SURVEYING THE SUBSTELLAR COMPONENT OF THE ORION DISPERSED POPULATIONS

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WITH THE COLLABORATION OF:
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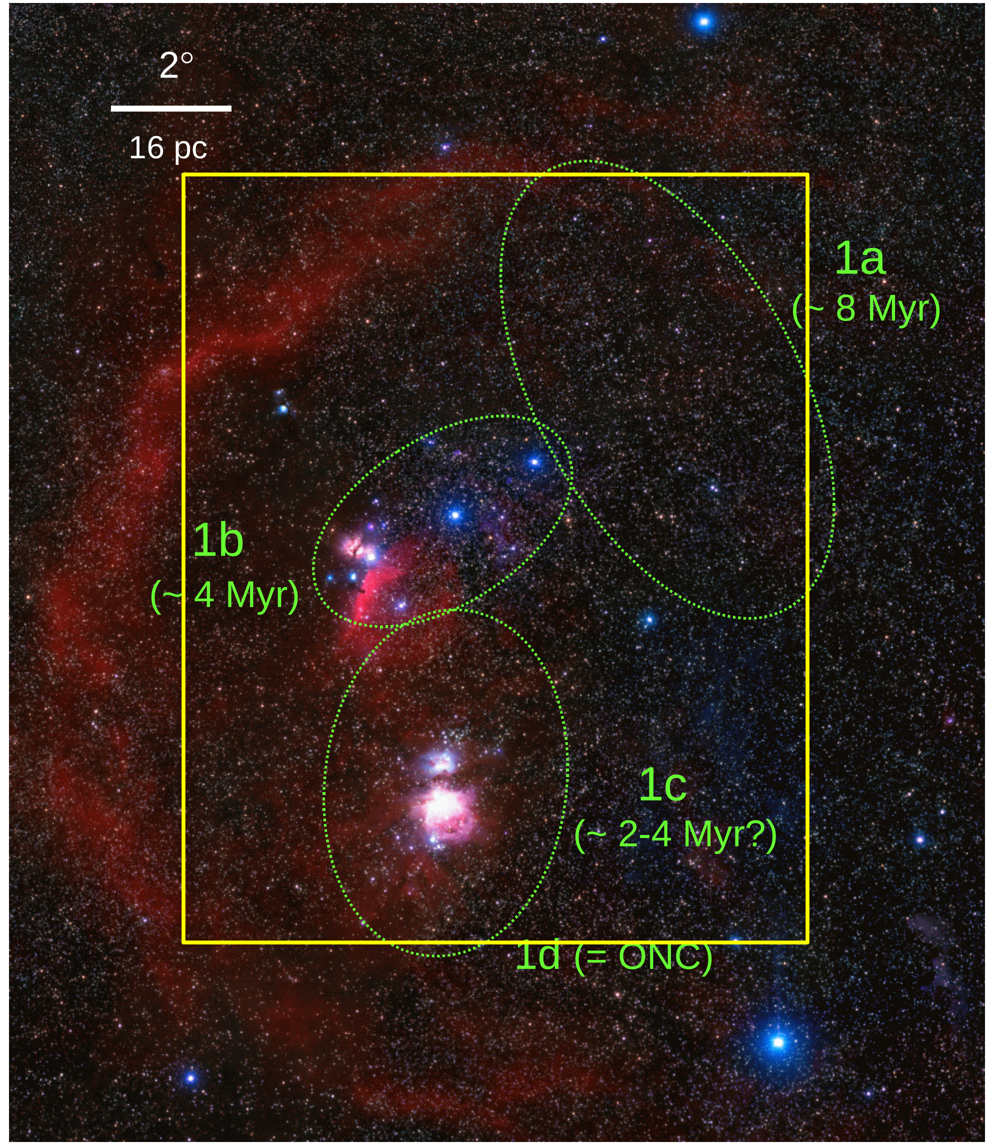
Why look for BDs in Orion?

1) Orion OB1 (*Blaauw 1964*) is nearby (d ~400 pc) → young BDs are rather bright and easier to find

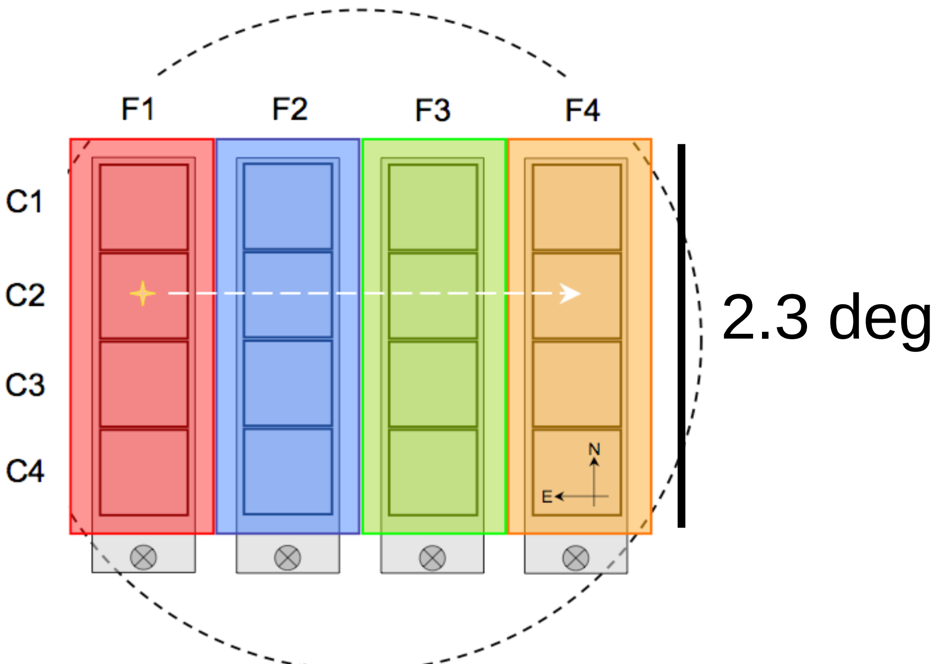
2) Harbors all the stages of the star and planet formation process, as well as the various modes of star formation: clustered, in dense concentrations of young stars, and dispersed, in widely spread, low surface density young stellar population → ideal to test formation scenarios and early evolution of BD

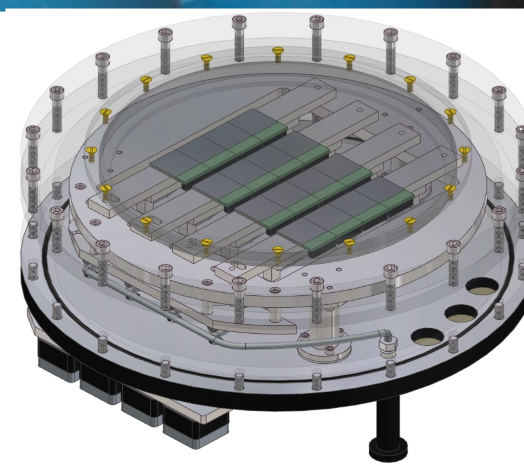
Problem: Orion OB1 spans ~180 deg^2, which has made difficult to conduct a reasonably complete population census



The Venezuela 1m Schmidt-type telescope and QUEST-I 8k x 8k CCD Mosaic Camera

NAOV: 8.7° N, 70.8° W, 3600m elevation



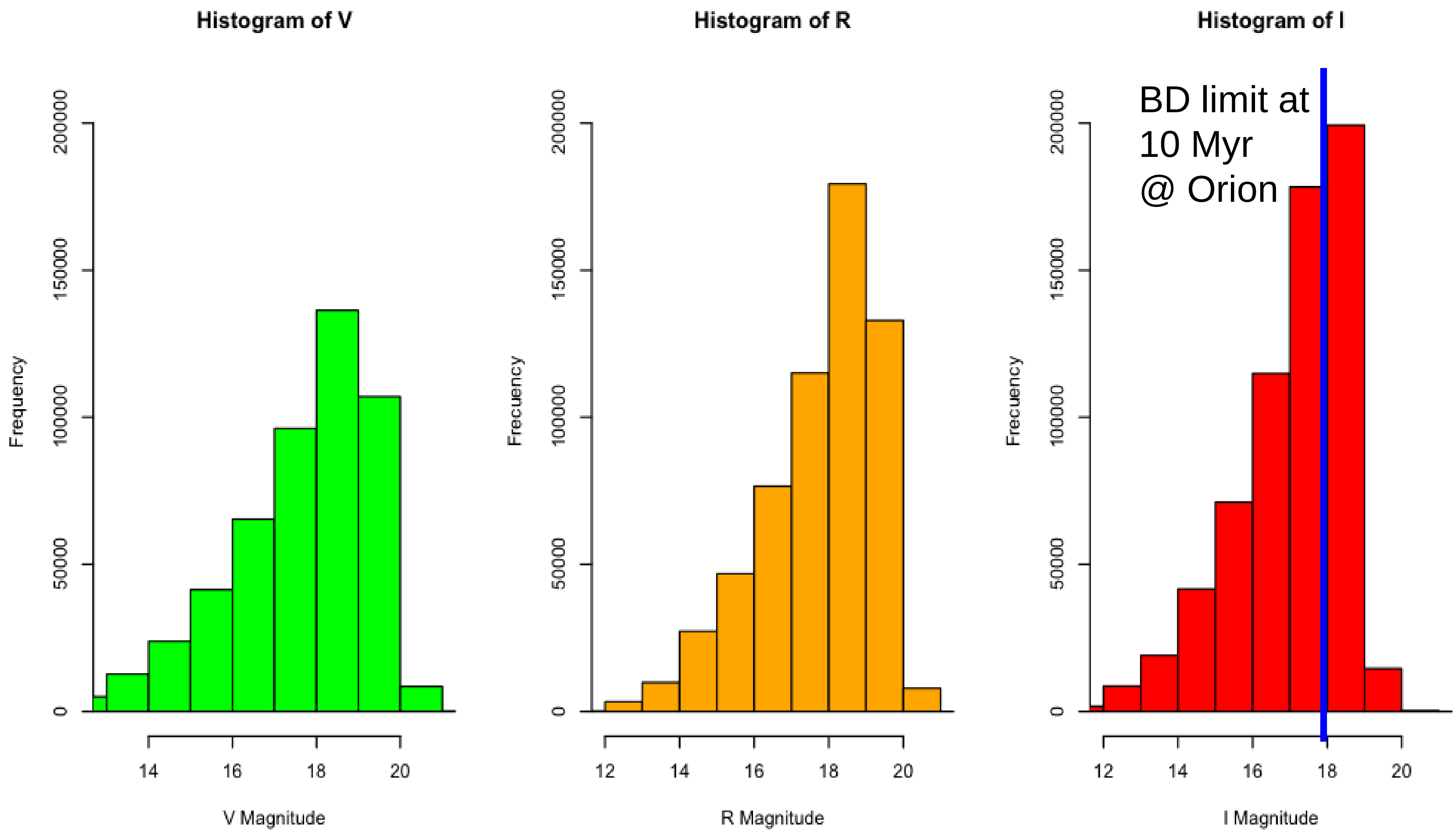


~ 5.5 deg^2 FOV (1 arcsec/pixel)

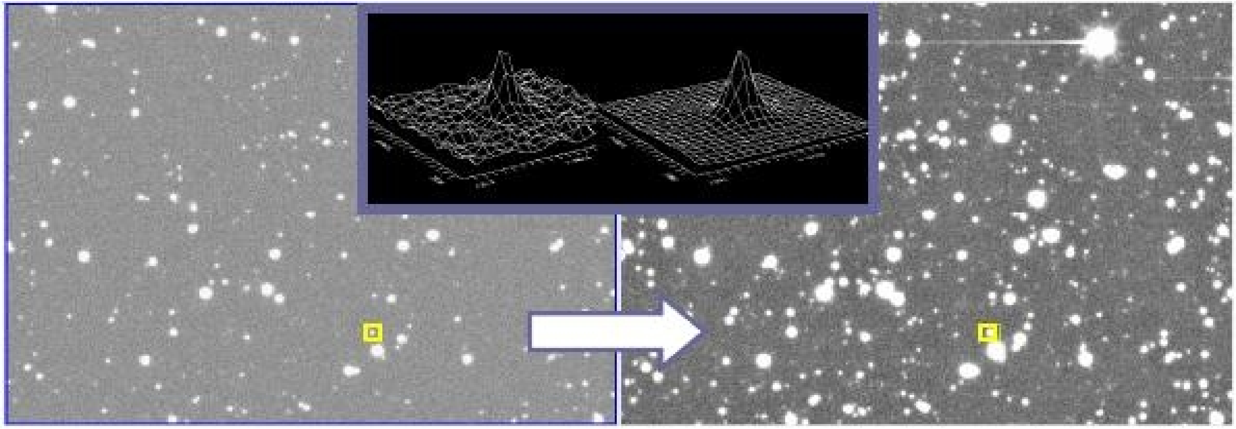
Optmized for Drift-scan: 34 deg^2/filter/hr → ~290 deg^2/filter/night

THE ORION VARIABILITY SURVEY
Multi-epoch drift-scans spanning ~200 deg^2

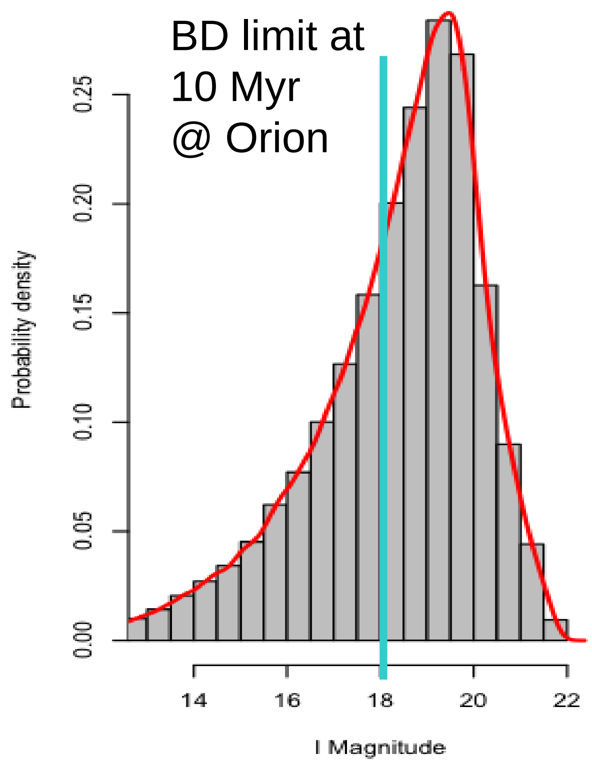
Great to detect TTS by their variability → but limited depth

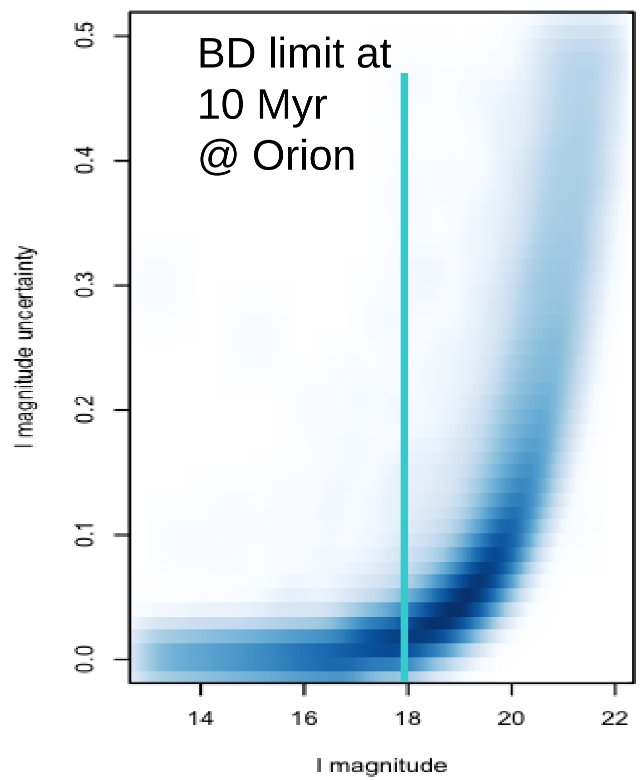


GOING DEEPER: COADDING SCANS

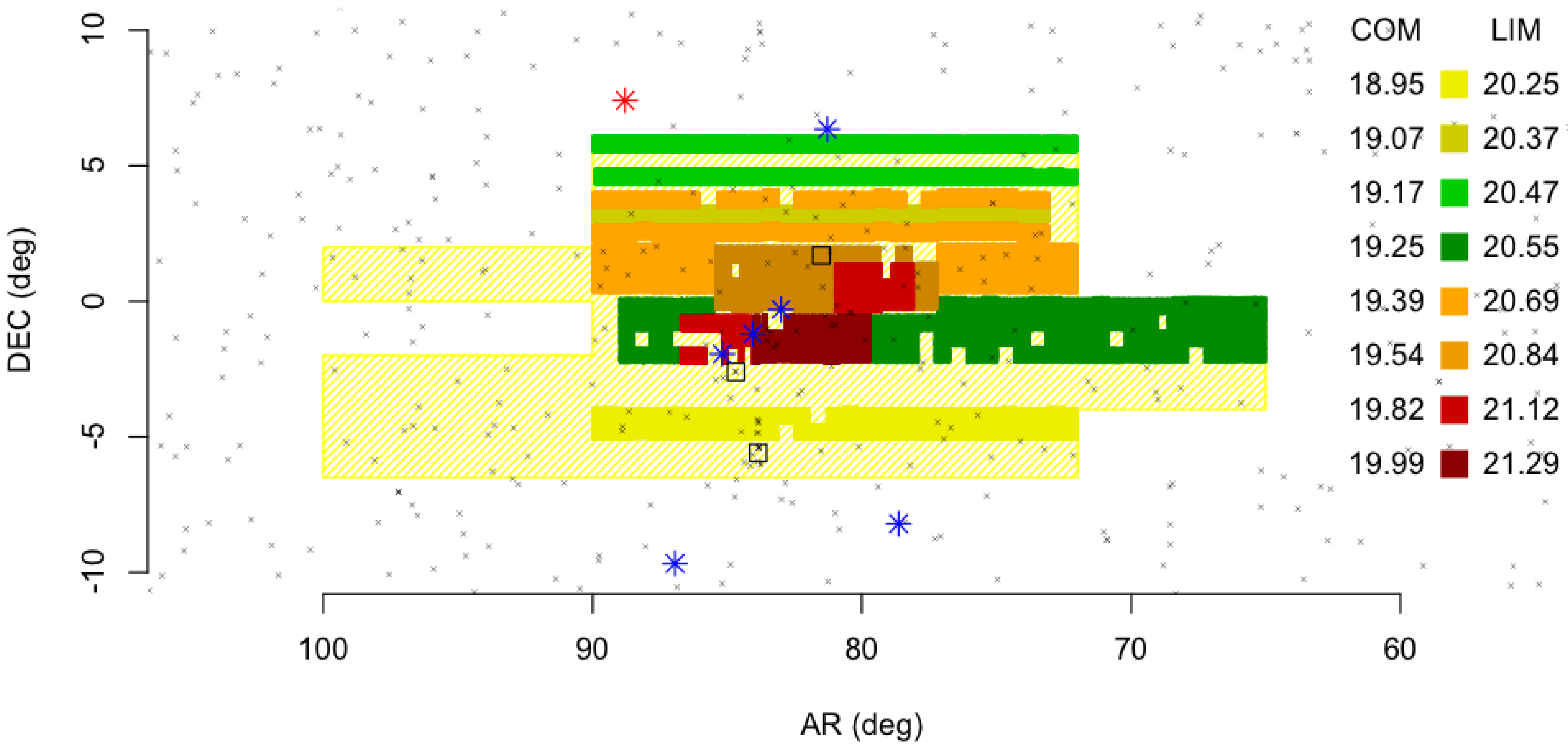


$$\Delta m = 2.5 * Log \sqrt{N}$$
$$4 < N < 30$$
$$0.75 \leq \Delta m \leq 1.85$$

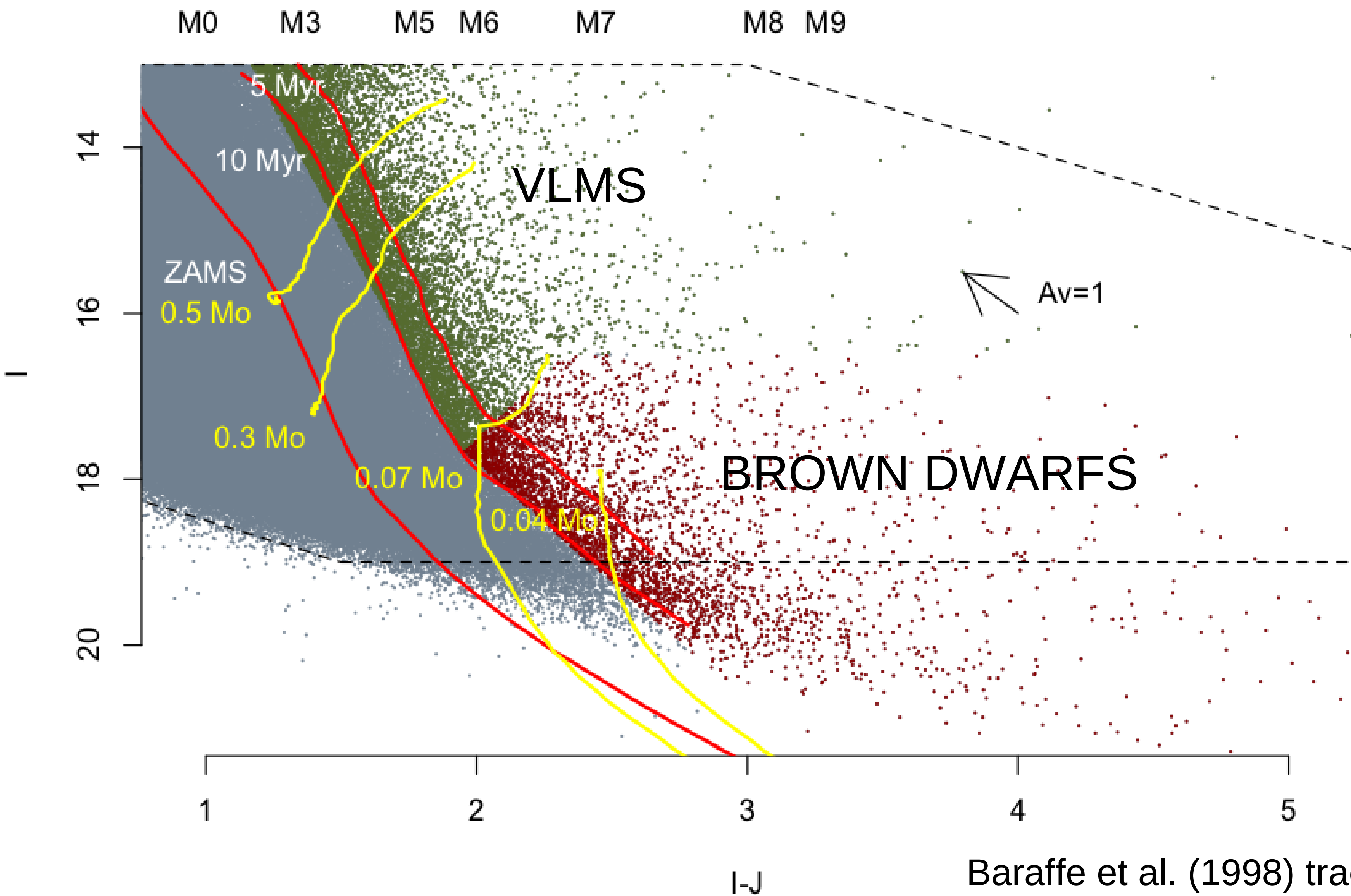




THE I-BAND PHOTOMETRIC SURVEY OF ORION

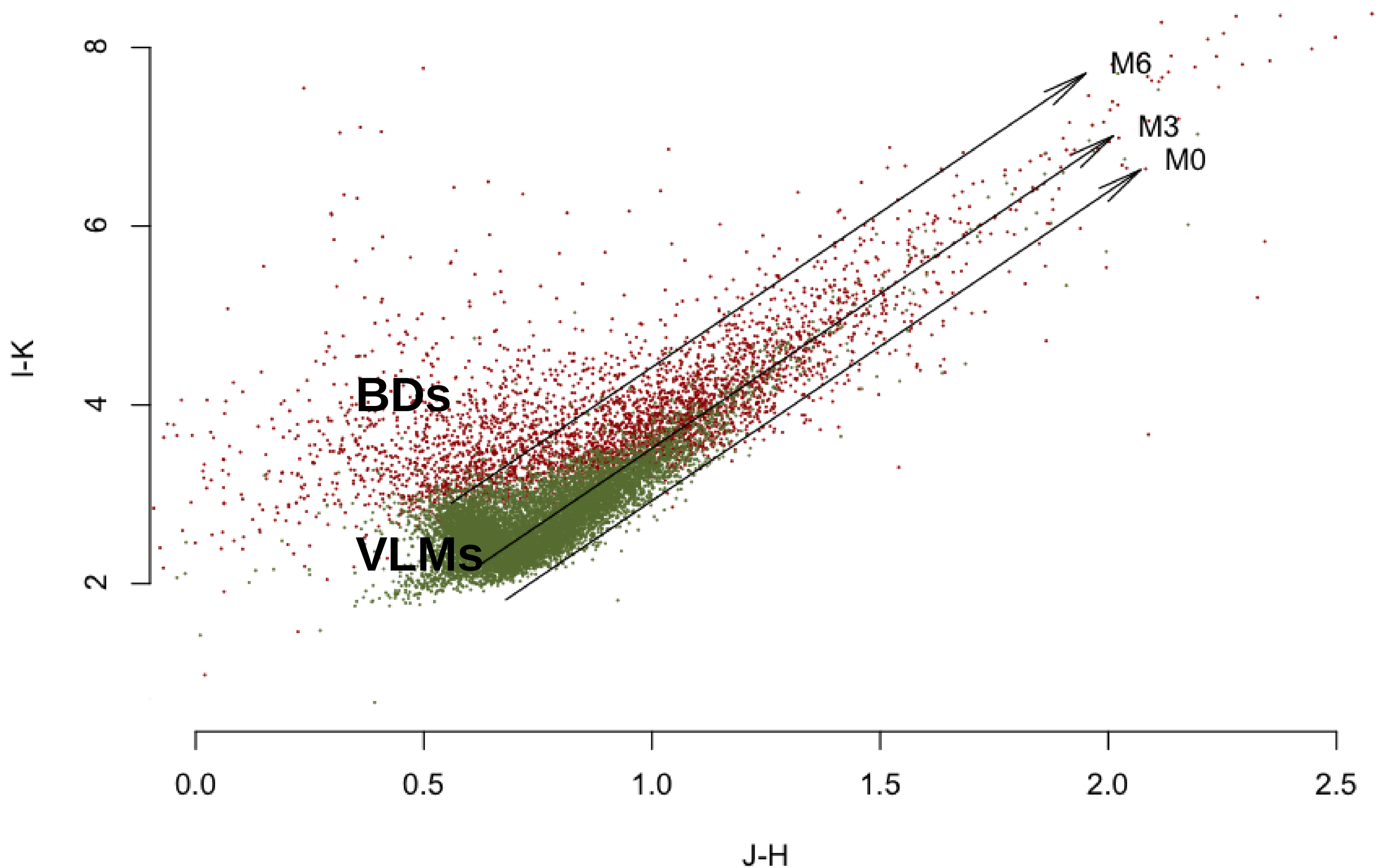


SELECTION OF PHOTOMETRIC CANDIDATES: I

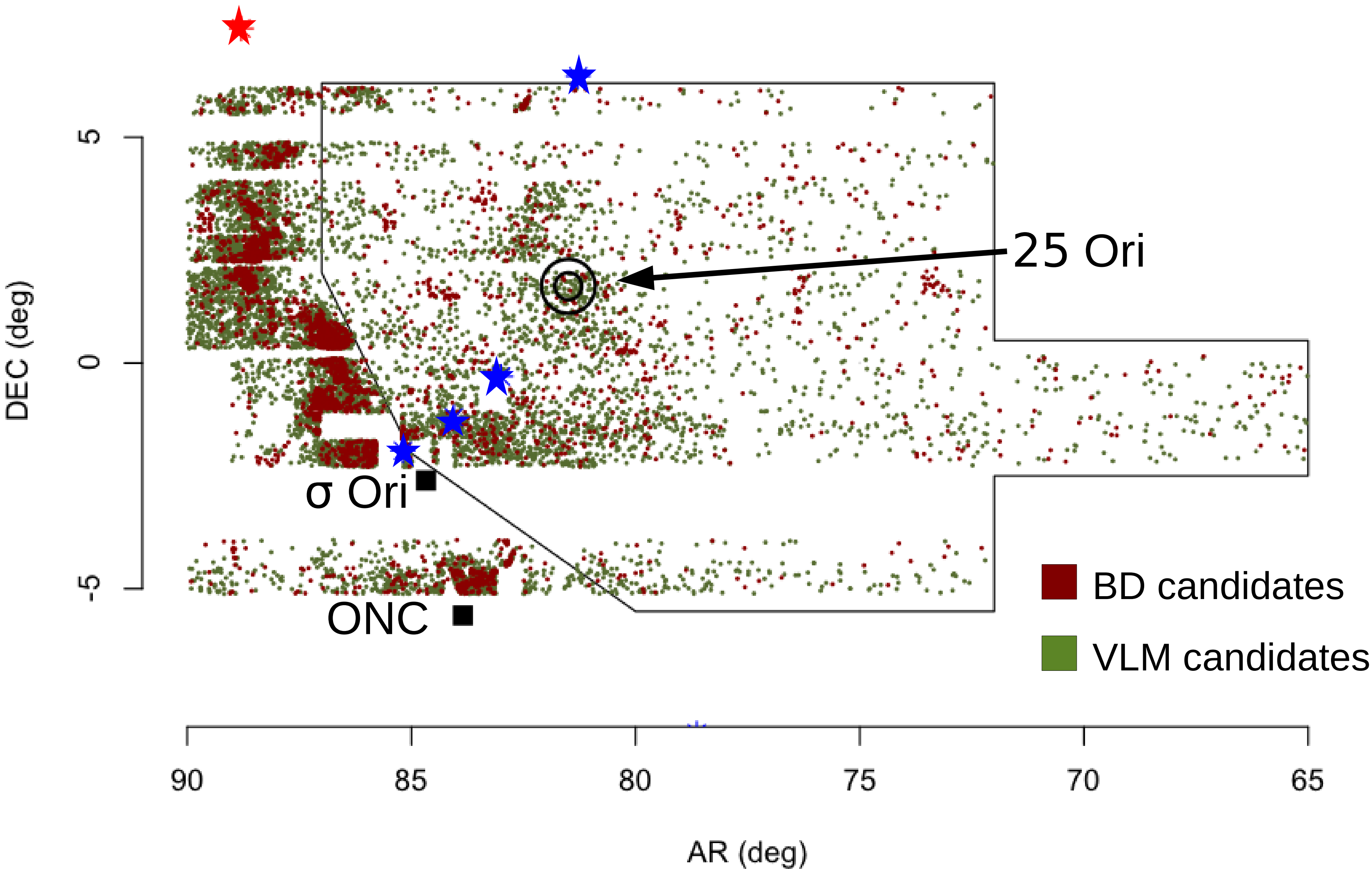


Baraffe et al. (1998) tracks

SELECTION OF PHOTOMETRIC CANDIDATES: II

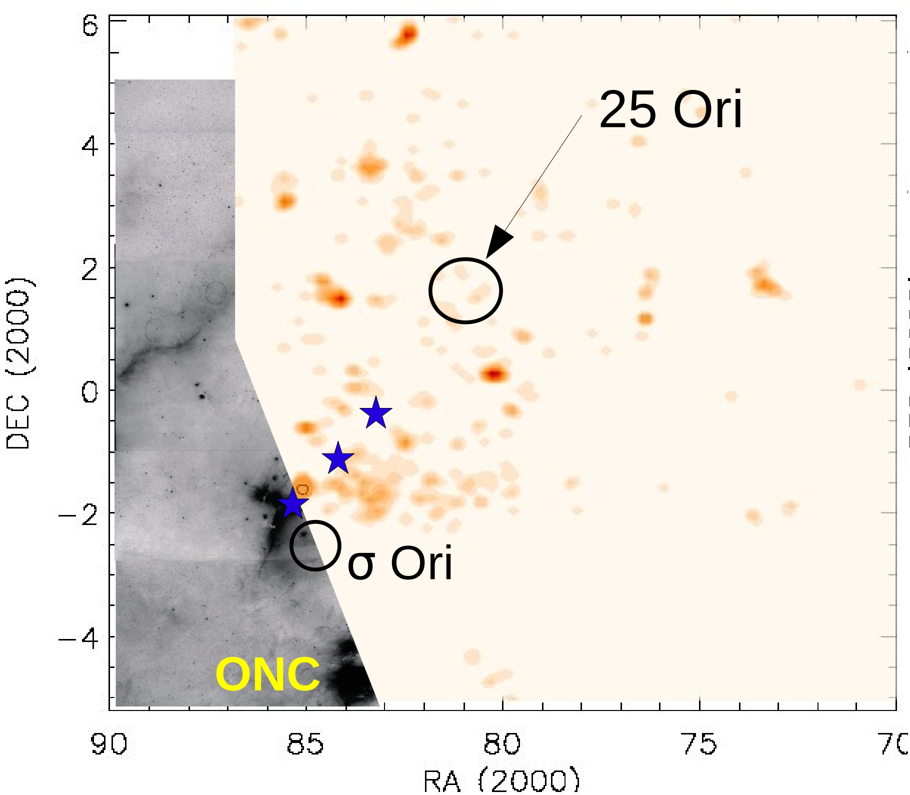


PHOTOMETRIC CANDIDATES ACROSS ORION

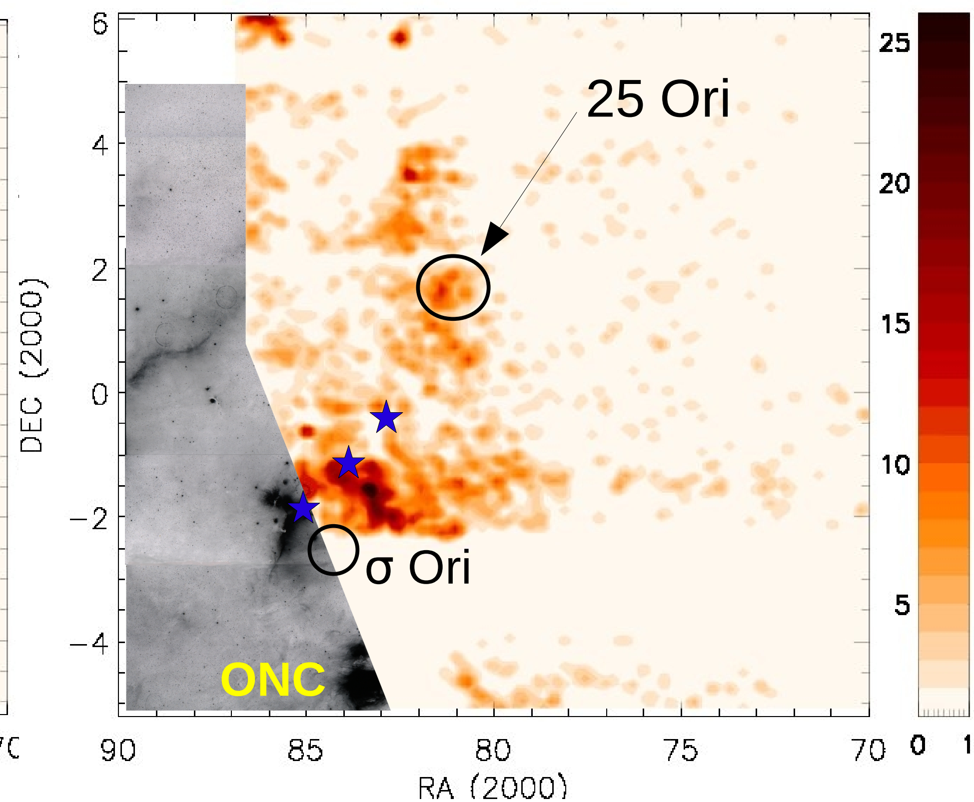


SPATIAL DENSITY OF CANDIDATES

Brown Dwarfs



Very Low Mass Stars

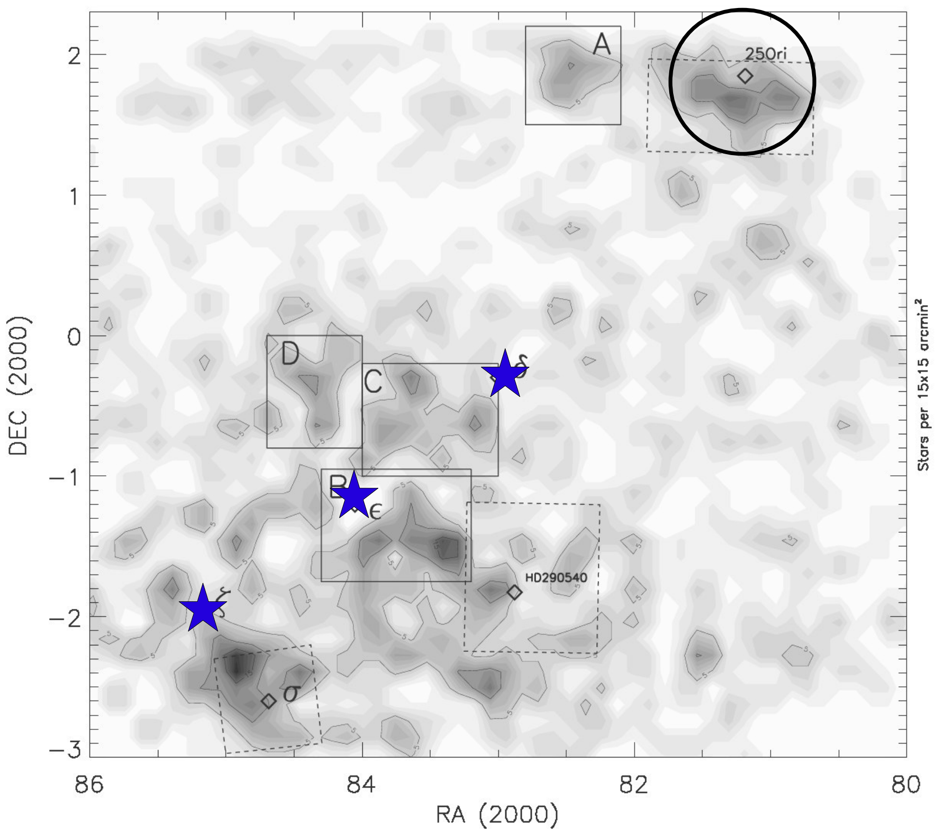


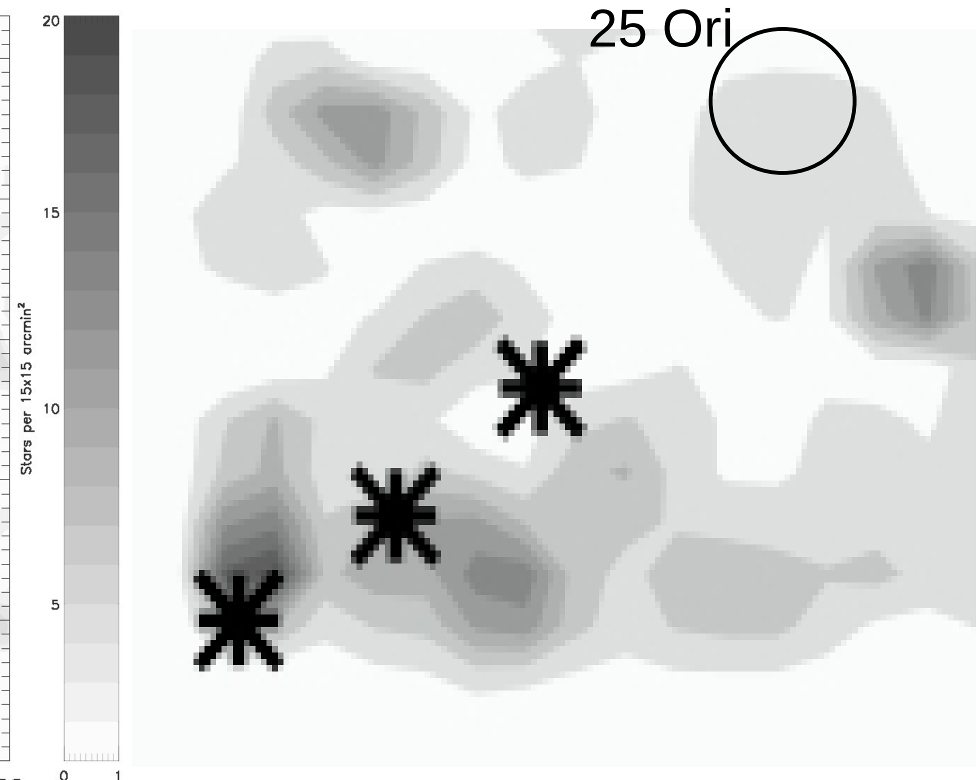
SPATIAL DENSITY OF T TAURI CANDIDATES:

selected as variable objects located above the ZAMS in V vs-V-J CMD

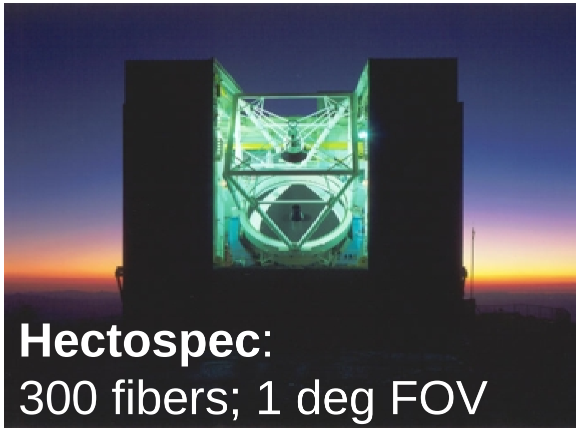
SPATIAL DENSITY OF BD CANDIDATES:

selected as above CMD in I vs I-J and I-K vs J-H

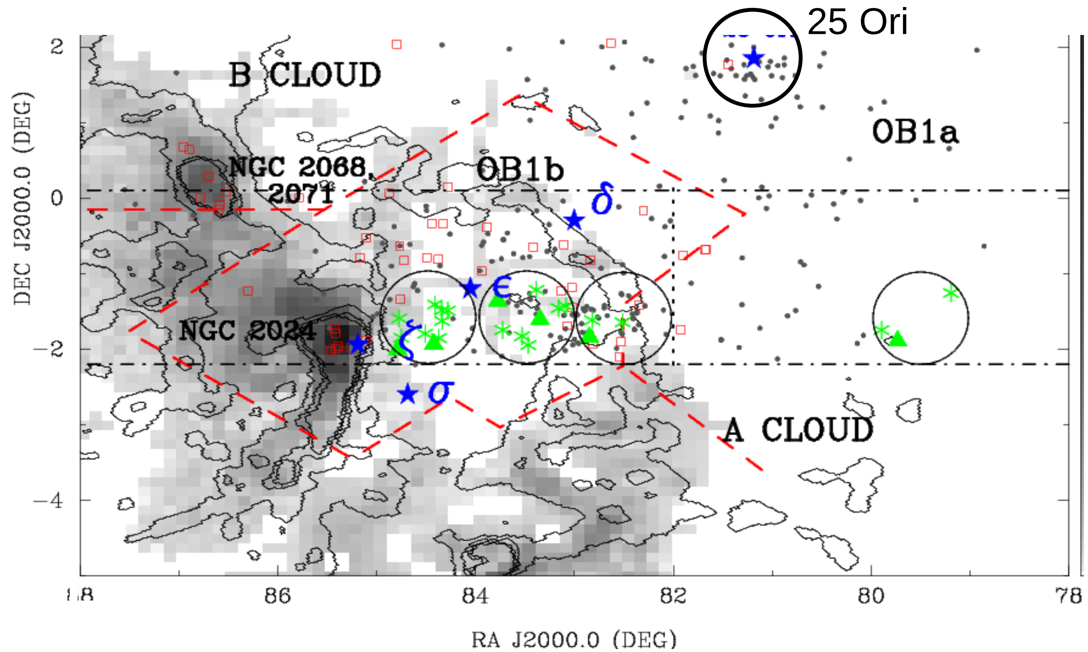


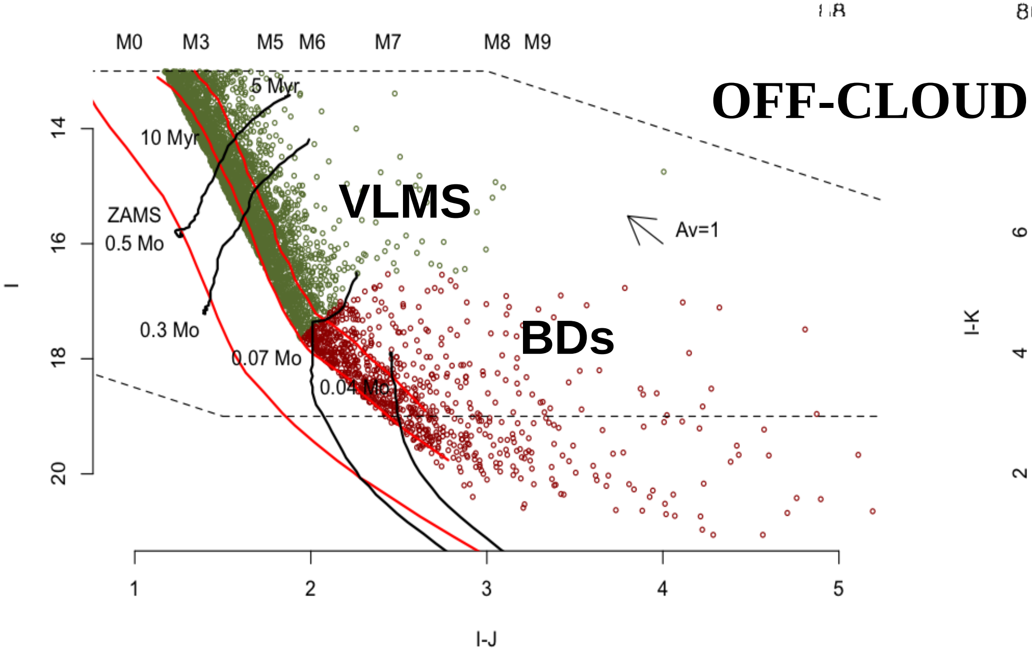


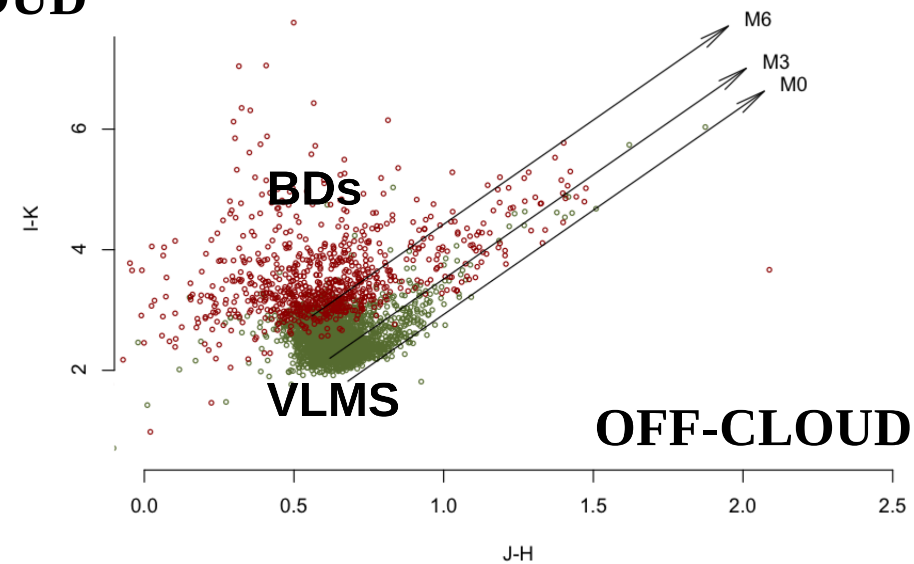
THE SPECTROSCOPIC SURVEY COUNTERPART



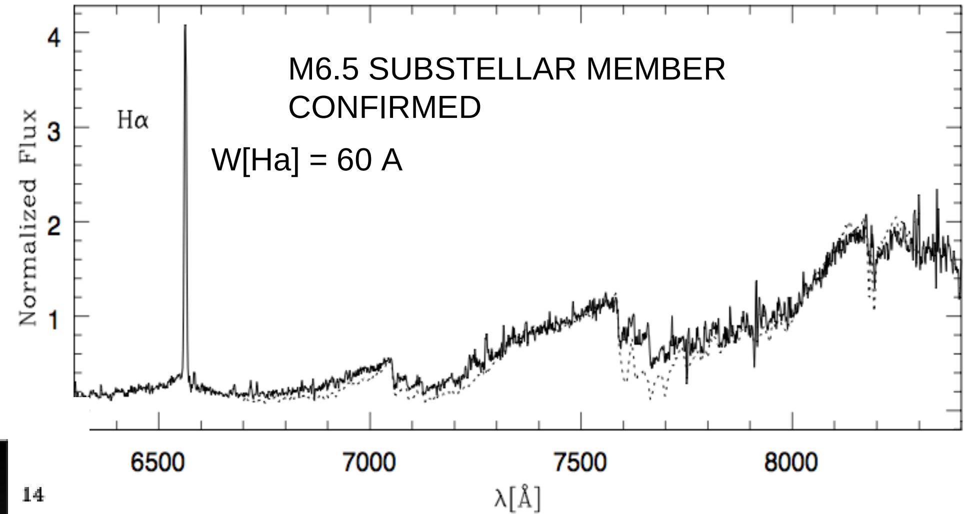
Resolution ~6 Å,
Spectral range: ~4000-9000 Å

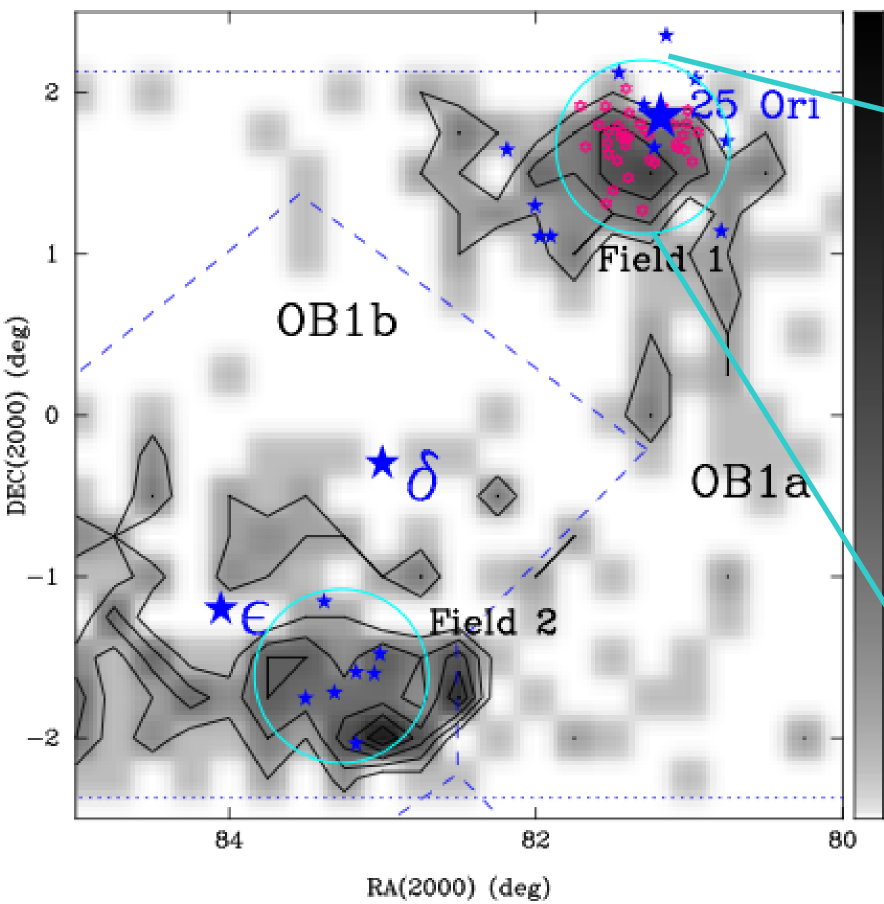


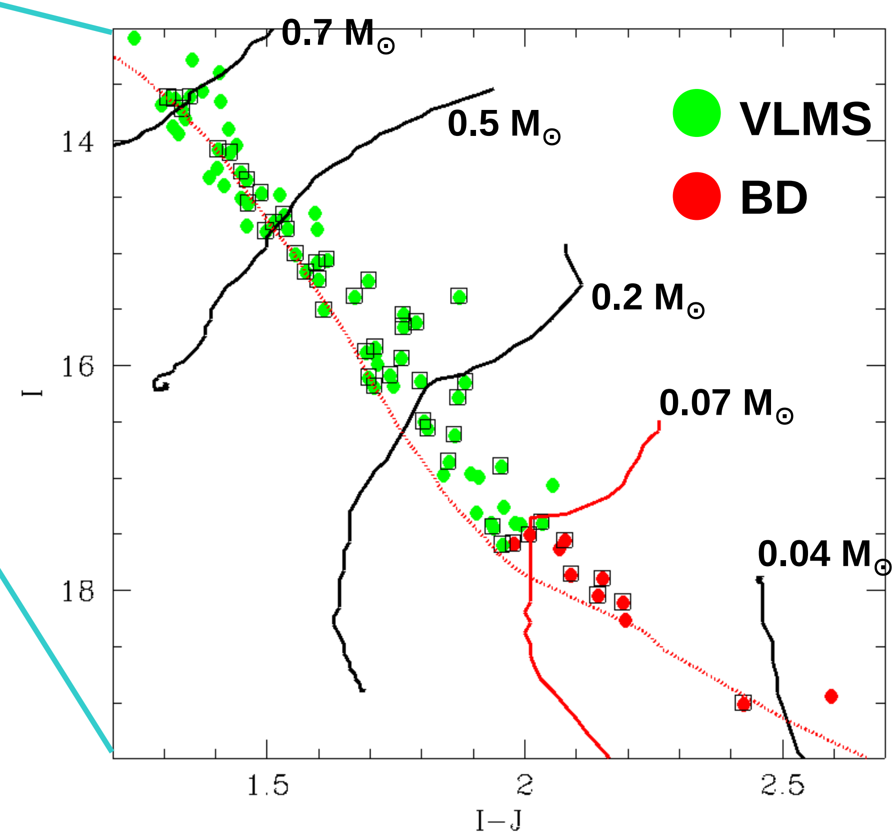




FIRST BDs IN THE 25 Ori CLUSTER
(~8 Myr)

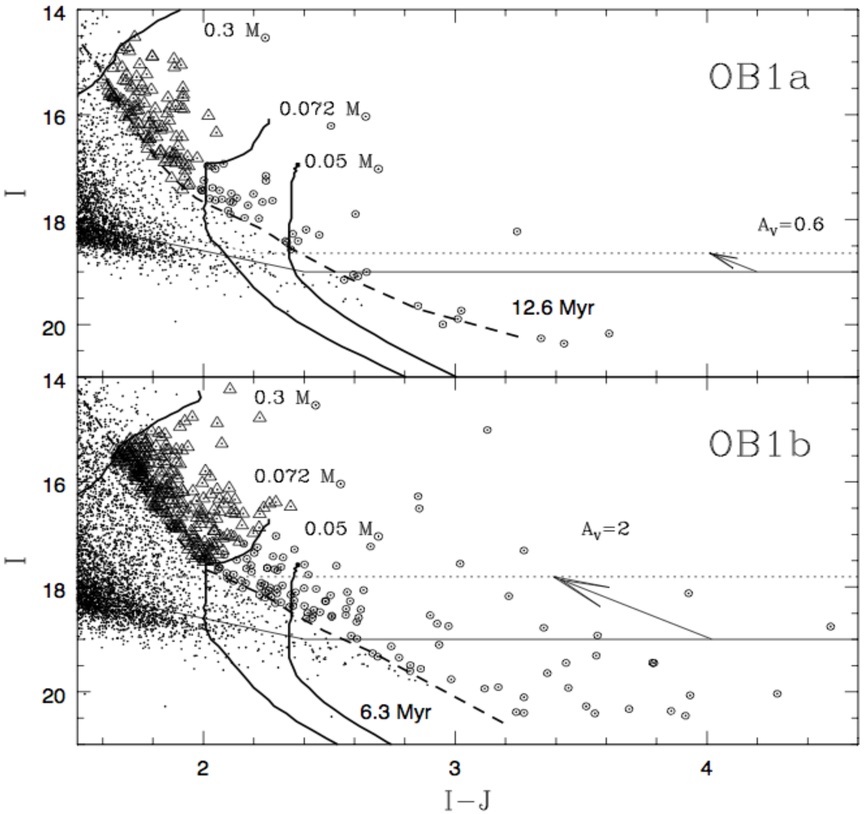


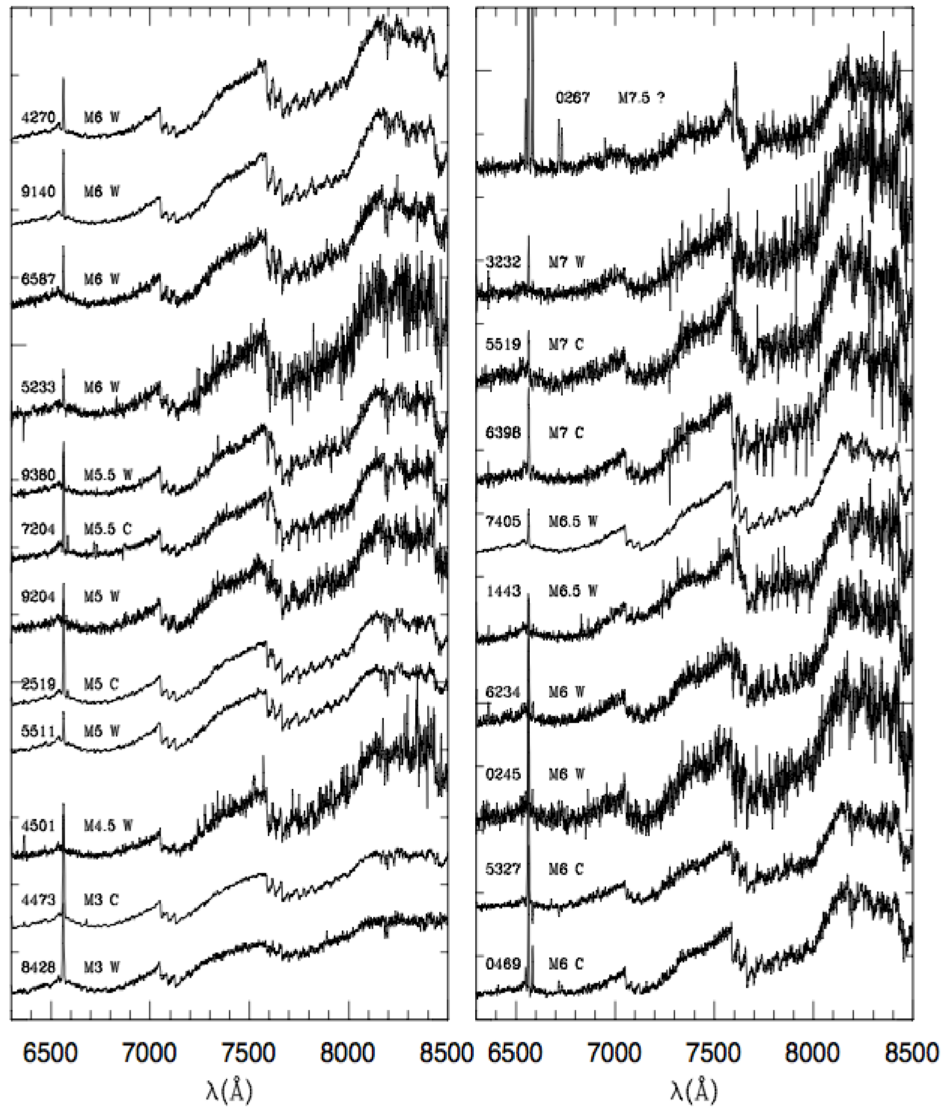


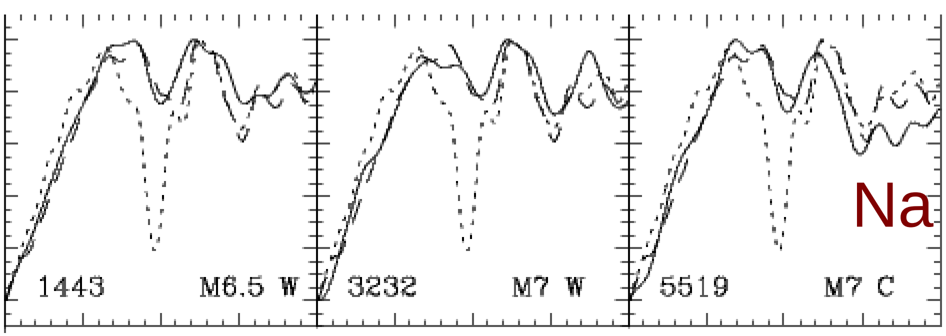


From Briceño et al. (2007)

VLMS and BDs IN ORION OB1a AND OB1b







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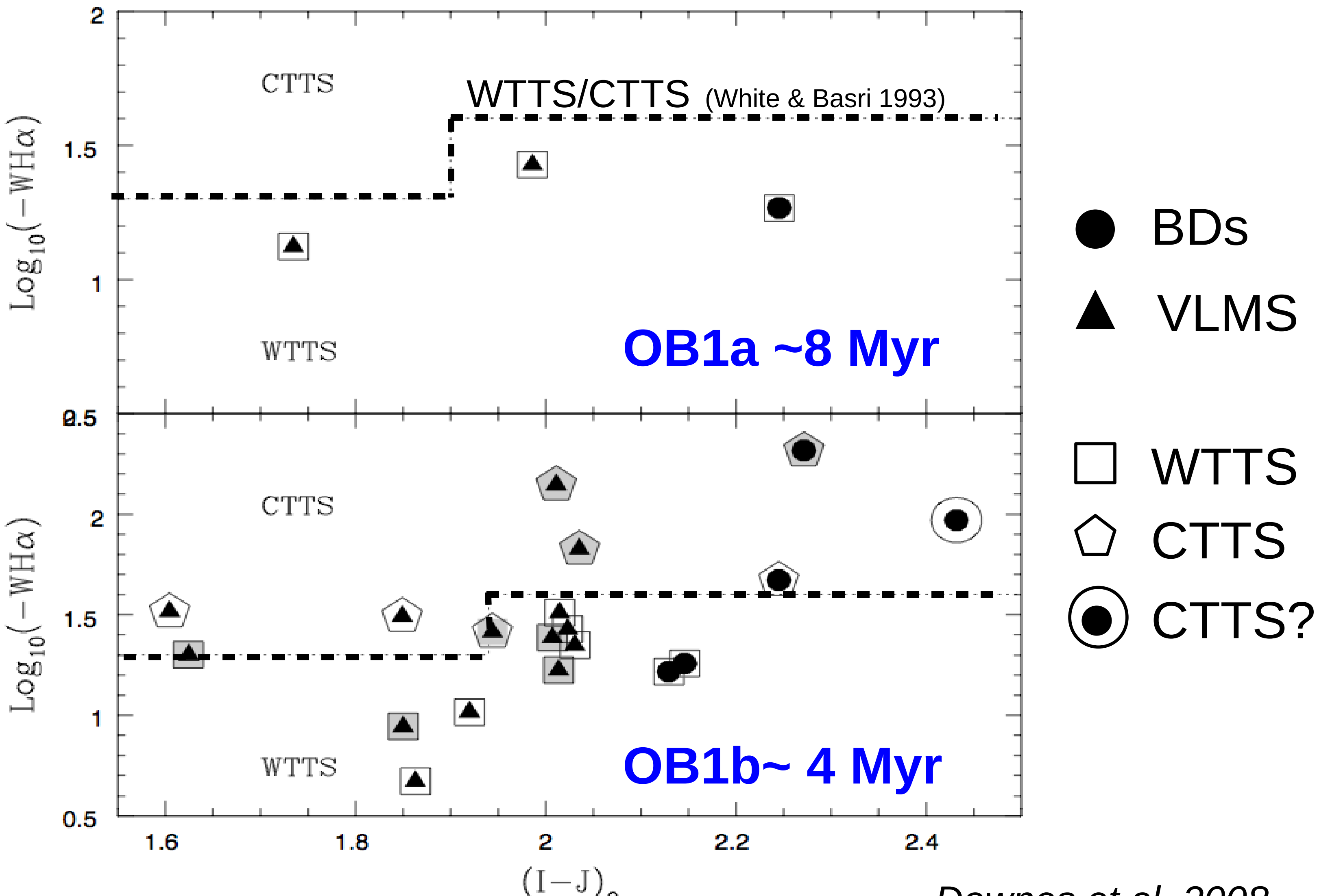
Downes et al. (2008)

ACCRETION INDICATORS AMONG VLMS/BDs IN ORI 1a and 1b



Downes et al. 2008

SUMMARY AND CONCLUSIONS (in the works)

- We find ~3000 VLMS and ~850 BD down to M~0.03 $M_{\odot}$, spread out across ~130 deg^2 in the Orion OB1 off-cloud regions (Av~<0.5)

- Several groupings → new clusters (more 25 Ori/σ Ori analogues)?

- Spectroscopic follow-up (so far ~4 deg^2 in Ori OB1a, OB1b and 25 Ori cluster) → confirmation of 37 VLMS and 8 BD (Estimated efficiency of our selection criteria is ~75 % in the off-cloud regions)

- The spatial density of the off-cloud VLMS and BD agrees reasonably well with that of the slightly higher mass TTS sample, selected by different criteria (V,V-J CMD +V-band variability) → BD & stars distributed similarly in Orion

- Accretion: ~< 16±14% in OB1a. OB1b: 50±35 % BD and 36±16 % VLMS. Consistent with Downes et al. 2008, and with estimates for Orion OB1a,b TTS (Briceño et al. 2005, 2007) → VLMS/BD show TTS-like properties across the HBMM, with a fall off in accretion fraction (over ~4 Myr) similar to that observed in Ori OB1 TTS.

ONGOING AND FUTURE WORK

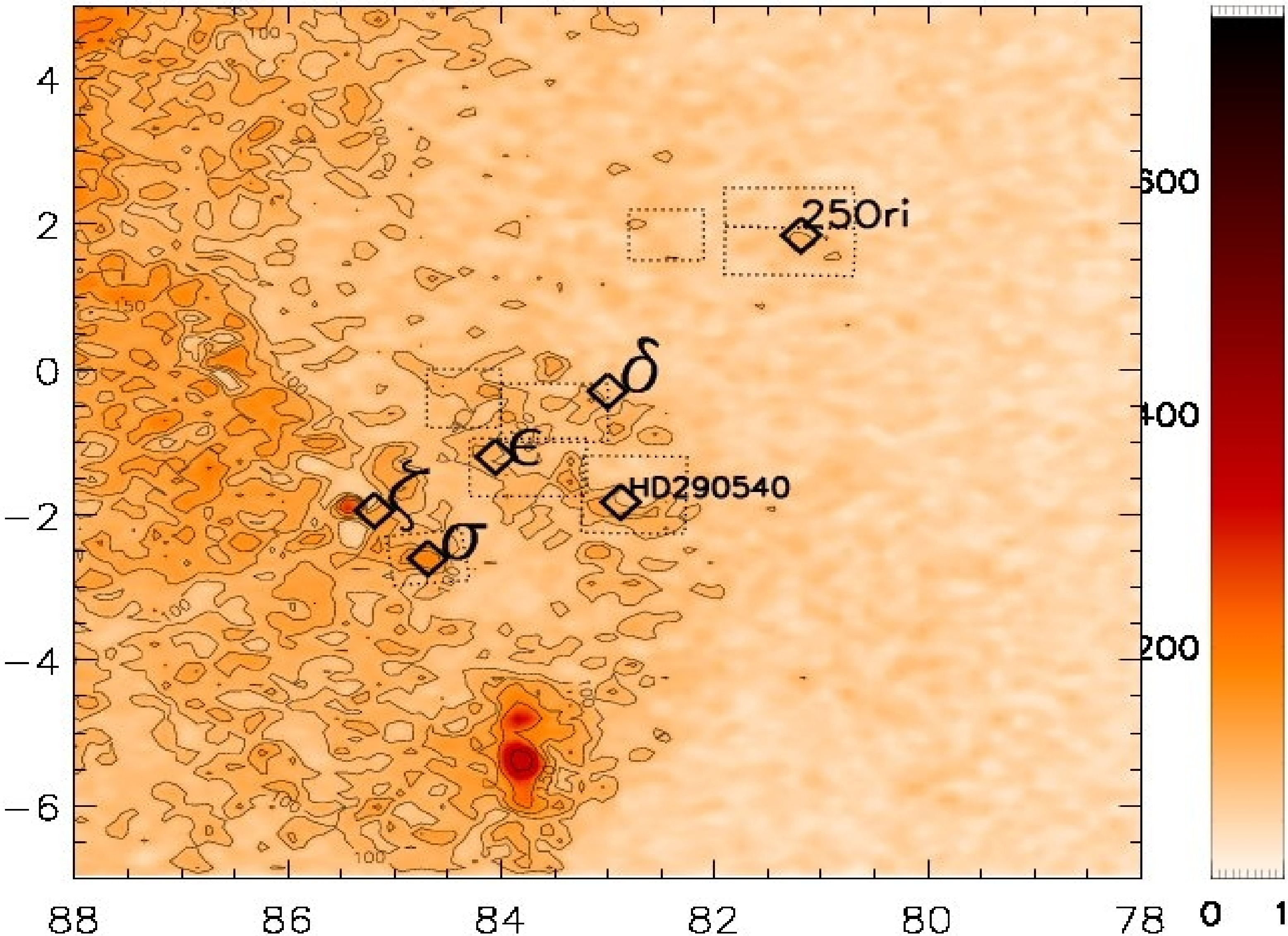
Our present sensitivity is limited not by the optical I-band sample, but by the relatively shallow limiting magnitudes of 2MASS. Next December 2009 we will start a deep JHK near-IR survey of selected off-cloud regions using the NEWFIRM camera (27 x 27 arcmin) on the 4m telescope at KPNO.

Our spectroscopic sample is still spatially incomplete in certain regions such as OB1b, the 25 Ori cluster and other candidate stellar groupings. Some additional fields have been obtained recently with Hectospec at the MMT (though not too deep exposures); these spectra are being analized.

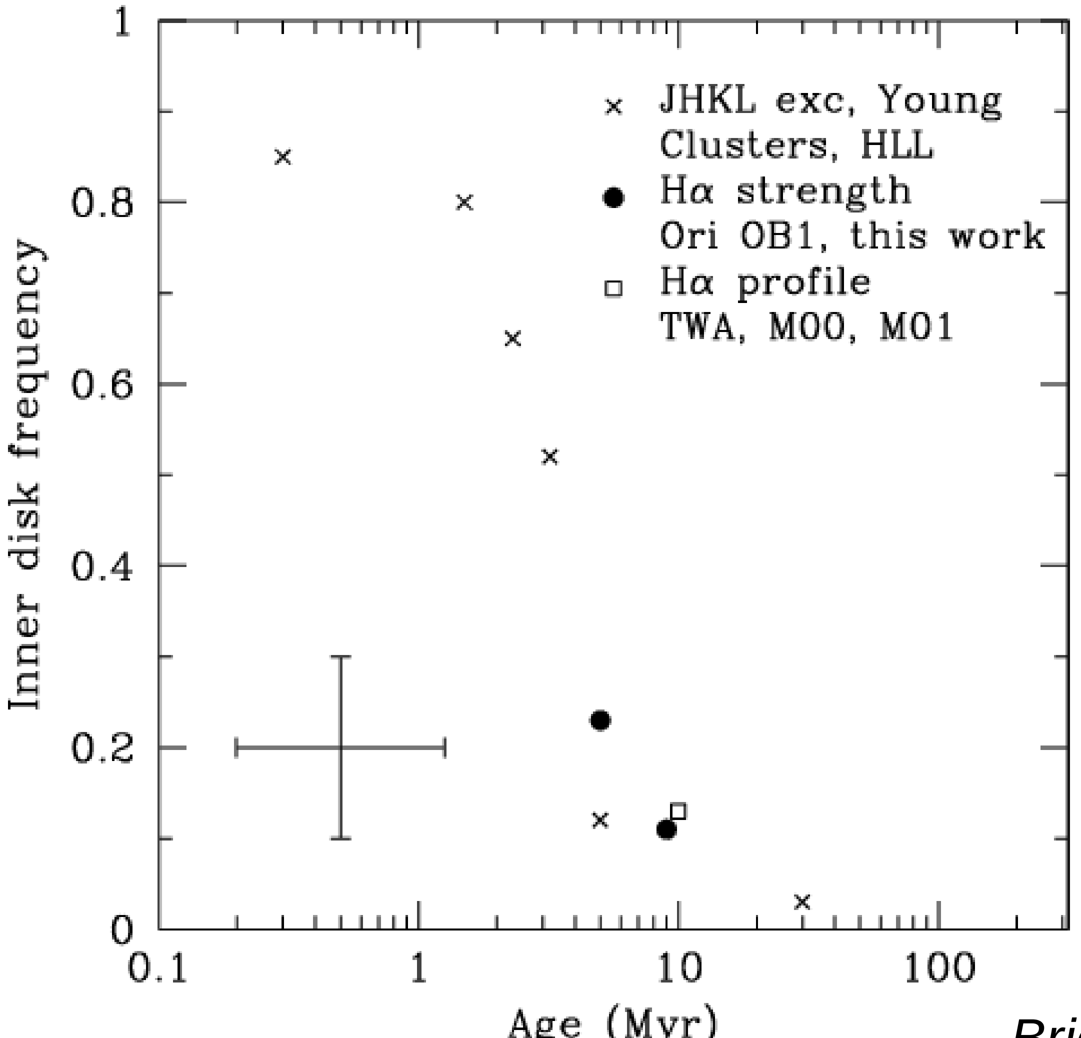
Additional observing time has been granted to us with the IMACS spectrograph on the 6.5m Baade Magellan telescope (Jan 2010), in order to expand the spectroscopy in 25 Ori and include other interesting regions.

Analisis of recently obtained Spitzer fields (IRAC/MIPS) is underway, to detect dusty disks at least among the VLMS.

SPATIAL DENSITY OF JHK-ONLY CANDIDATES



INNER DISK EVOLUTION



Briceño et al. (2005)