The complete mass function of the young σ Orionis cluster

Karla Peña Ramírez / IAC

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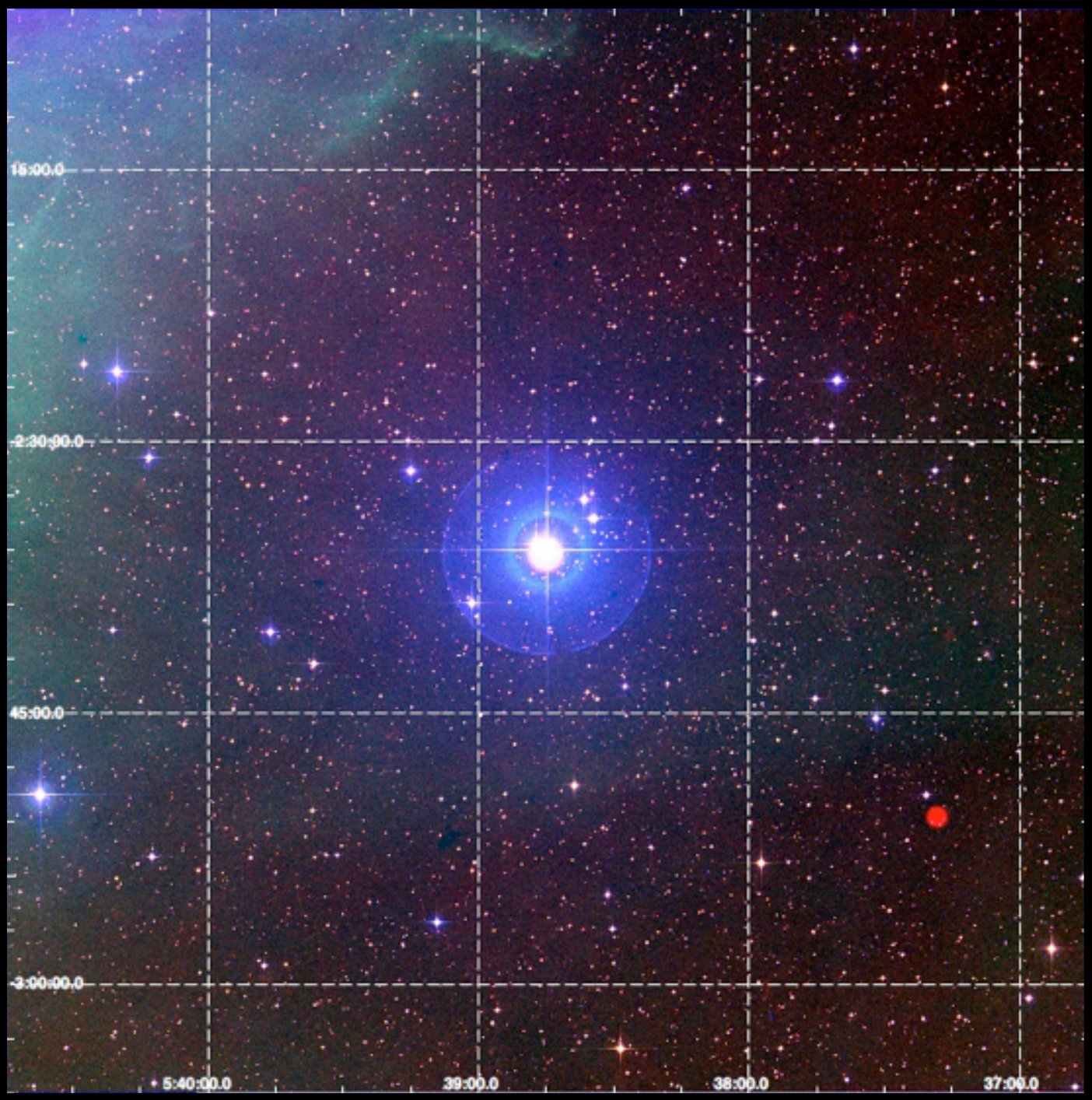
ESO-Garching * 12 October 2011

Outline

1. σ Orionis cluster seen by VISTA.
2. VISTA photometric selection.
3. Infrared excesses.
4. Spatial distribution.
5. Stellar and substellar mass function.

σ Orionis cluster



Age ~3 Myr

Distance ~350 pc

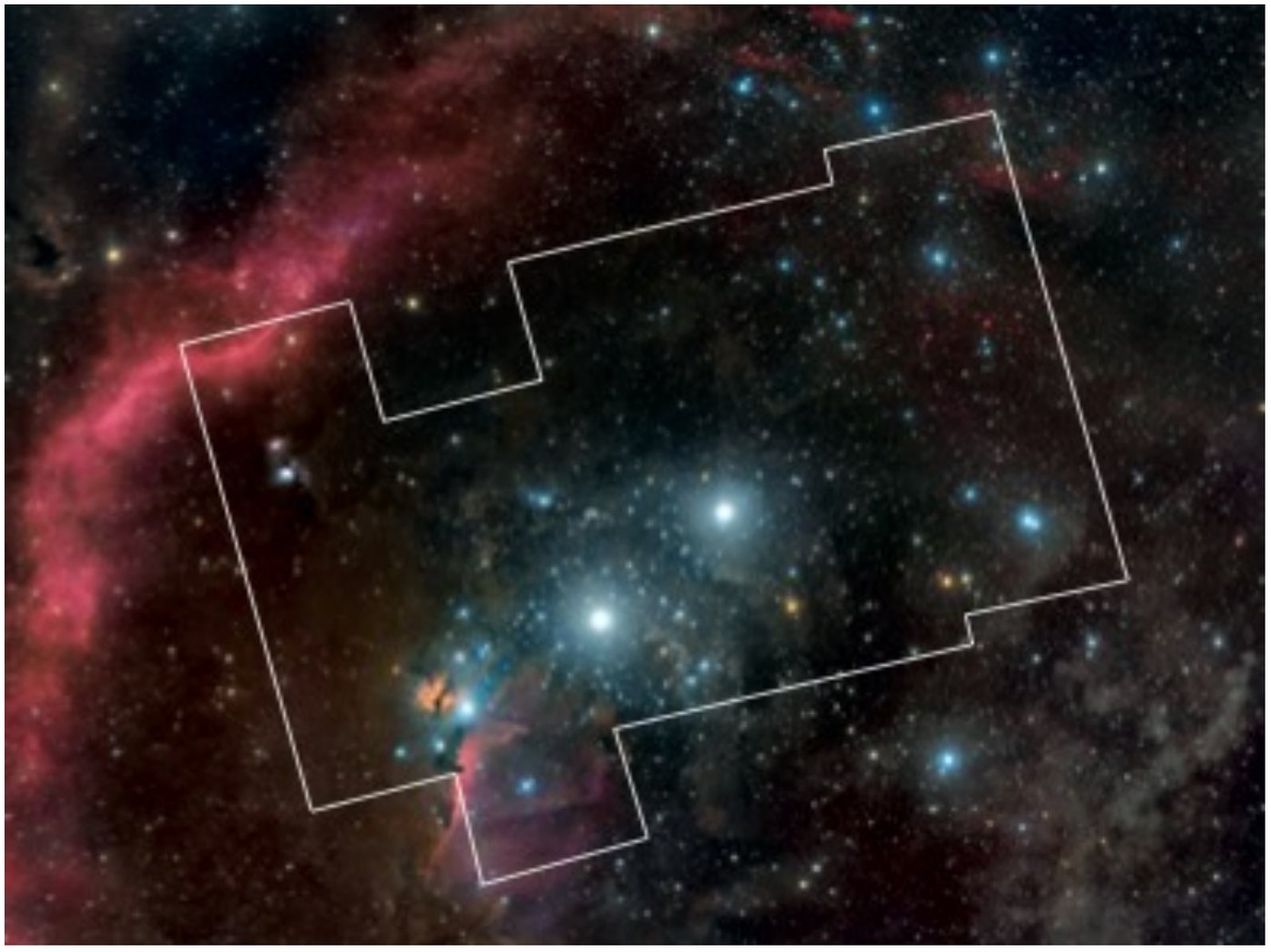
Av < 0.25 mag

[Fe/H]=0.02±0.09 dex

~400 members / ~280 confirmed

19 $M_{\odot}$ to ~6 M_{Jup}

VISTA Orion survey

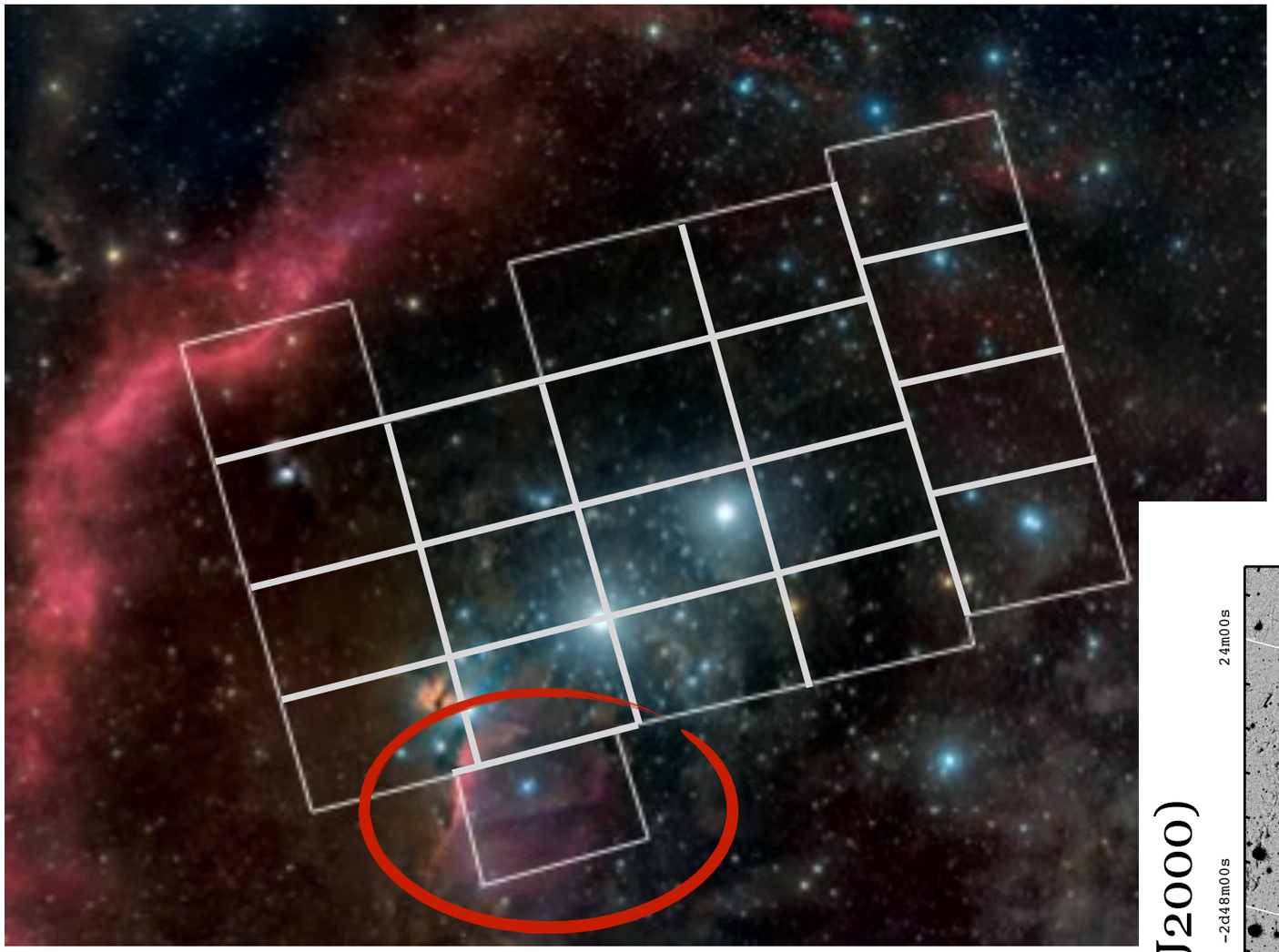


VISTA/VIRCAM

Science Verification Data

ZYJHKs filters

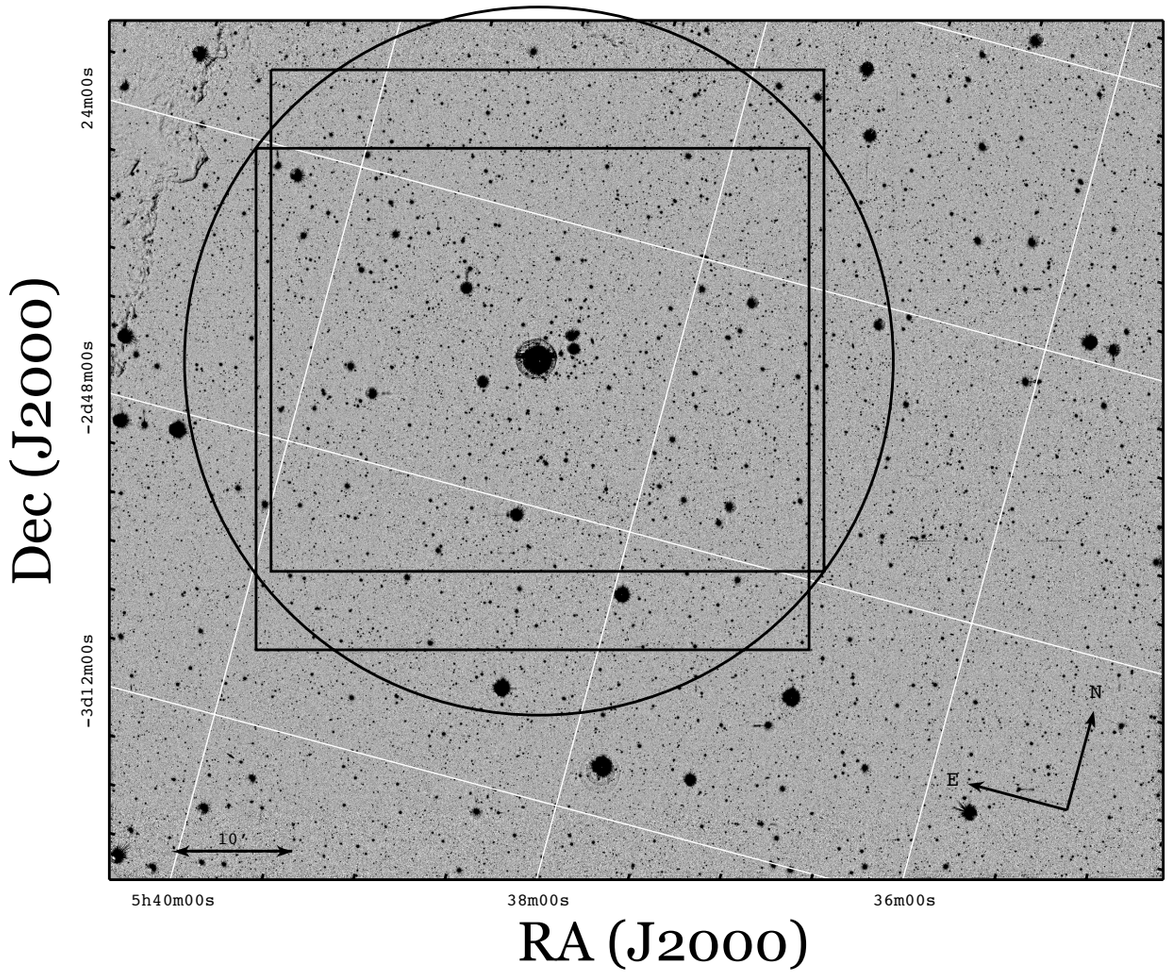
VISTA Orion survey



VISTA/VIRCAM

Science Verification Data

ZYJHKs filters



Z comp ~ 22.6 mag (~6 M_{Jup}, 3Myr)

J comp ~ 21.0 mag (~3.7 M_{Jup}, 3Myr)

~ 2800 arcmin²

VISTA photometric selection

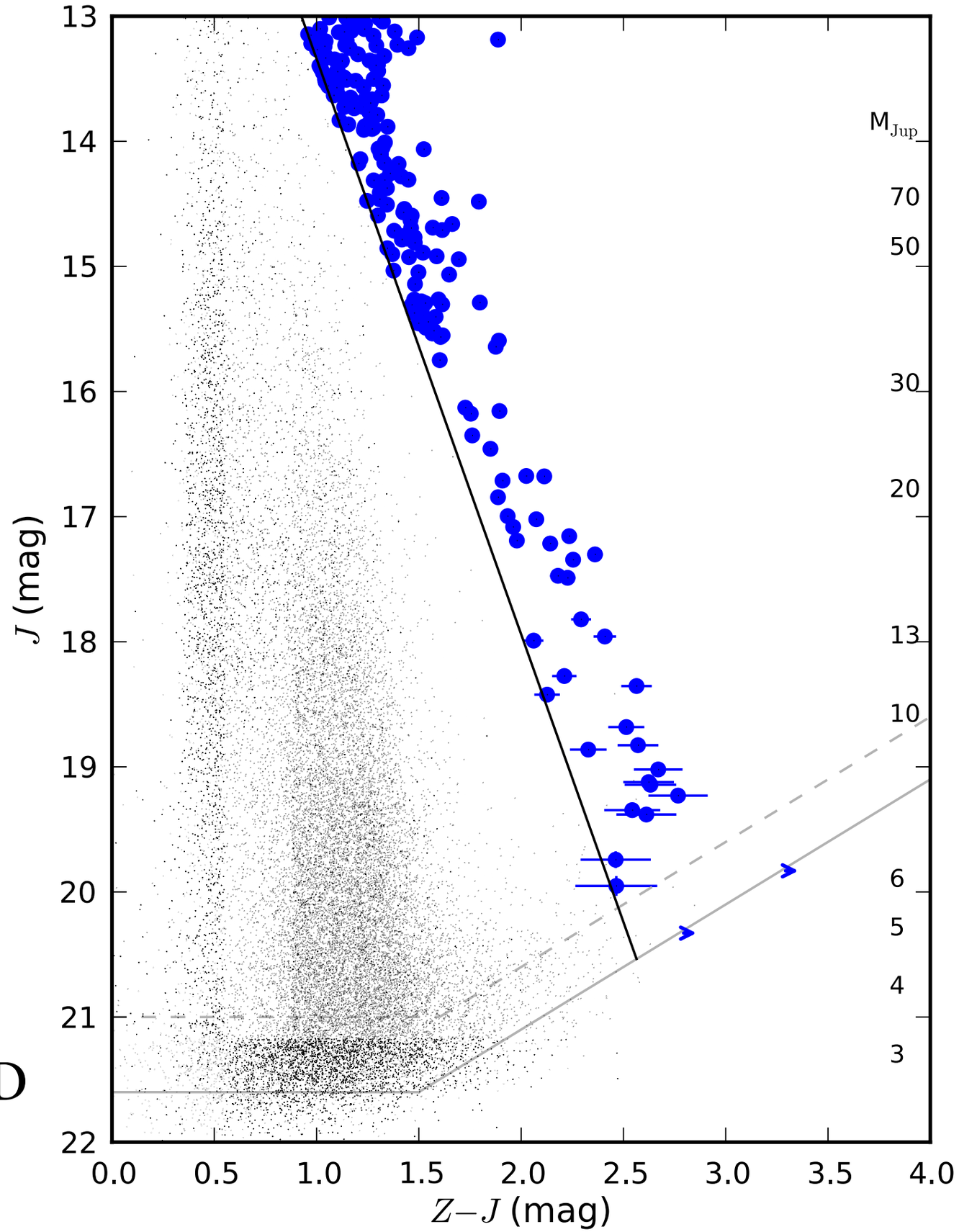
210 photometric candidates

J = 13 - 21 mag

0.25 - 0.006 $M_\odot$

Cluster coverage

Masses: NextGen / DUSTY / COND models (Lyon group)



VISTA photometric selection

210 photometric candidates

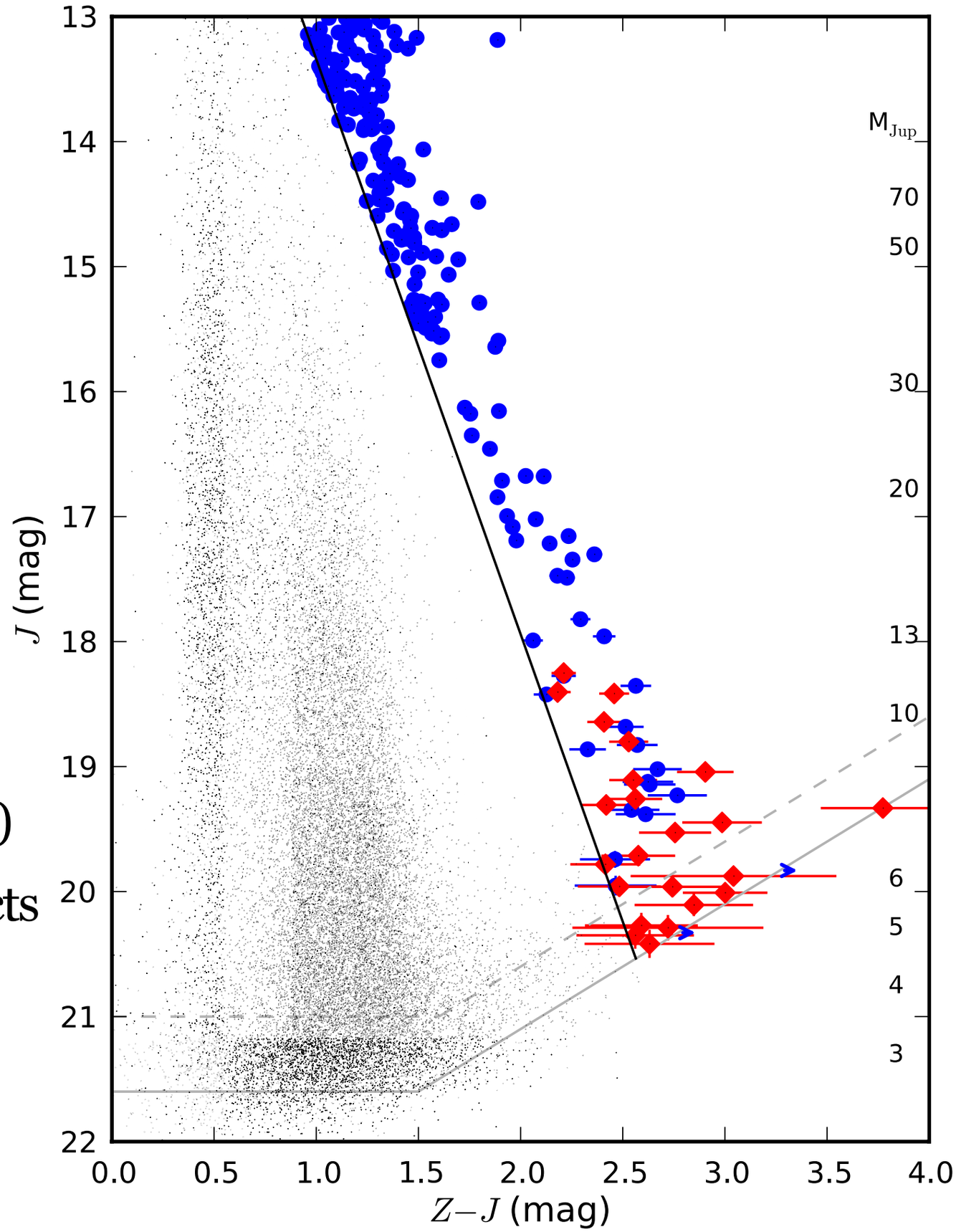
VISTA has doubled the known cluster planetary mass population

J = 13 - 21 mag

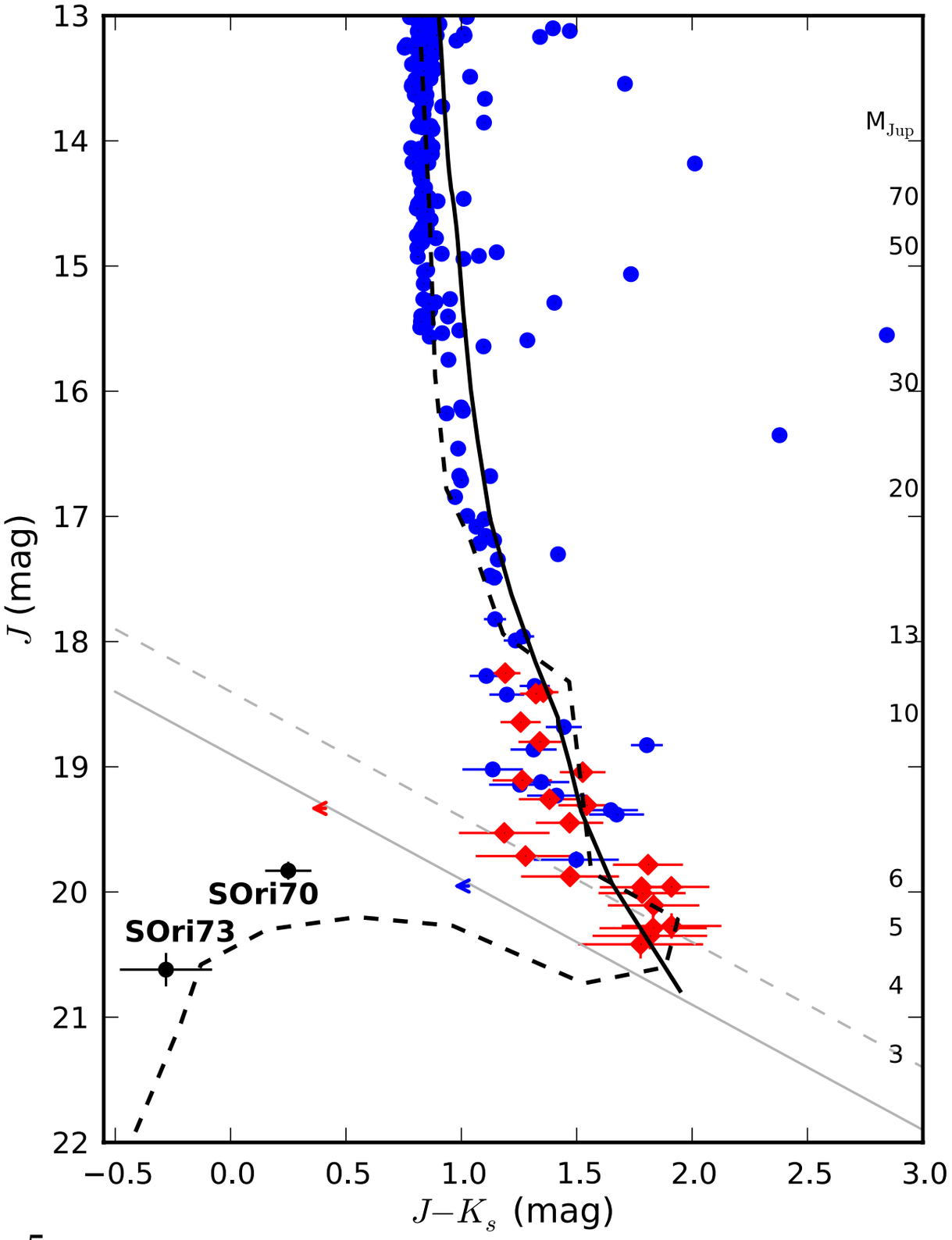
0.25 - 0.006 $M_\odot$

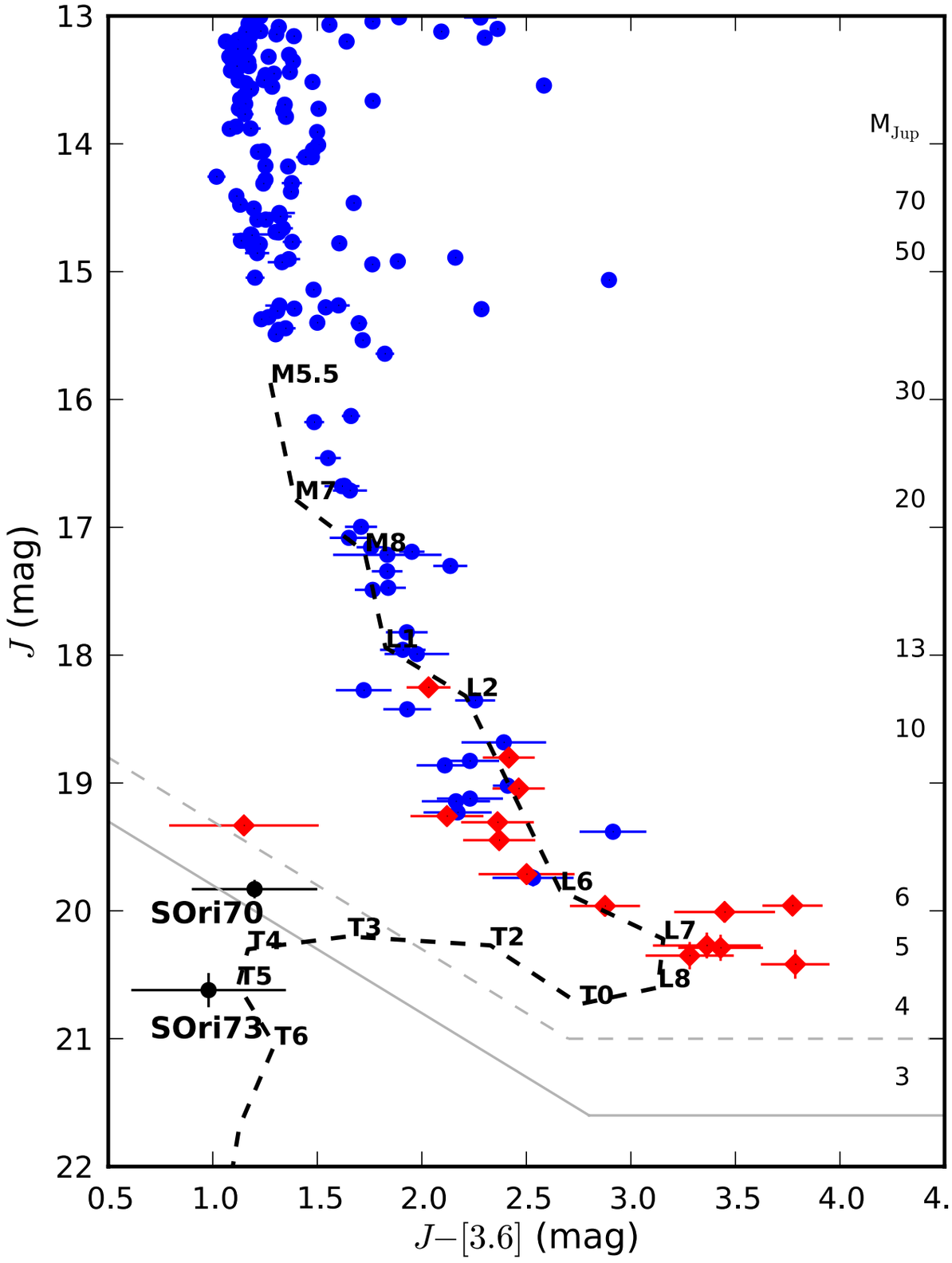
- Low mass stars (0.25 $M_\odot$-75 M_{Jup})
- Brown dwarfs (~75 M_{Jup}-13 M_{Jup})
- Planetary mass objects (M<13 M_{Jup})

Masses: NextGen / DUSTY / CON models (Lyon group)

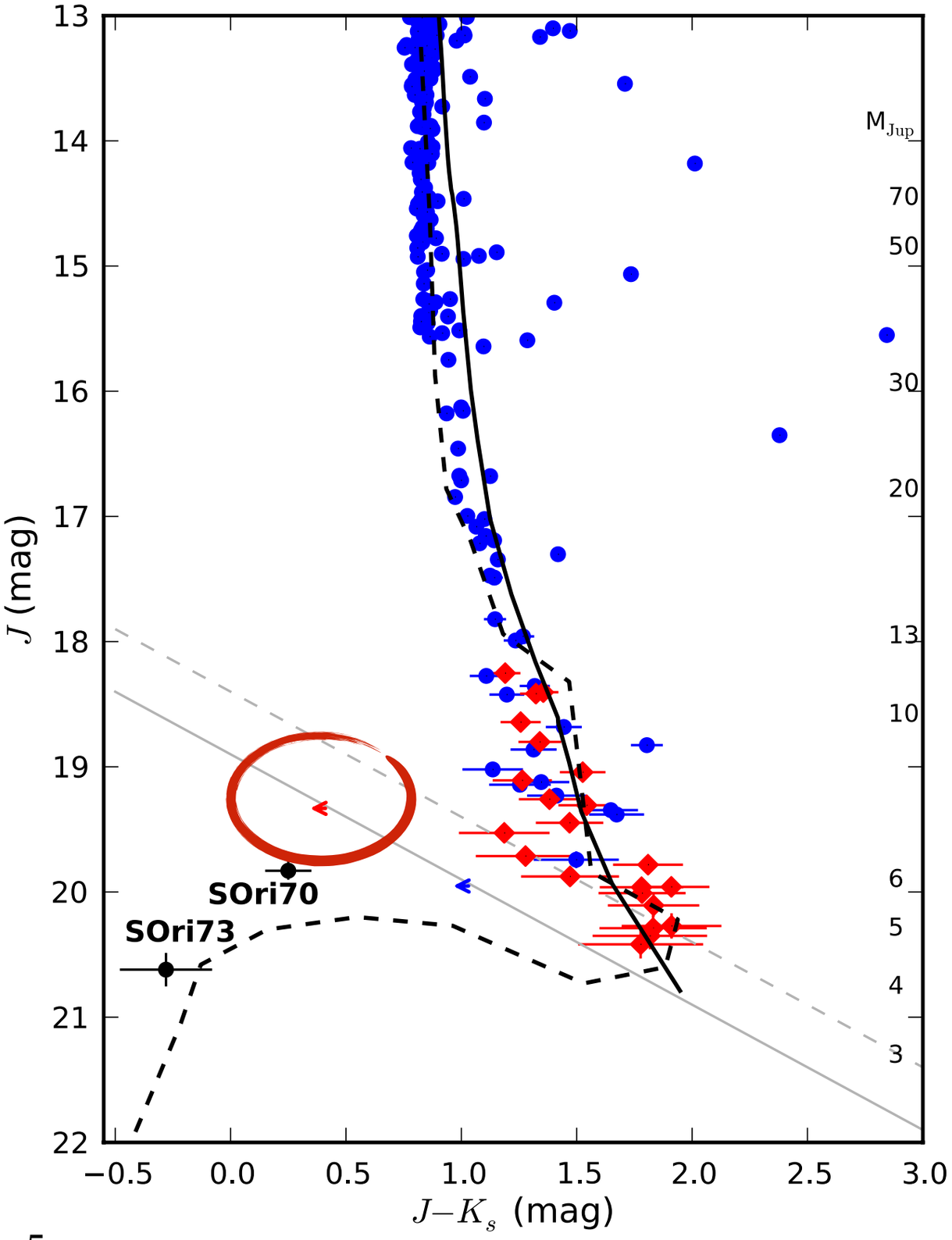


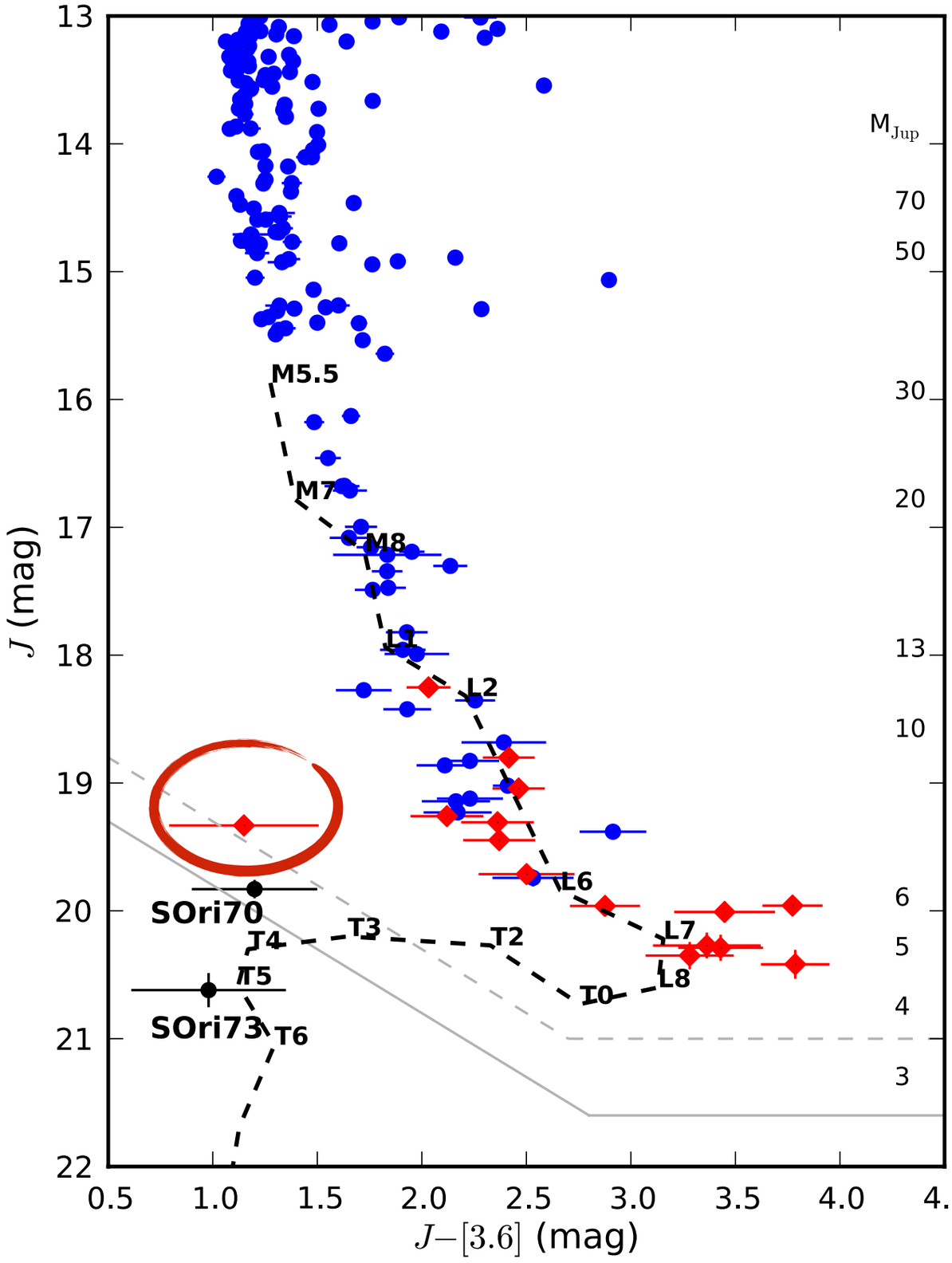
Other VISTA colors





Other VISTA colors



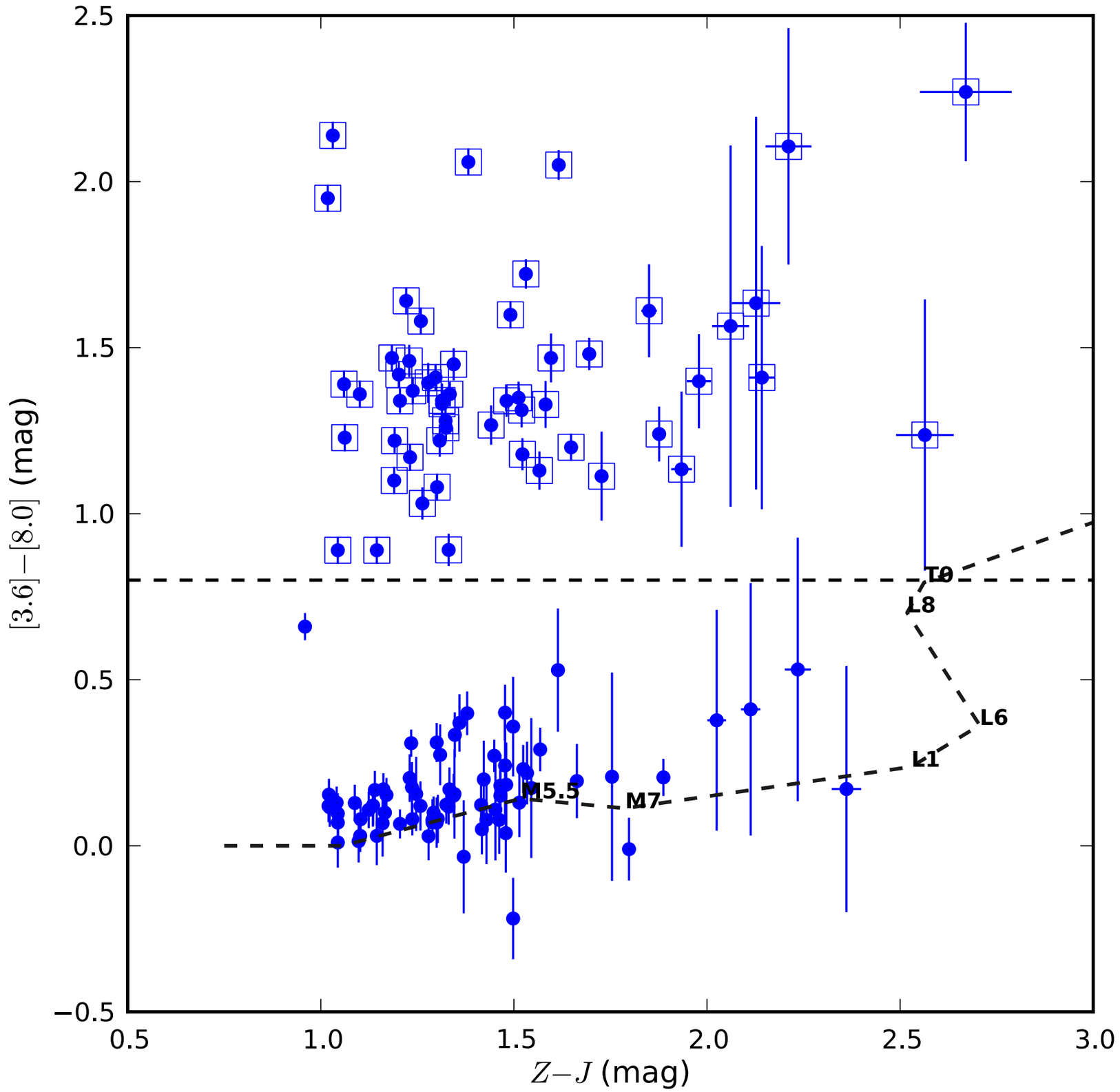


Infrared flux excesses: disks

Based on
infrared excesses at
8.0 μm

Low mass stars
41± 8 %

Brown dwarfs
39 ± 9 %



Infrared flux excesses: disks

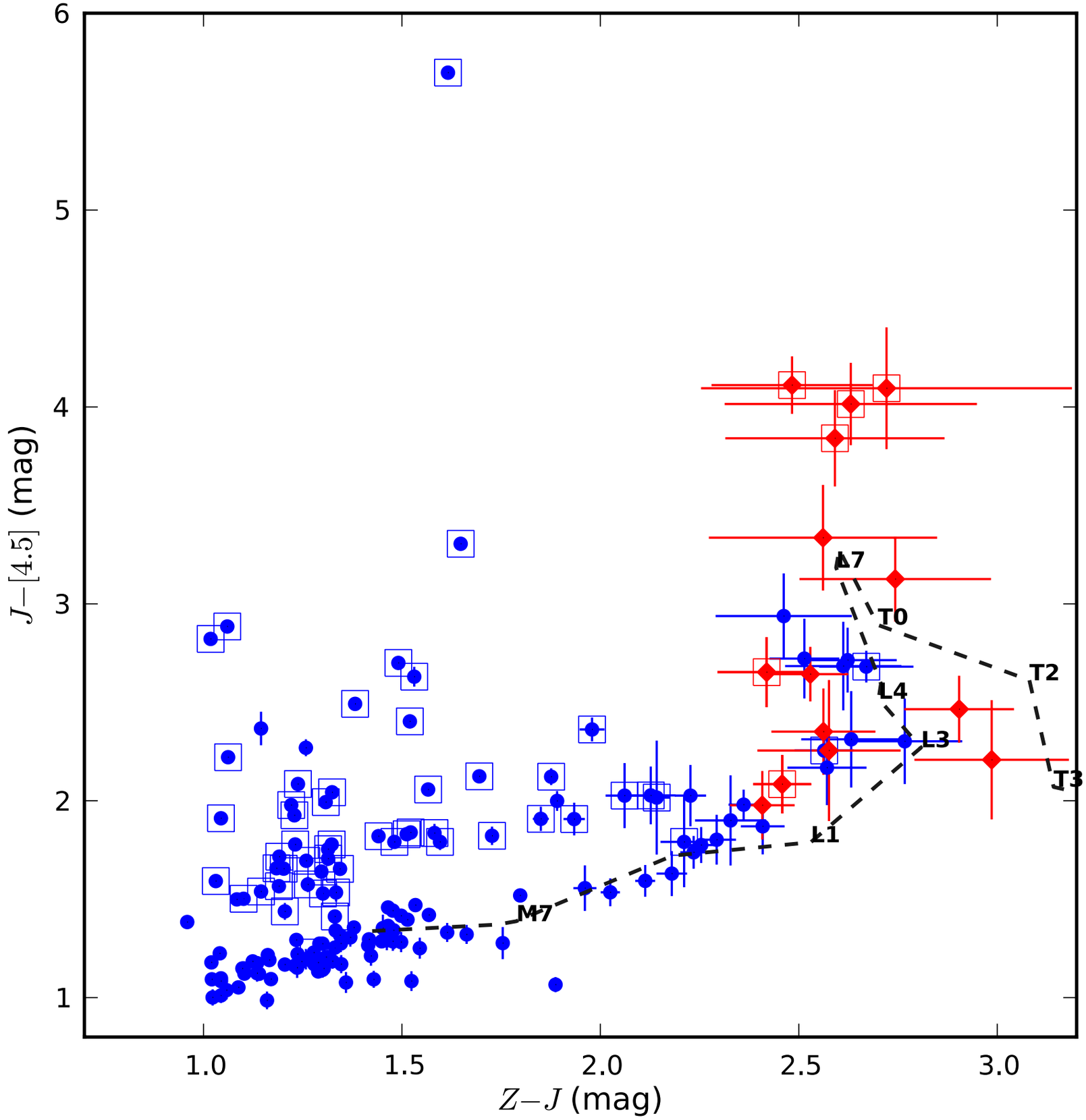
Based on infrared excesses at

4.5 μm

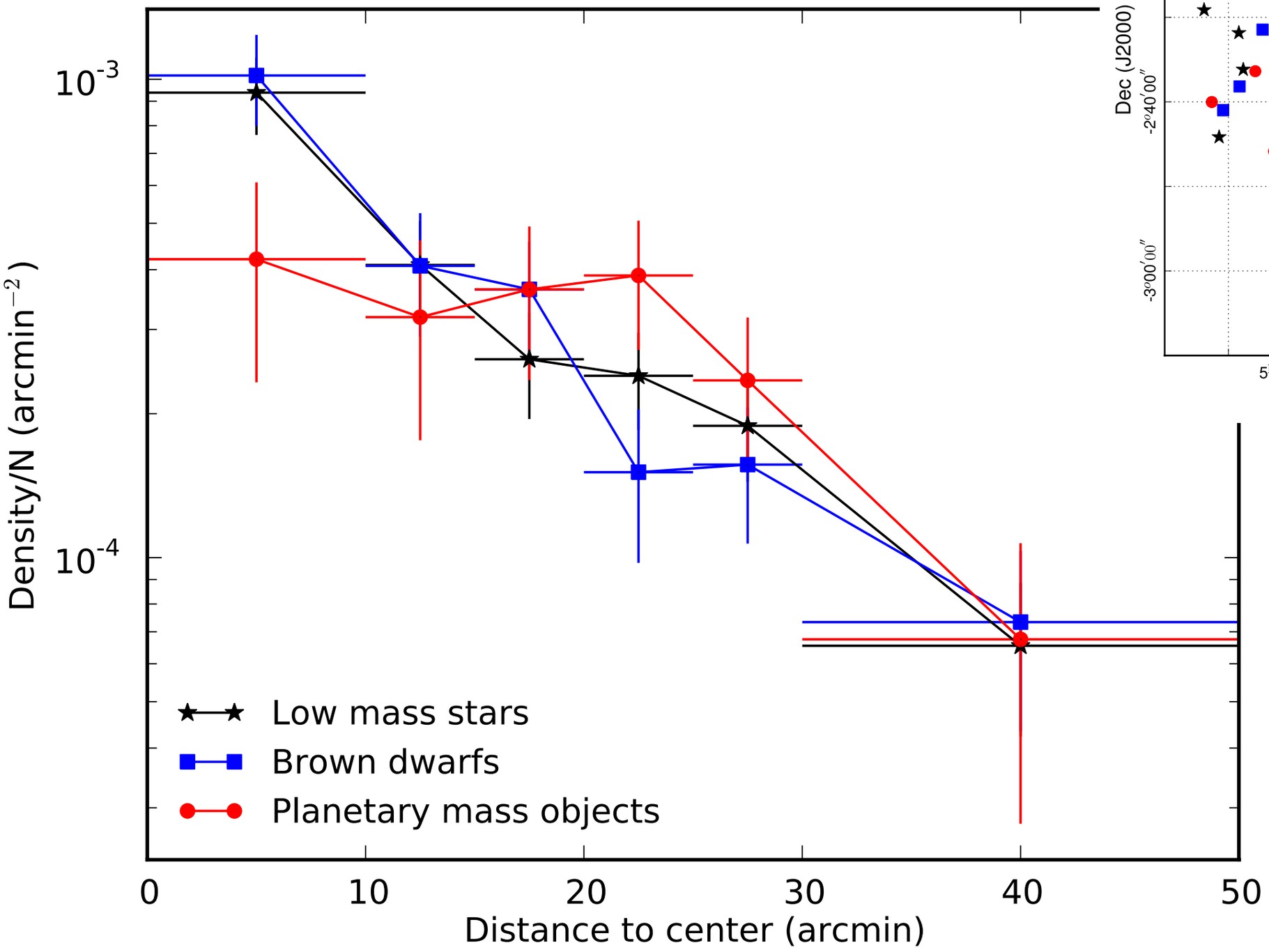
Extension to planetary mass regime
~ 31 ± 11 %

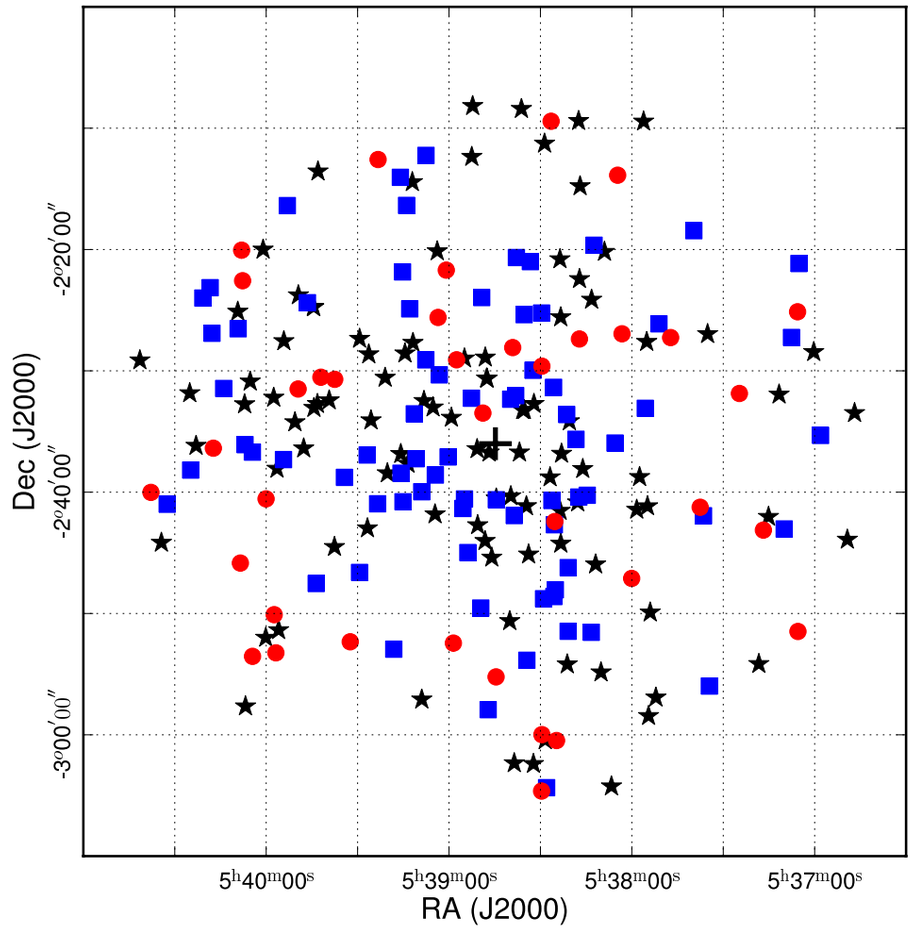
Low mass stars
42± 7 %

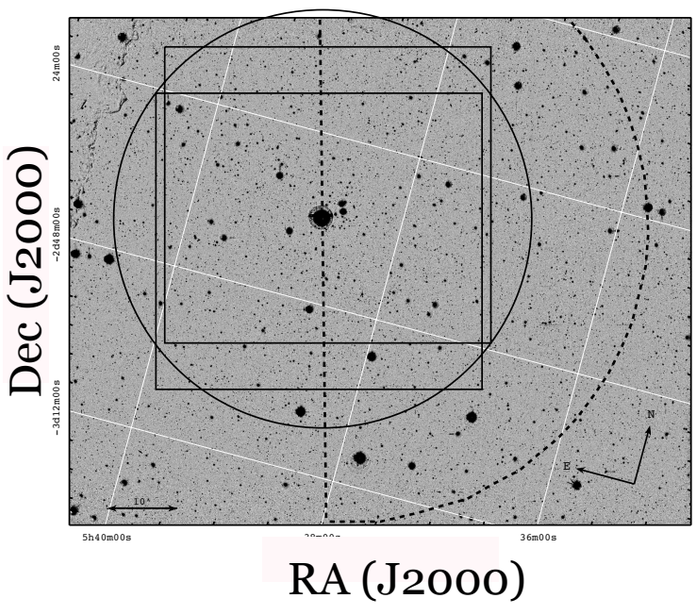
Brown dwarfs
36 ± 8 %



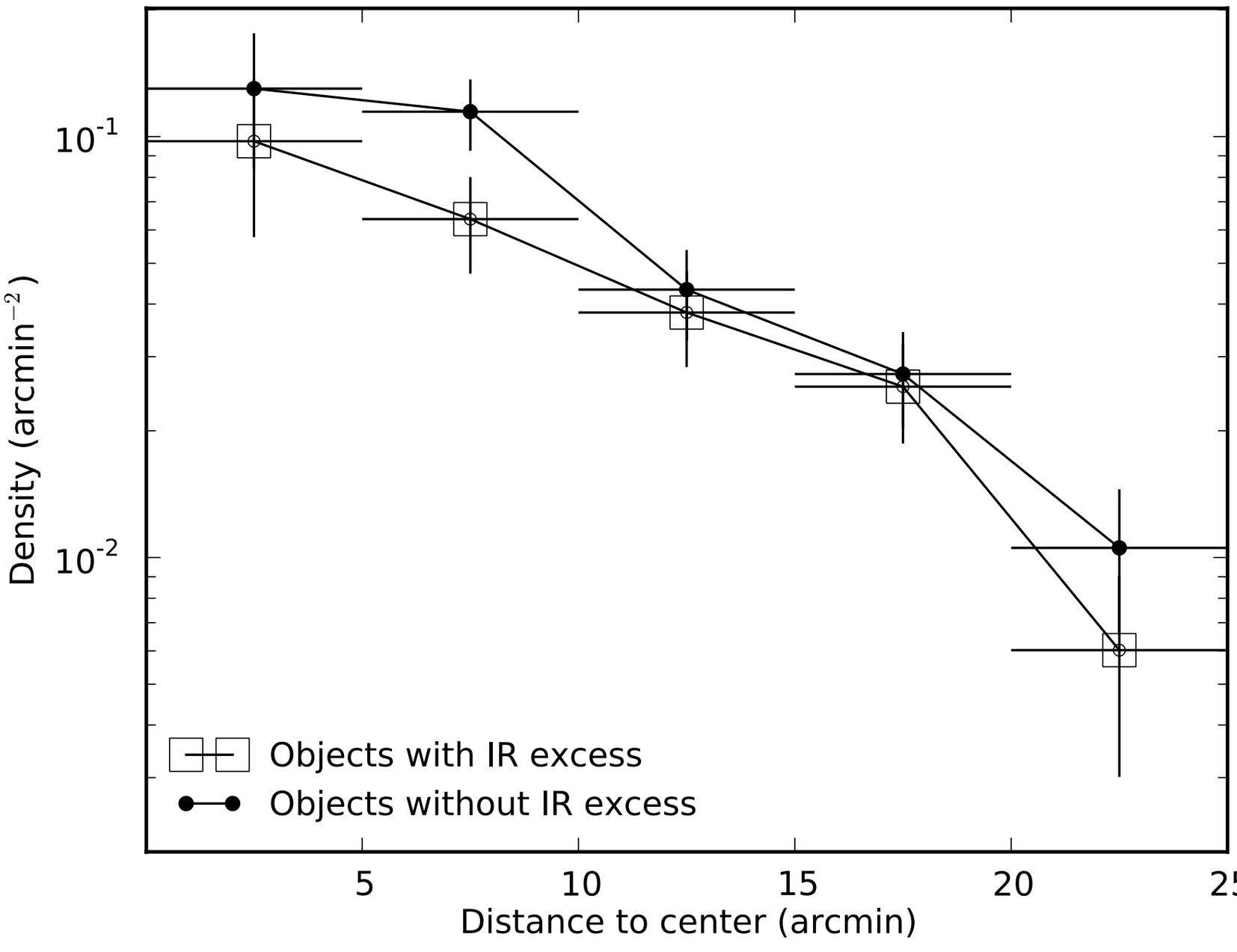
Spatial distribution



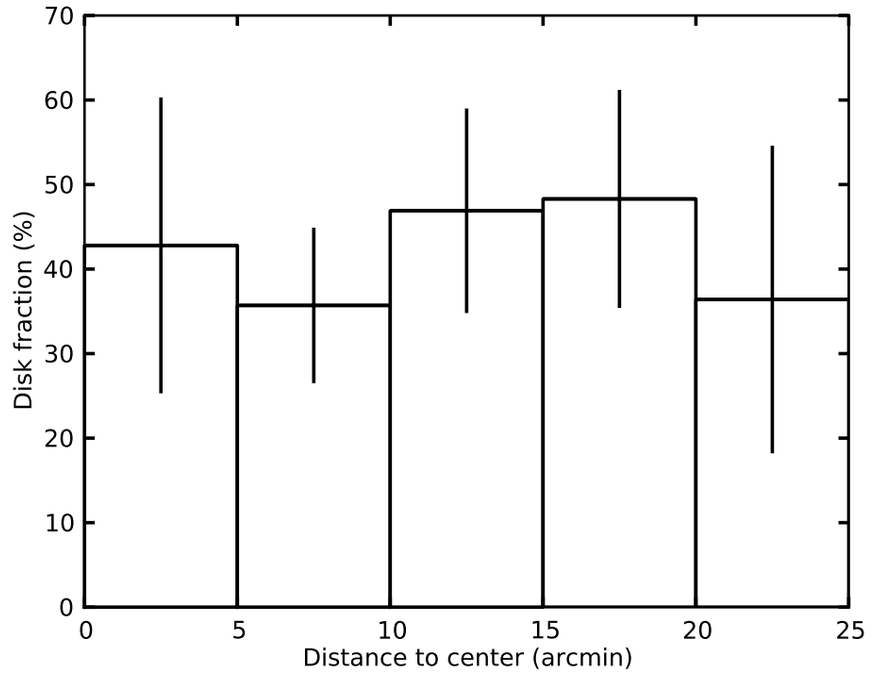




Spatial distribution: disks

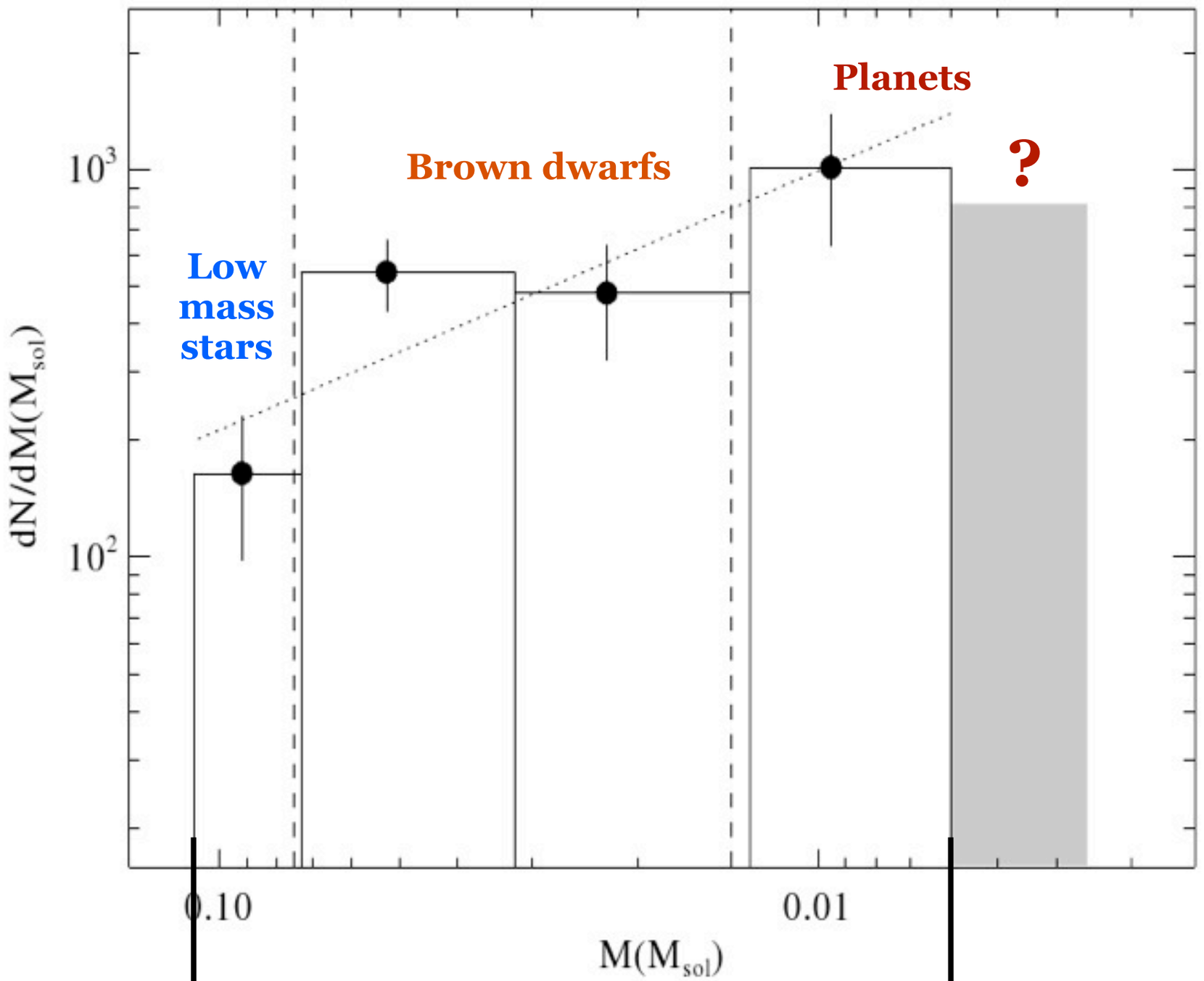


No spatial segregation of objects with and without disks



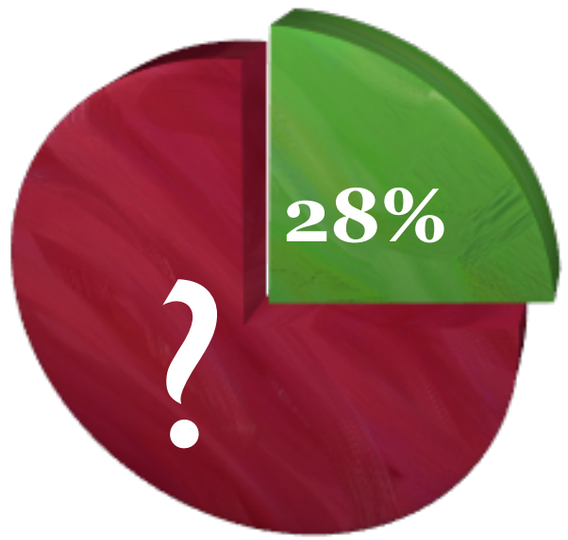
σ Orionis substellar mass function / literature

Bihain et al. 2009



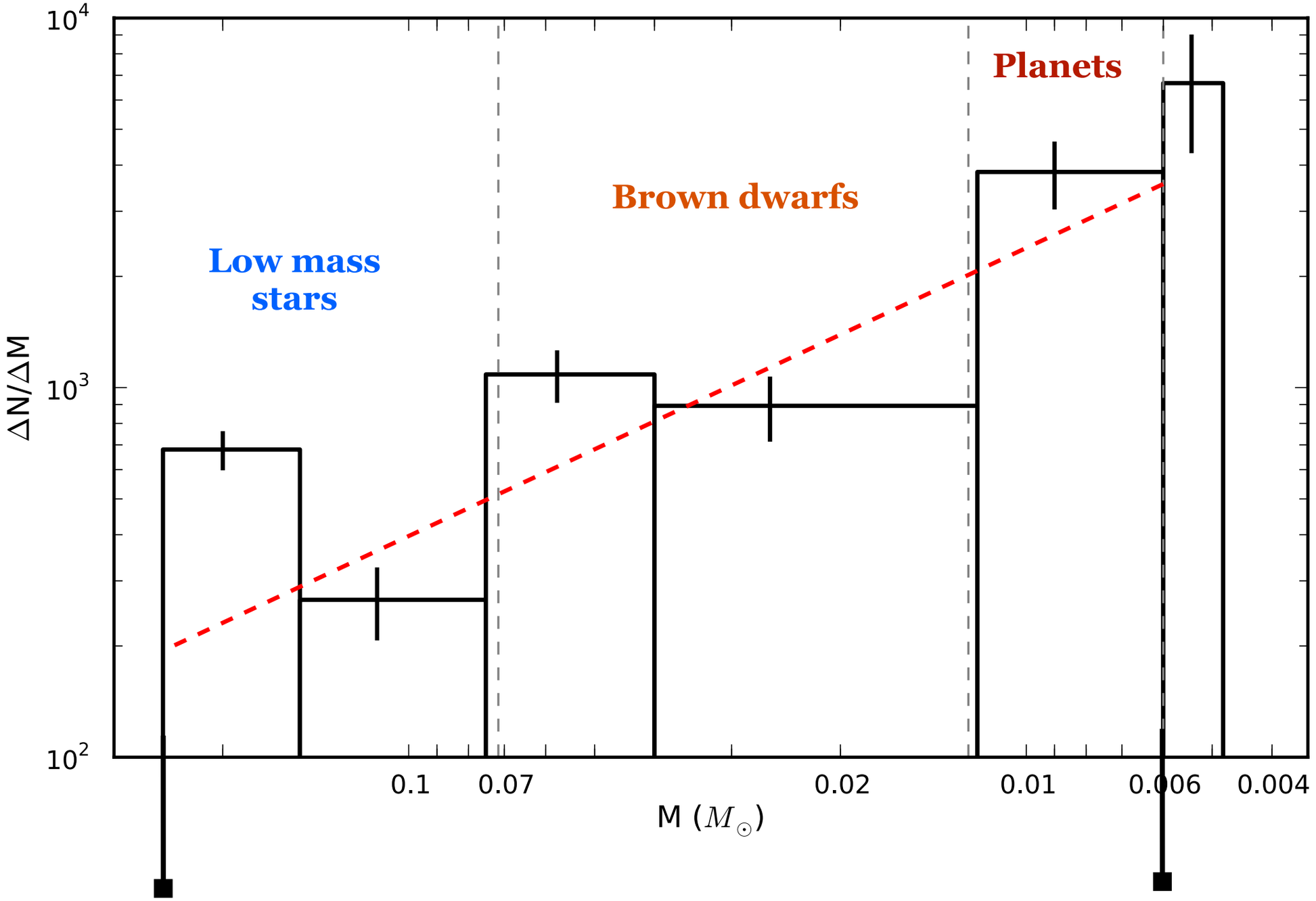
$$\frac{dN}{dM} \sim M^{-\alpha}$$

$$\alpha \simeq 0.4 - 1.0$$



Spatial cluster coverage

σ Orionis substellar mass function / VISTA



$$\frac{dN}{dM} \sim M^{-\alpha}$$

$$\alpha = 0.65 \pm 0.2$$

3 Myr

~ 90%

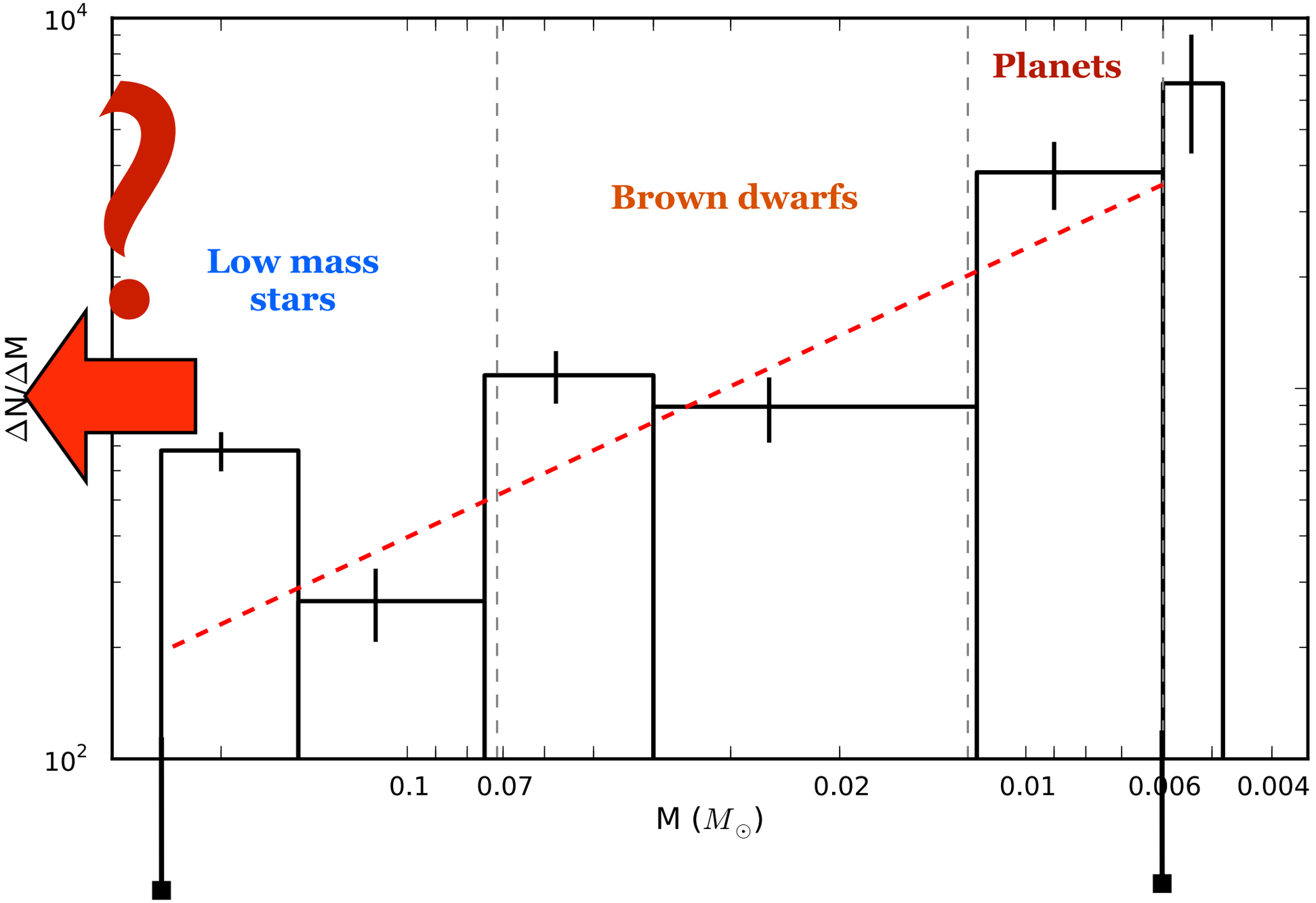
Cluster coverage

0.25 M⊙

0.006 M⊙

$ZJ_{\rm comp} \sim 20.0$ mag

σ Orionis substellar mass function / VISTA



$$\frac{dN}{dM} \sim M^{-\alpha}$$

$$\alpha = 0.65 \pm 0.2$$

3 Myr

~ 90%

Cluster coverage

0.25 M⊙

0.006 M⊙

$ZJ_{\rm comp}$ ~ 20.0 mag

σ Orionis stellar and substellar mass function / preliminary

Mayrit catalog

(Caballero et al. 2008)

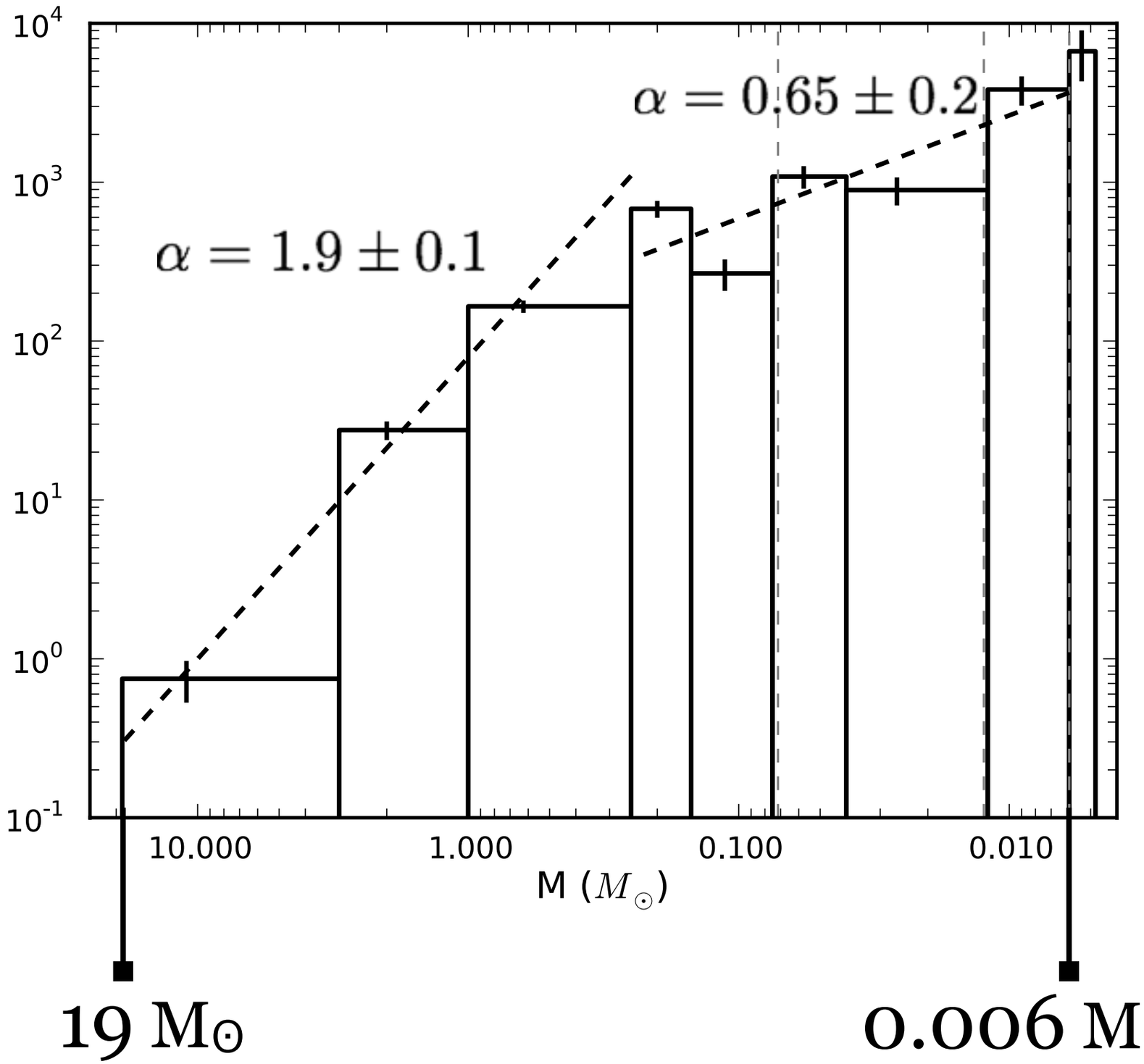
70% of the Mayrit sources have youth features

Cluster coverage

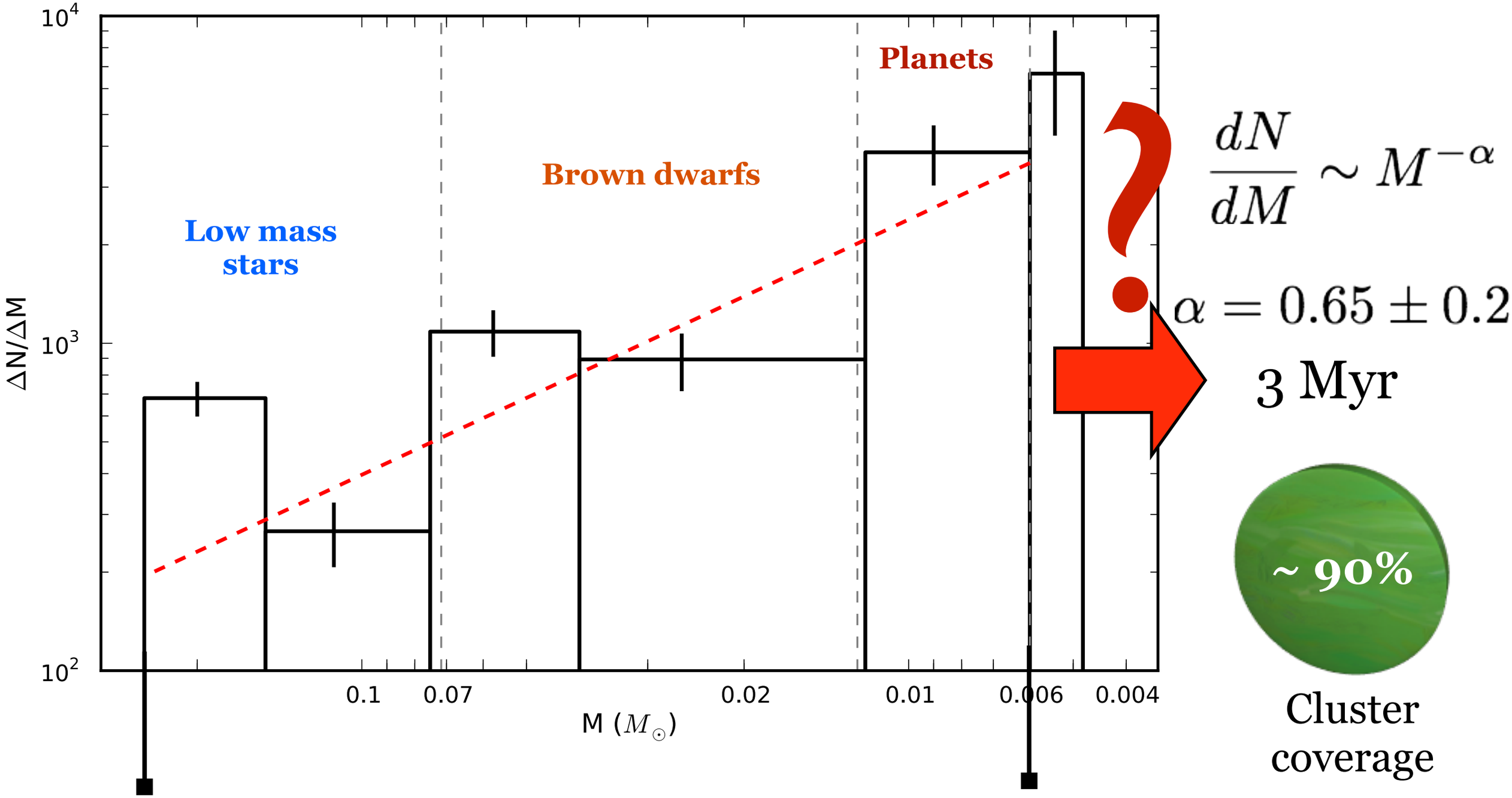
Infrared excesses at 8.0 μm

Stars 45± 6 %

(19-0.25 M⊙)



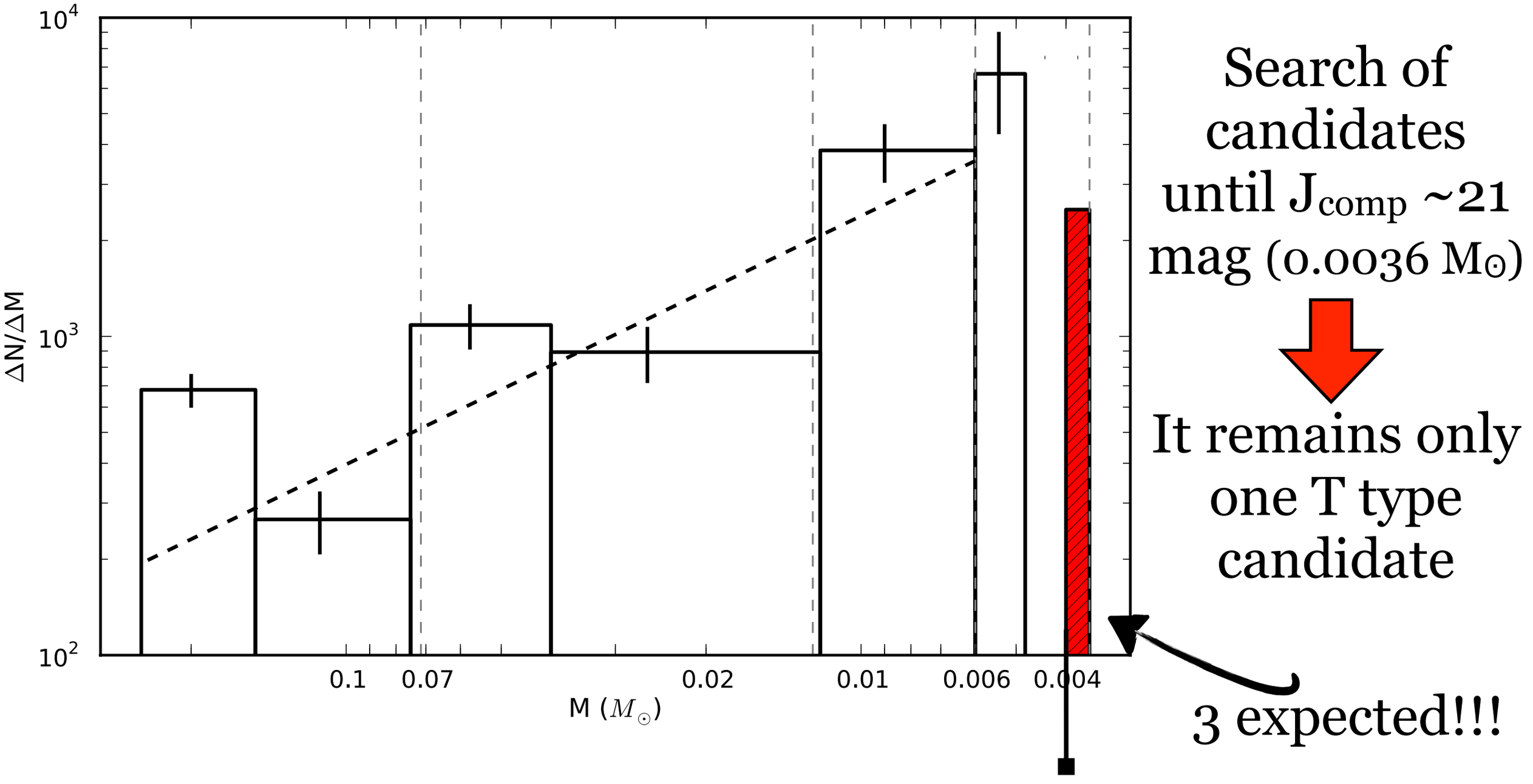
σ Orionis substellar mass function / VISTA



Cluster coverage

$ZJ_{\rm comp} \sim 20.0$ mag

σ Orionis substellar mass function: reaching the end of the mass function?



T type dwarfs in σ Orionis by models: 0.004 $M_\odot$

Summary

- VISTA data have covered the entire cluster area.
- New planetary mass candidates doubles the known population in this mass regime. One new T type candidate.
- About 40% of stars and brown dwarfs present infrared excesses at 4.5 and 8.0 μm. At 4.5 μm infrared excesses in the planetary mass domain are ~30%.
- There is no spatial segregation between objects with and without disks.
- The spatial distribution of low mass stars and brown dwarfs is similar. The radial profile in the planetary mass regime has a flattening within the first 20 arcmin.
- We present the cluster mass function from 19 $M_{\odot}$ down to ~6 M_{Jup}. We found α=1.9±0.1 (19 - 0.25 $M_{\odot}$) and α=0.65±0.2 (0.25 $M_{\odot}$ - 6 M_{Jup}).

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