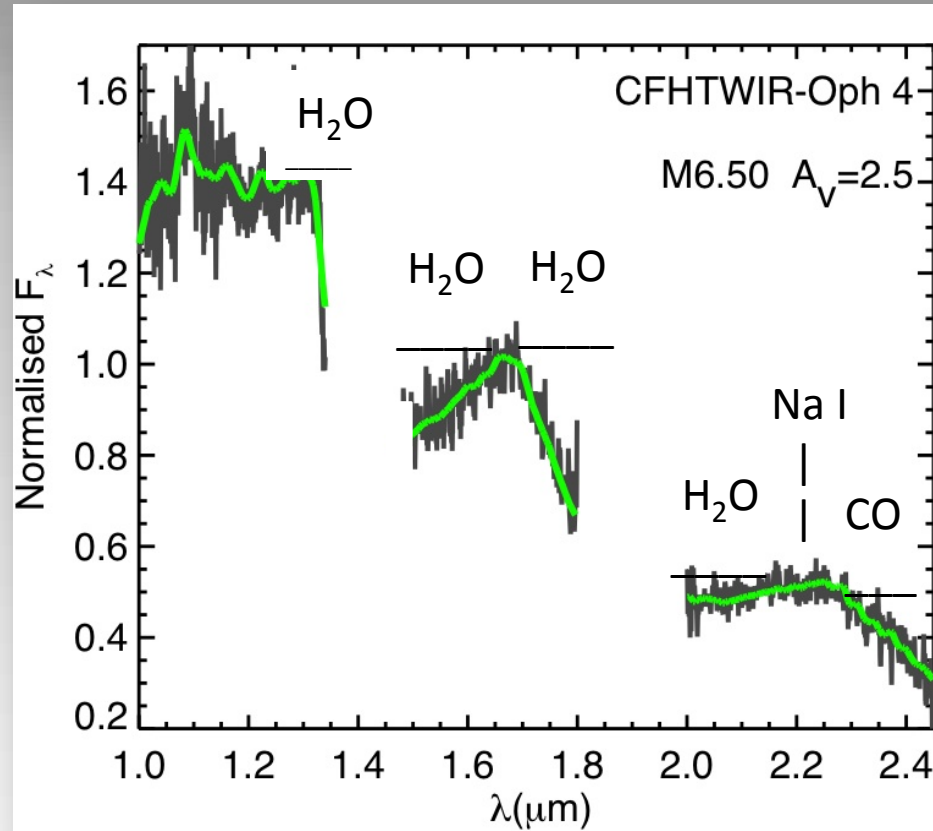


# Near- and mid-IR WIRCam & *Spitzer*

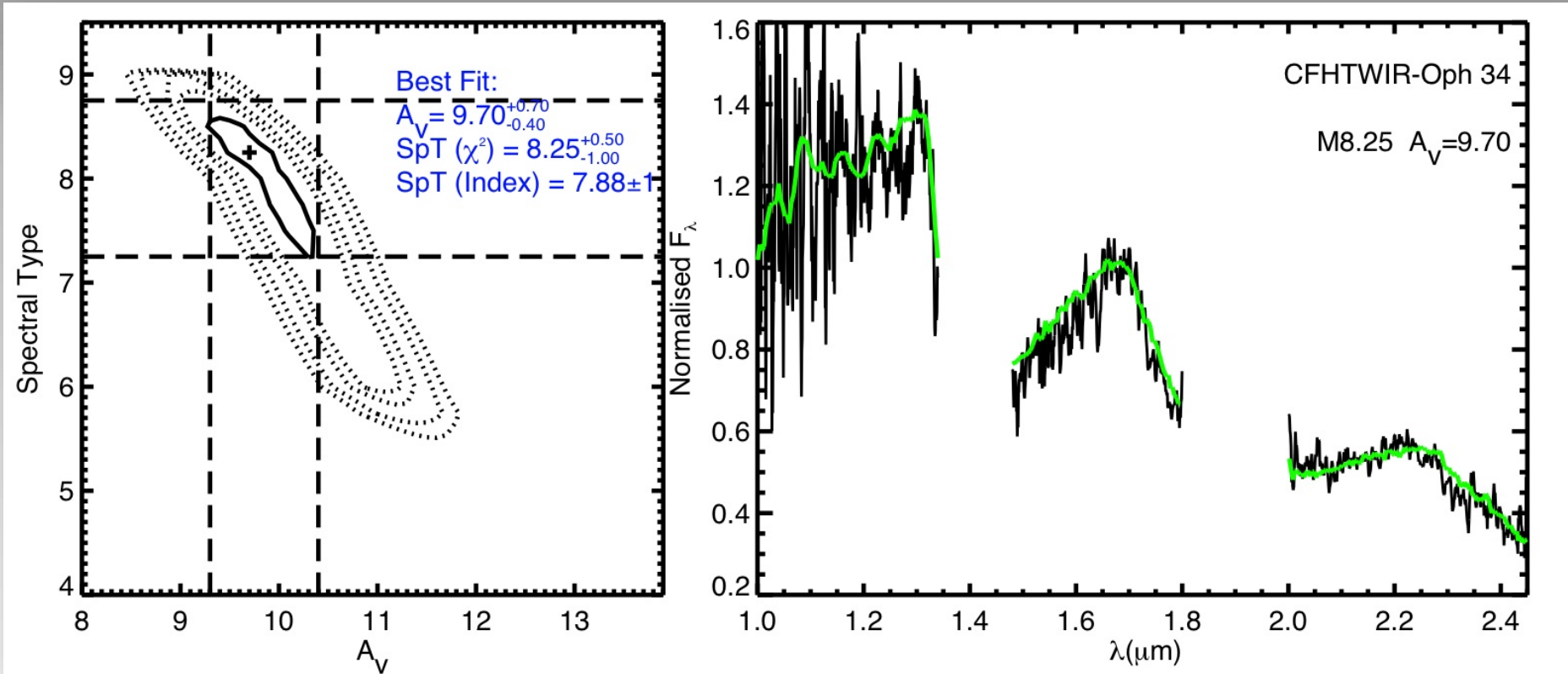


# Spectroscopy follow-up

SofI/NTT, NICS/TNG, ISAAC/VLT, Osiris/GTC



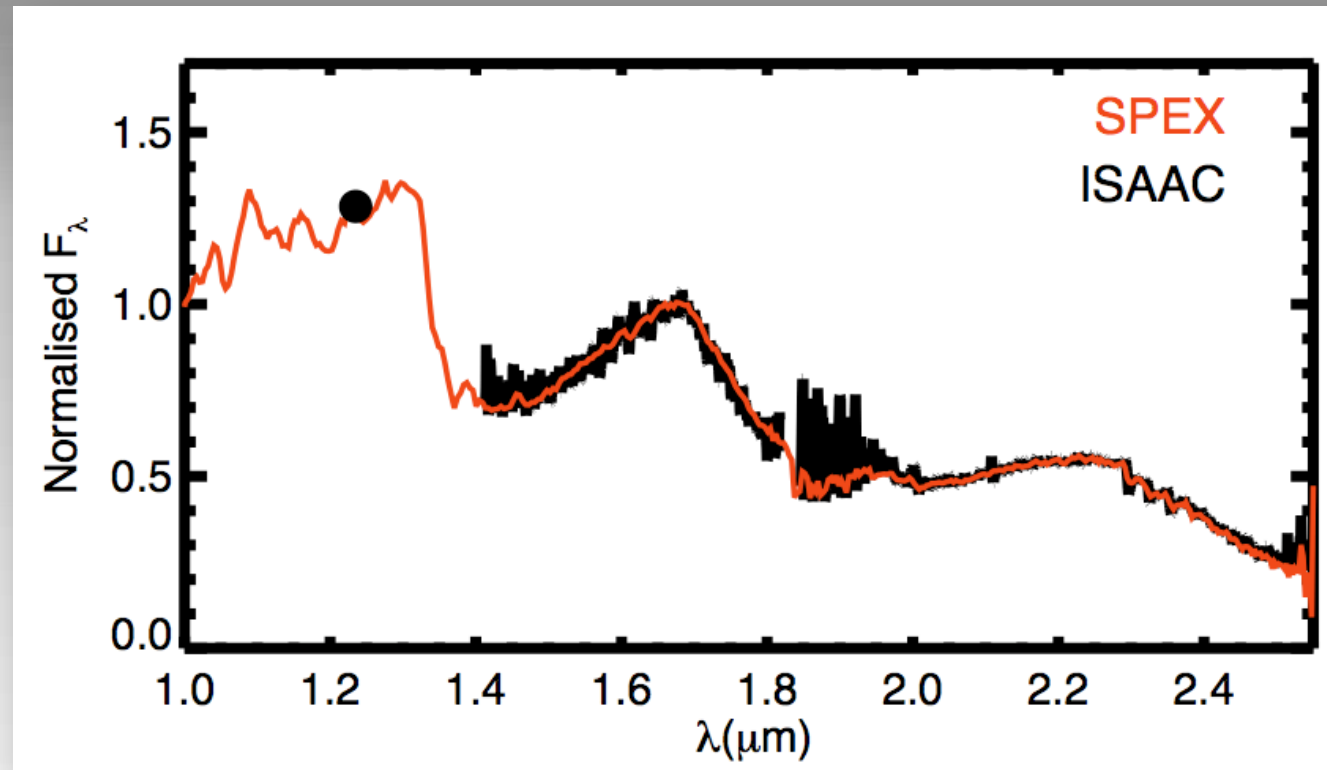
SofI/NTT + NICS/TNG: 6 new BDs / 6 VLMS / 4 contaminants  
Increased to 21 the total number of substellar members of Rho Oph



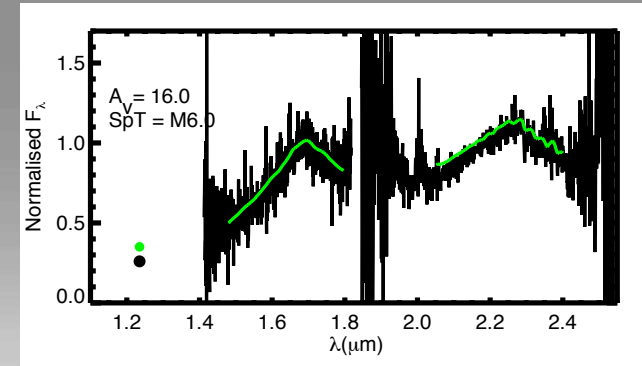


# ISAAC/VLT: *H* and *K* band low-resolution spectroscopy

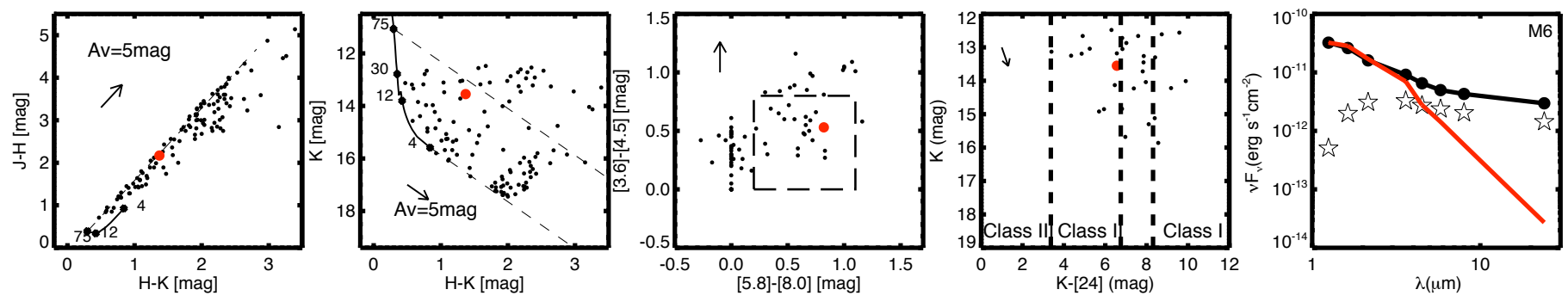
TWA 26  
(*test*)

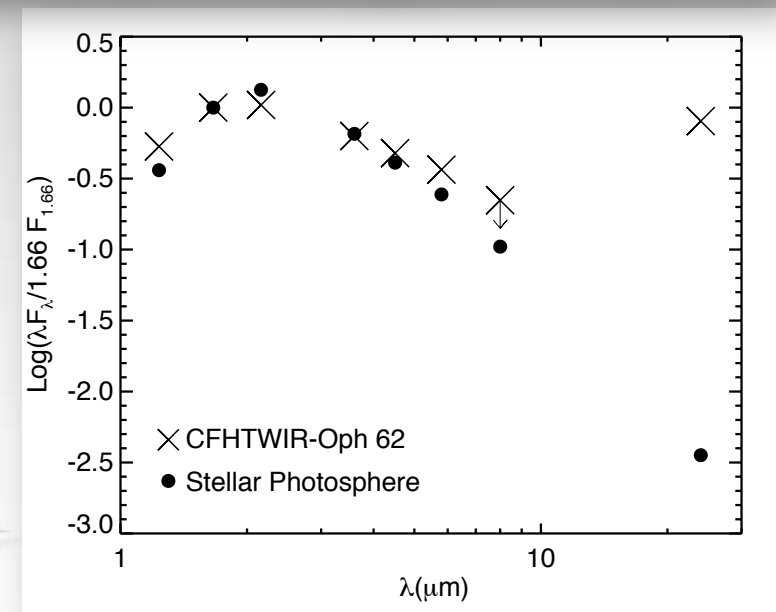
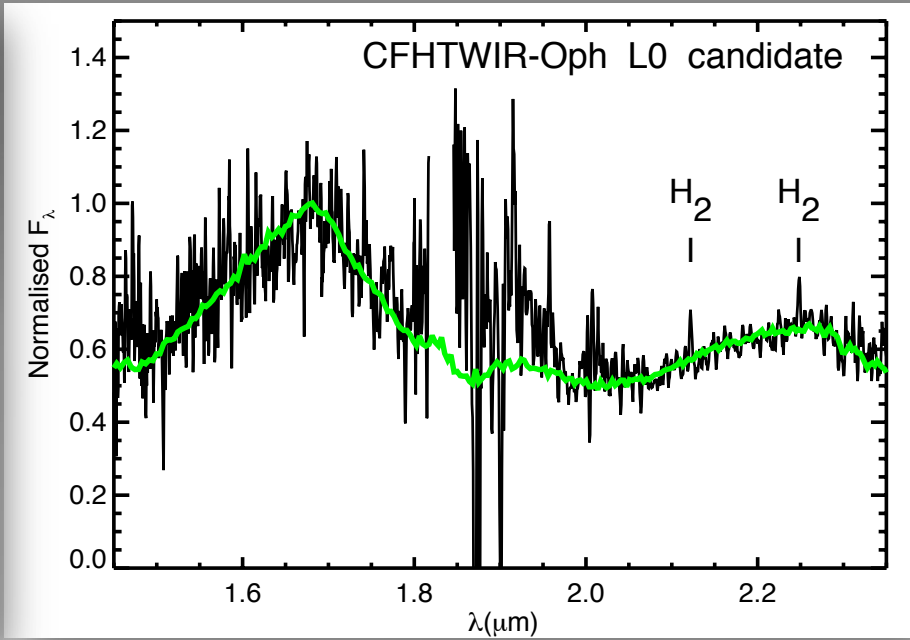
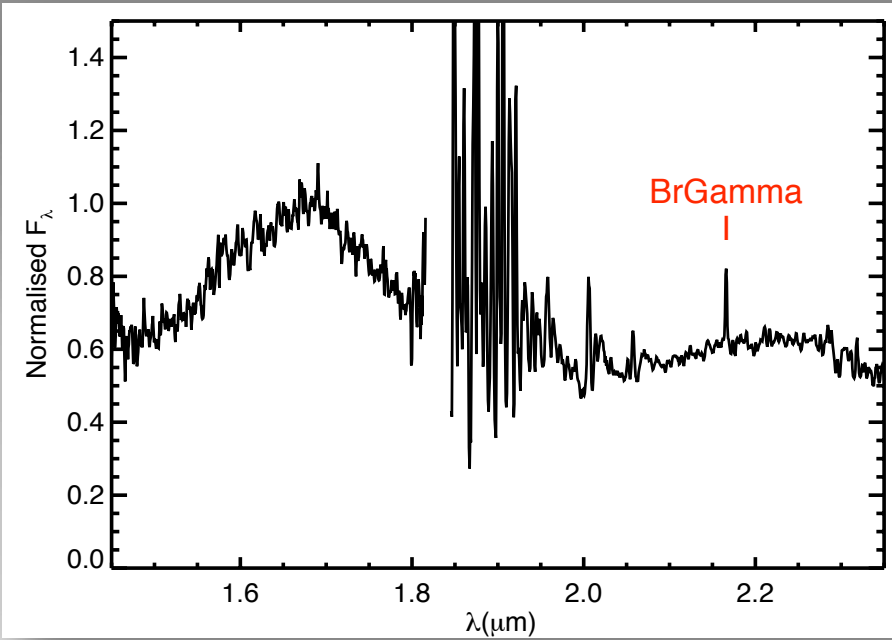


# ISAAC/VLT: 15 new BDs

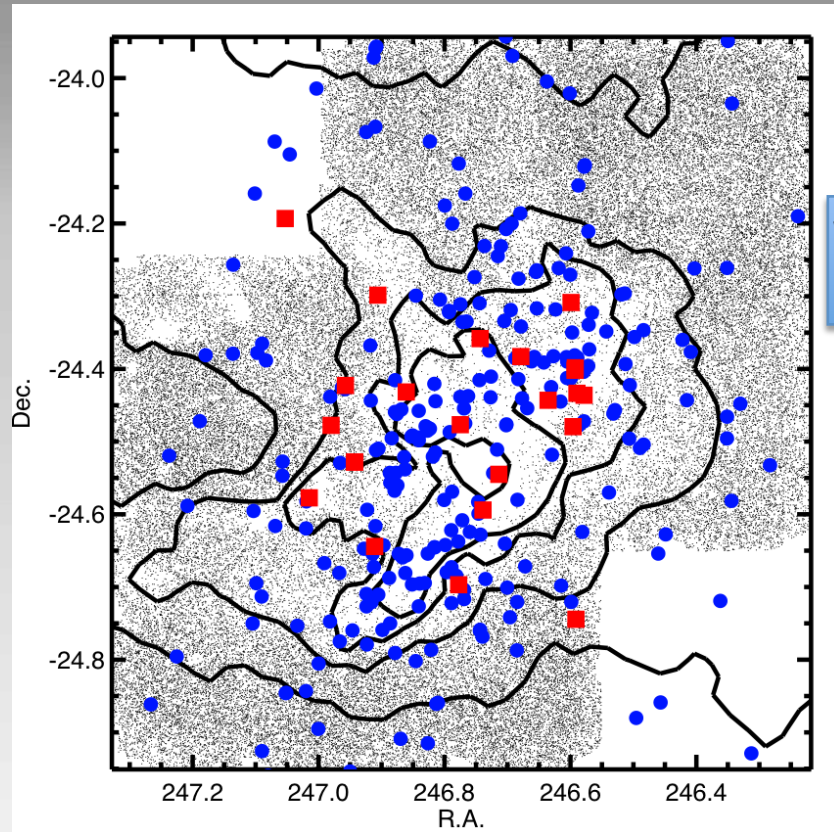


RA	Dec	i	z	J	H	Ks	[3.6]	[4.5]	[5.8]	[8.0]	[24.]	Others
16:26:18.58	-24:29:51.6	99.99(99.99)	21.90(0.03)	17.09(0.05)	14.92(0.05)	13.55(0.05)	12.14(0.06)	11.61(0.06)	11.00(0.07)	10.18(0.14)	6.99(0.12)	variable

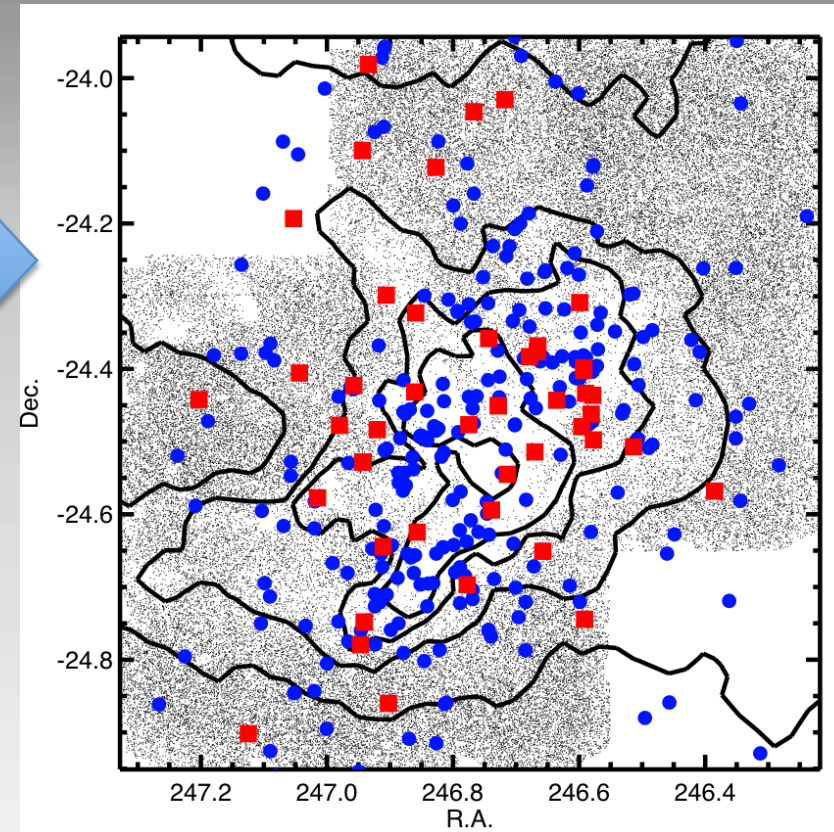




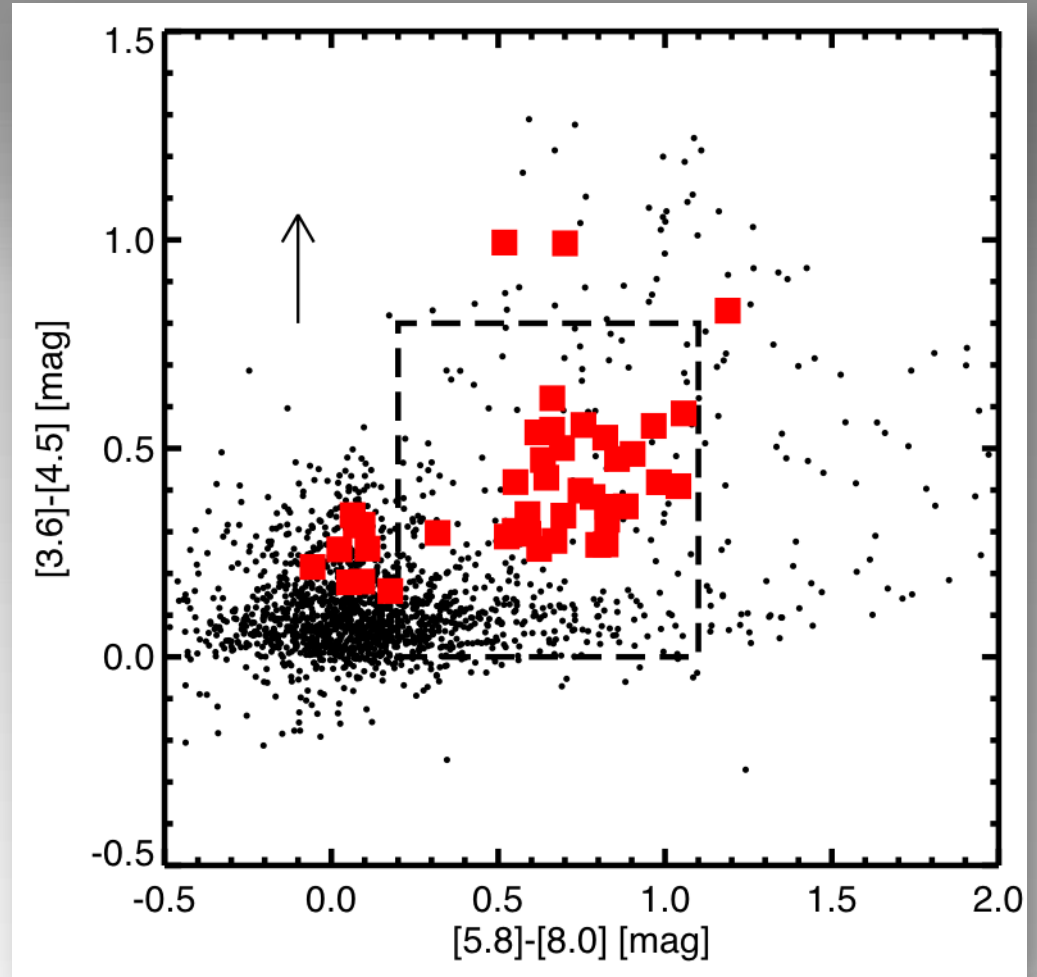
$$N_{\text{Brown dwarf}} / N_{\text{stars}} \approx 0.19 \quad (R^{-1} \approx 5.4)$$



WIRCam  
survey



Fraction of brown dwarfs  
with disks = 79%

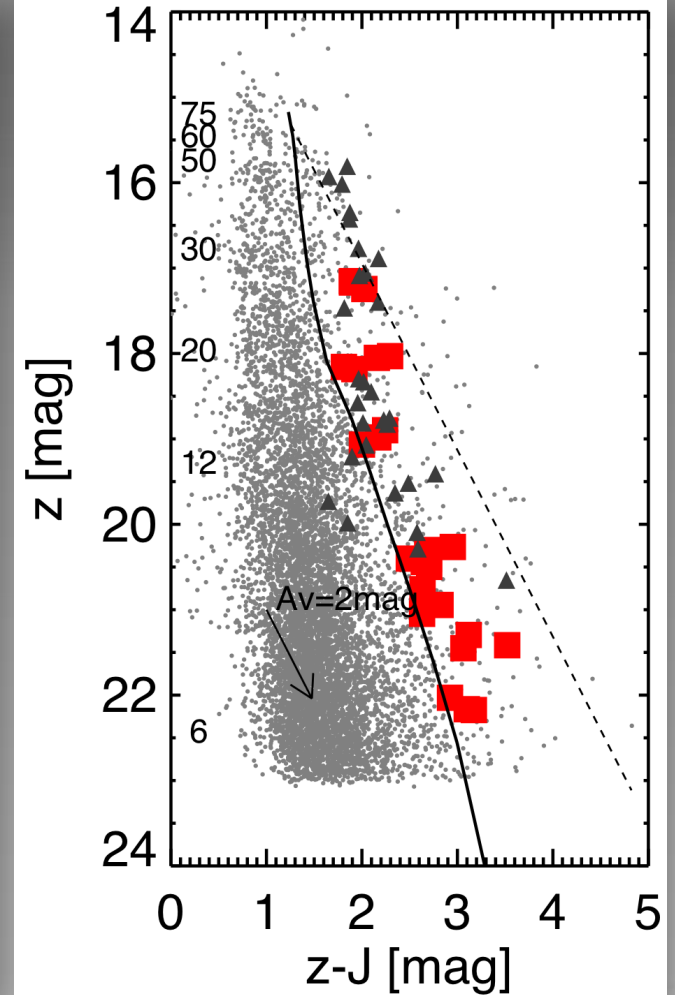
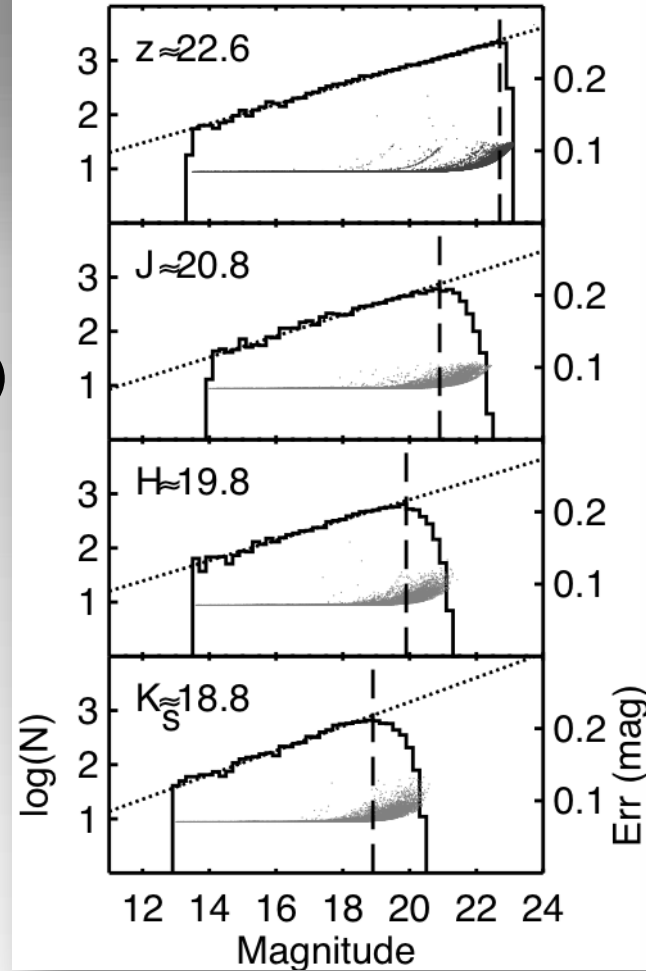


# IC 348

WIRCam survey  
candidate selection

Follow-up

- \_ 10h GTC (Osiris)
- \_ 24.5h Gemini (NIRI)



# Conclusions & Outlook

**Alves de Oliveira et al. 2010, A&A, 515, 75A**

- \_ Uncovered a candidate population of BDs in Ophiuchus
  - **23 new brown dwarfs confirmed spectroscopically**
- \_ L0 candidate in Ophiuchus core
- \_ Number of stars to brown-dwarfs similar to other star forming regions
- \_ High fraction of brown dwarfs with discs
  - Next step: determine accretion & disc properties



Thank you.

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