

The VISTA Survey in Orion

Monika Petr-Gotzens
(ESO - Garching, Germany)

+

Orion SV team:



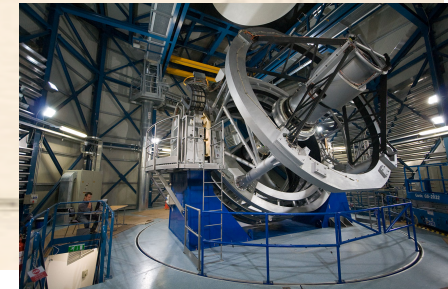
Overview of VISTA



❖ **Dedicated to survey observ.:**
6 Public surveys (started ~2.5yrs ago)

❖ **Data Reduction performed via VDFS
pipeline at Cambridge - CASU**
(similar to UKIDSS/WFCAM data reduction pipeline)

❖ **Science verification before the start of
survey operations → Survey of Orion!**



VISTA Orion Survey

~ 30 square degrees

Main goal: uncover & study young stellar/substellar objects

Filters: Z, Y, J, H, Ks imaging within the closest possible time (typically within 2 hours for each tile)

Data Reduction performed via VDFS pipeline at CASU

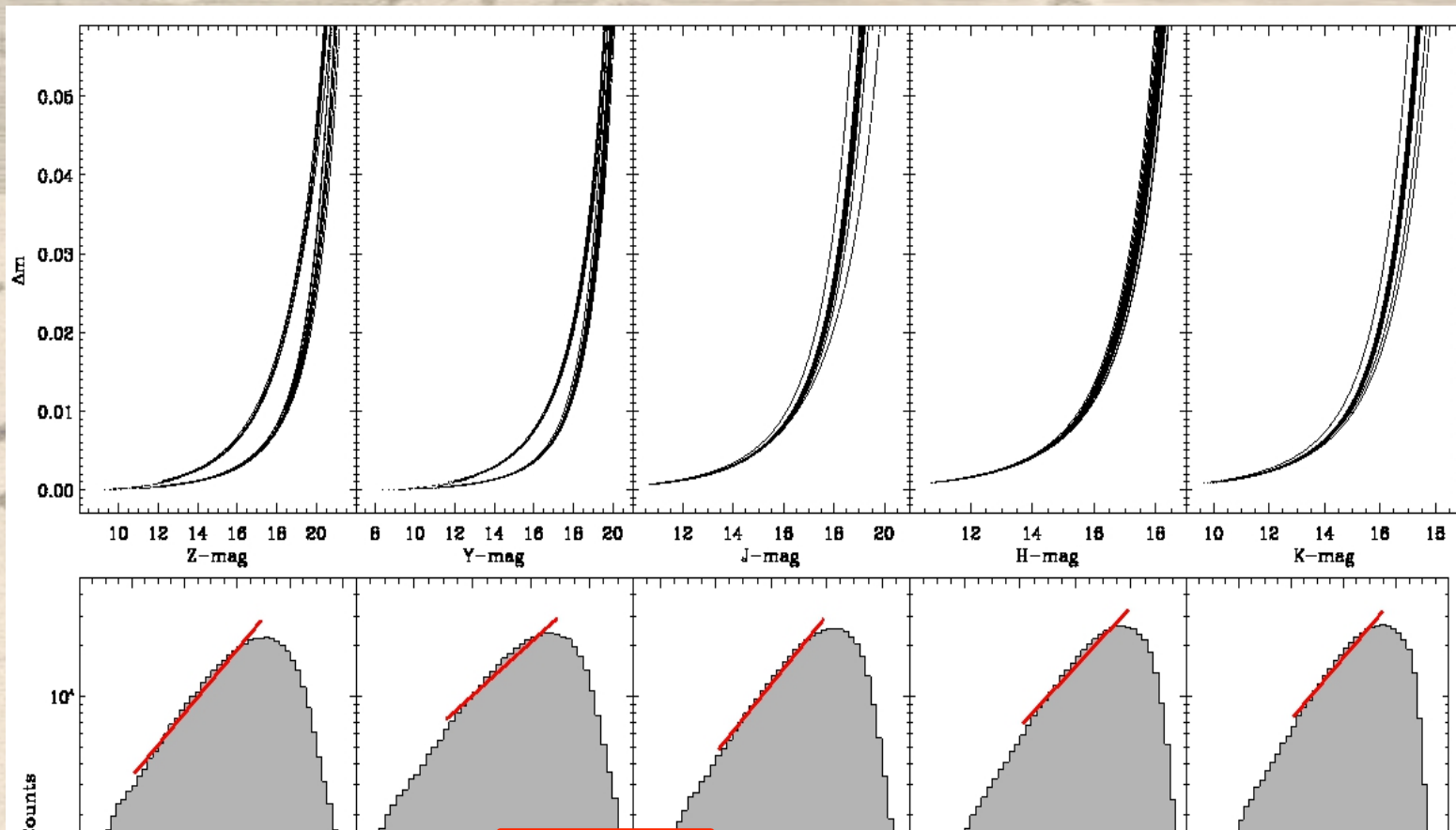
stacked images and mosaics
catalogs with astrom and
phot calibrated sources

~3.2 million sources

Data access via:

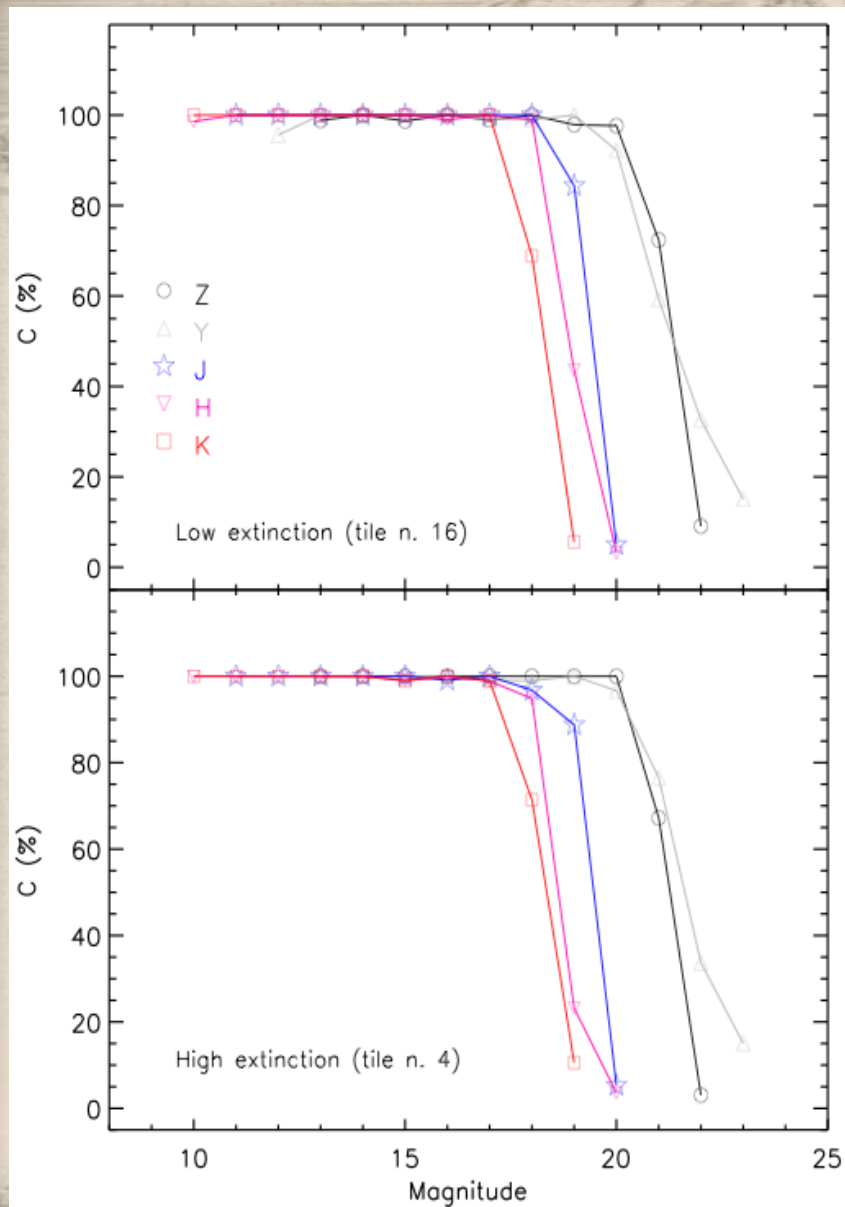
http://www.eso.org/sci/activities/vistasv/VISTA_SV.html

VISTA Orion Survey: Performance - Photometry



Filter	mag-Sat.	mag-5 σ	mag-3 σ	mag-C
Z	9.5	22.5	23.0	19.2
Y	9.5	21.2	21.8	18.7
J	10.5	20.4	21.0	18.4
H	10.5	19.5	20.1	17.6
K	9.5	18.5	19.0	17.5

VISTA Orion Survey: Performance - Completeness



DAOPHOT/Addstar
(Stetson 1987, PASP 99, 191)

Assuming: $D=414$ pc
Age ≈ 1 Myr

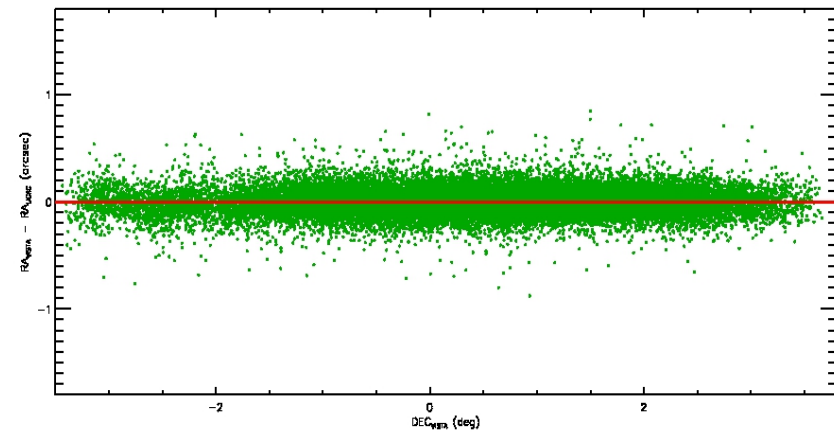
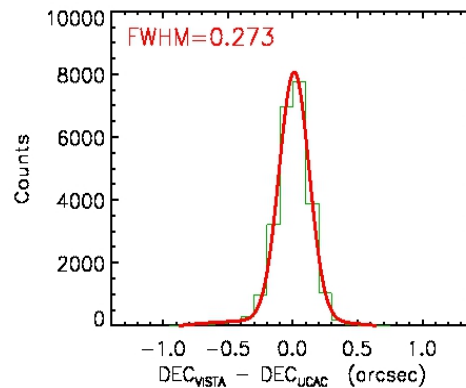
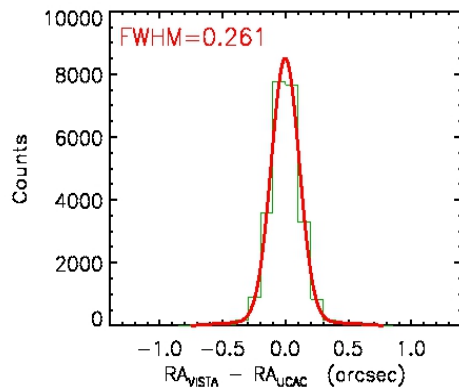
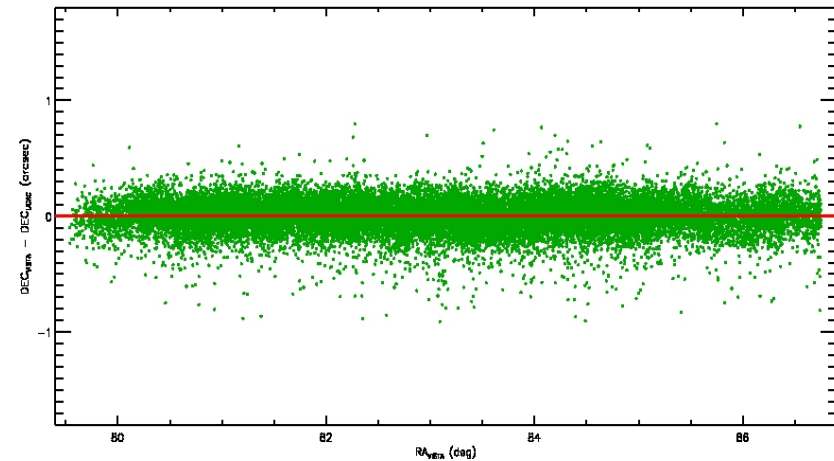
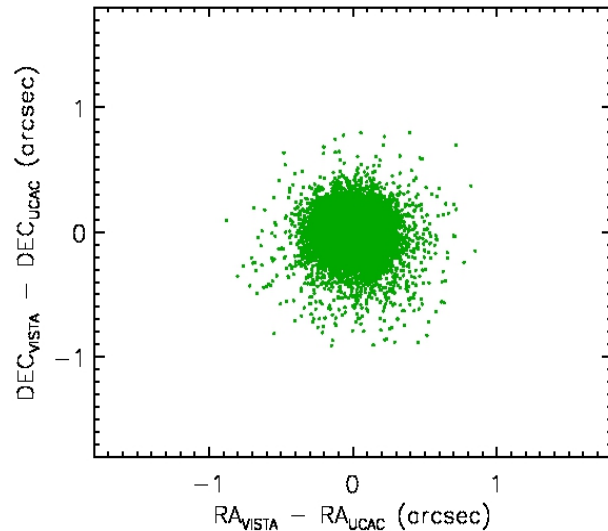


Filter	C(90%)	Mass (M_{\odot})
Z	20.3	0.005
Y	20.1	0.005
J	18.8	0.006
H	18.2	0.005
K	17.2	0.006

Ideal mass limit ($A_v=0$)

VISTA Orion Survey: Performance - Astrometry

UCAC-3 catalog (Zacharias et al. 2009), absolute accuracy 15-70 mas depending on mag
Matched sources 24550 (matching radius 1 arcsec, only stellar objects)

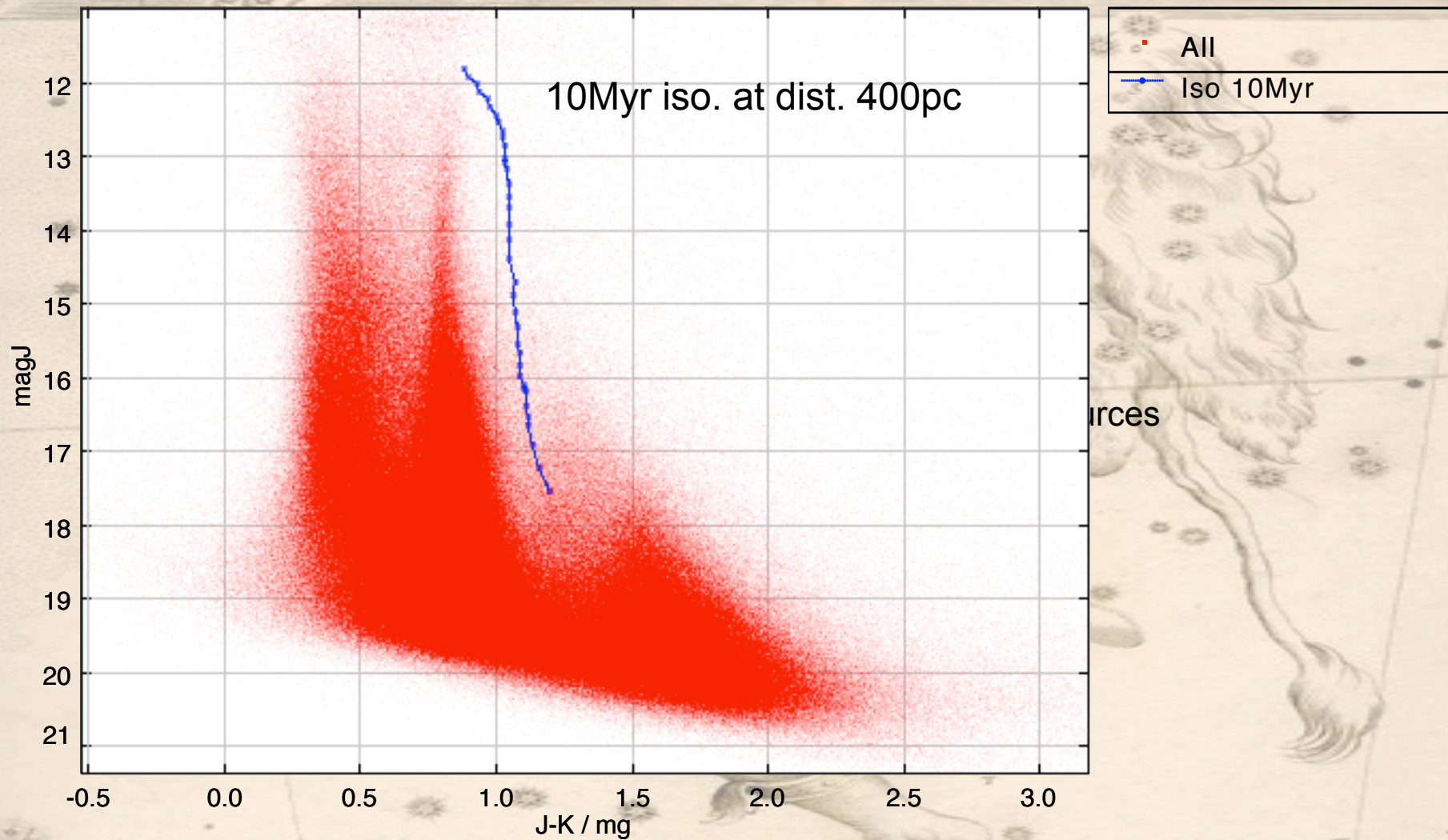


Accuracy relative to UCAC-3 $\approx 0.27''$

No distortion!

VISTA Orion Survey: CMD

All survey sources (3.2×10^6)

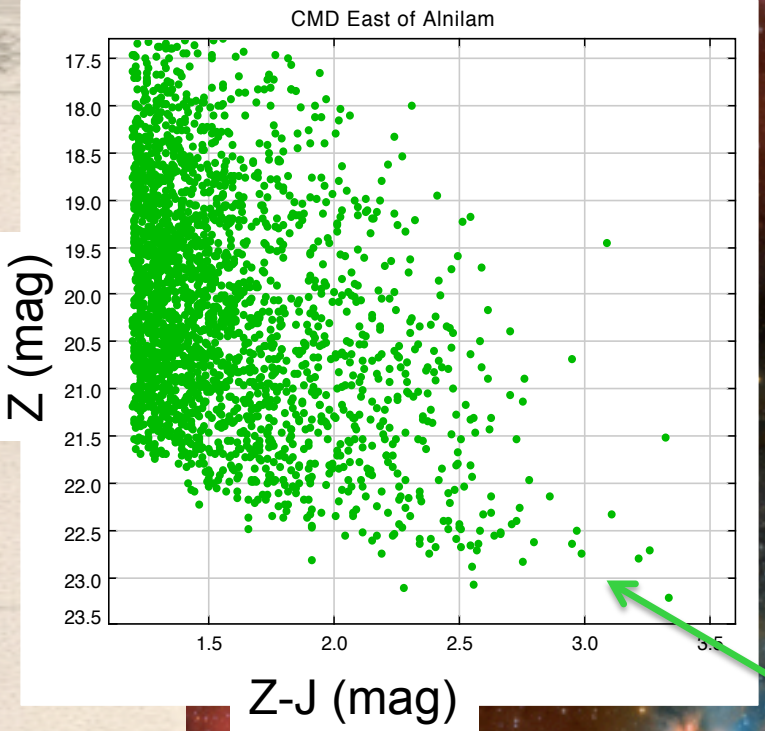
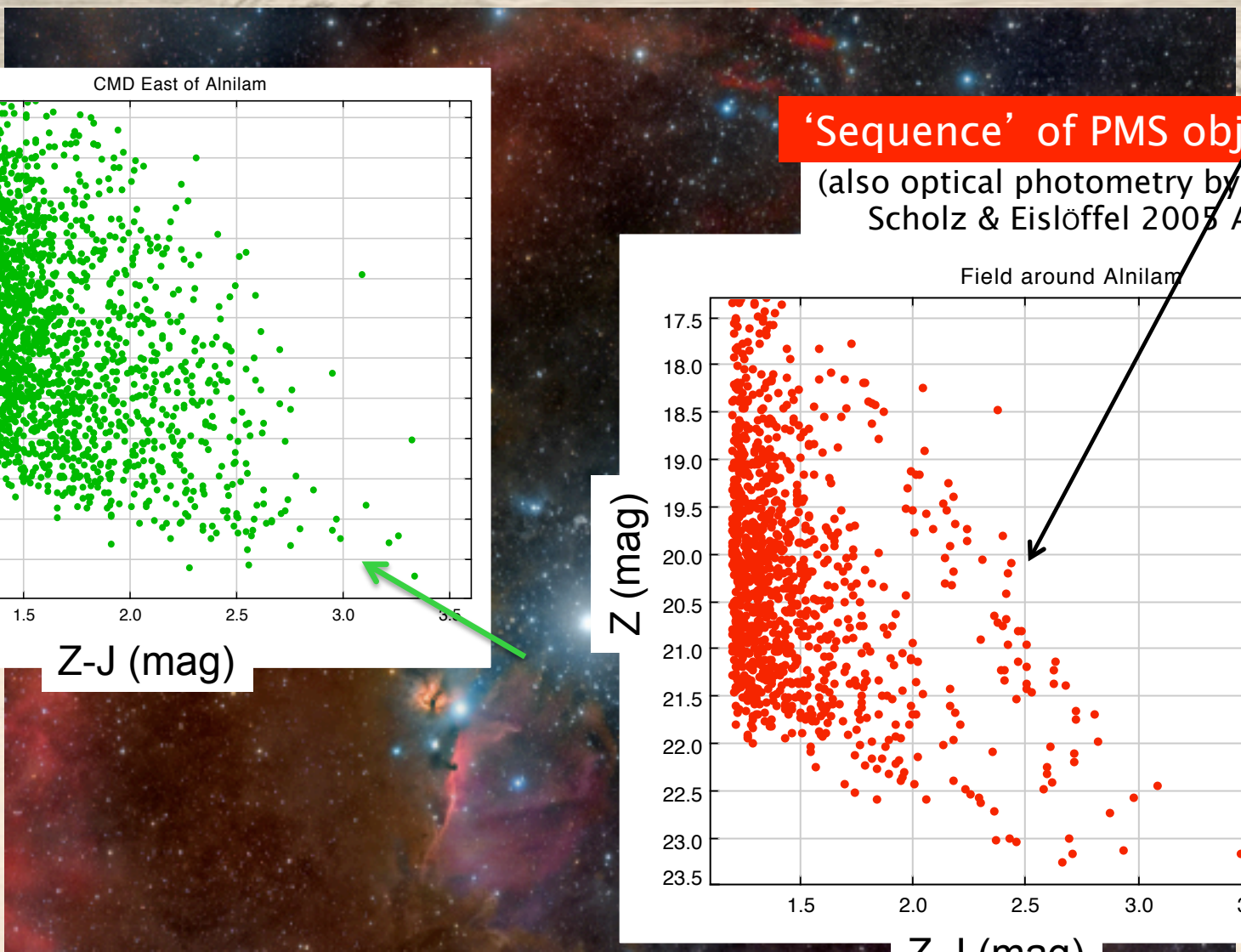




**VISTA Orion Survey:
Photometric selection of young VLM
stars and brown dwarfs**

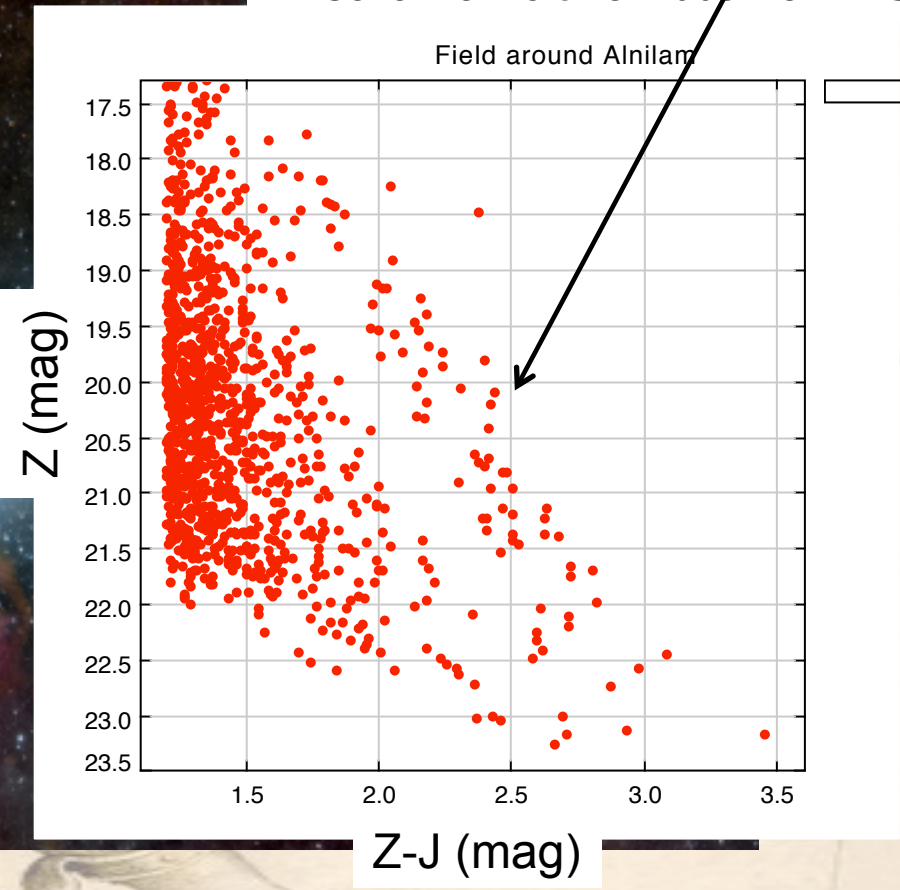
- 1. Cluster of young VLM stars and BDs
in the vicinity of Alnilam (epsilon Ori)**
- 2. Sigma Ori Cluster**
- 3. New young stellar objects in NGC2068/71**

VISTA Orion Survey: Alnilam Cluster

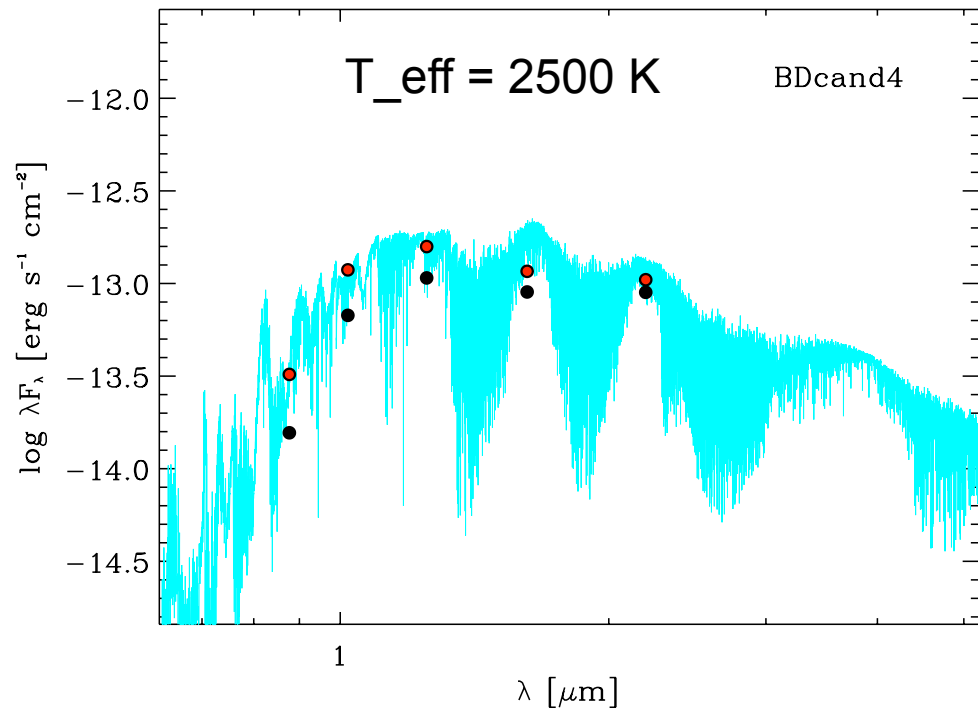
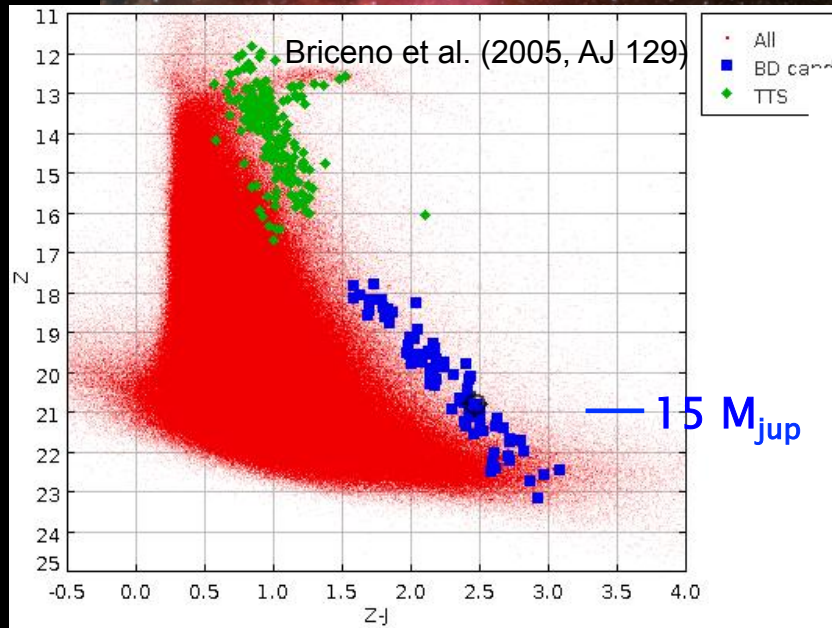


'Sequence' of PMS objects!

(also optical photometry by e.g. Scholz & Eislöffel 2005 A&A 429)



VISTA Orion Survey: Alnilam Cluster



High abundance of sub-stellar mass objects !? But Age ?

Star formation process close to massive stars may produce numerous brown dwarfs!

(Whitworth & Zinnecker 2004 A&A 427, Hester et al. 1996 AJ 111)

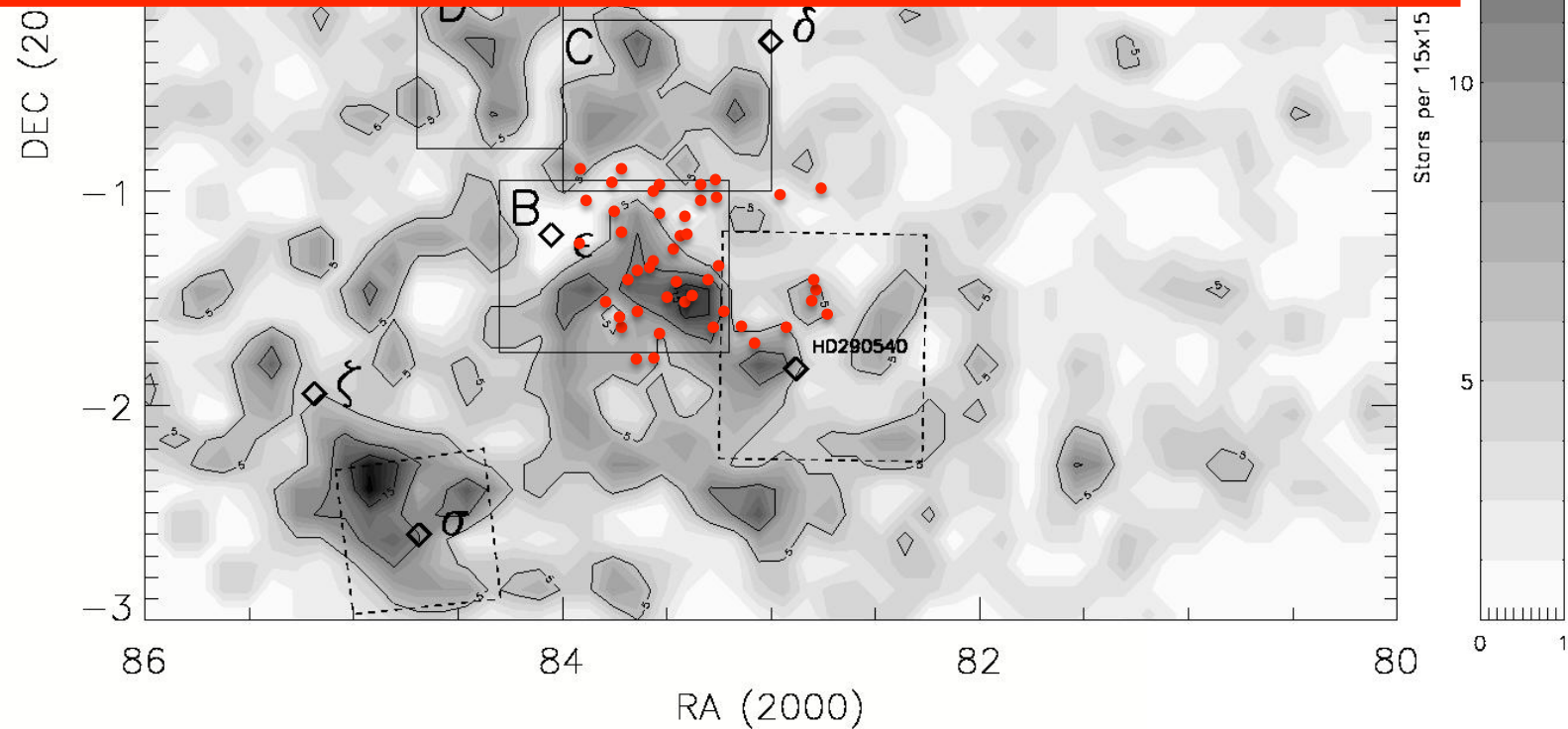
VISTA Orion Survey: Alnilam Cluster

Contours: density plot of variable stars → young objects!

Briceno et al. (2005, AJ 129)

Red dots: BD candidates of the Alnilam Cluster

good correlation

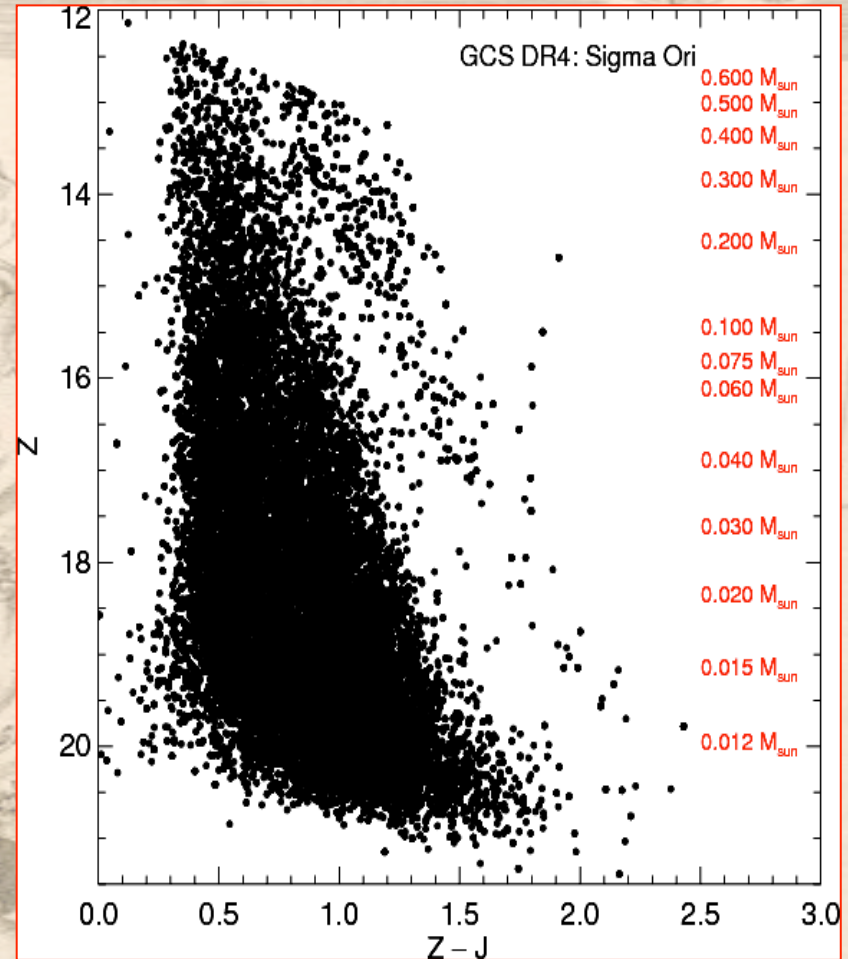
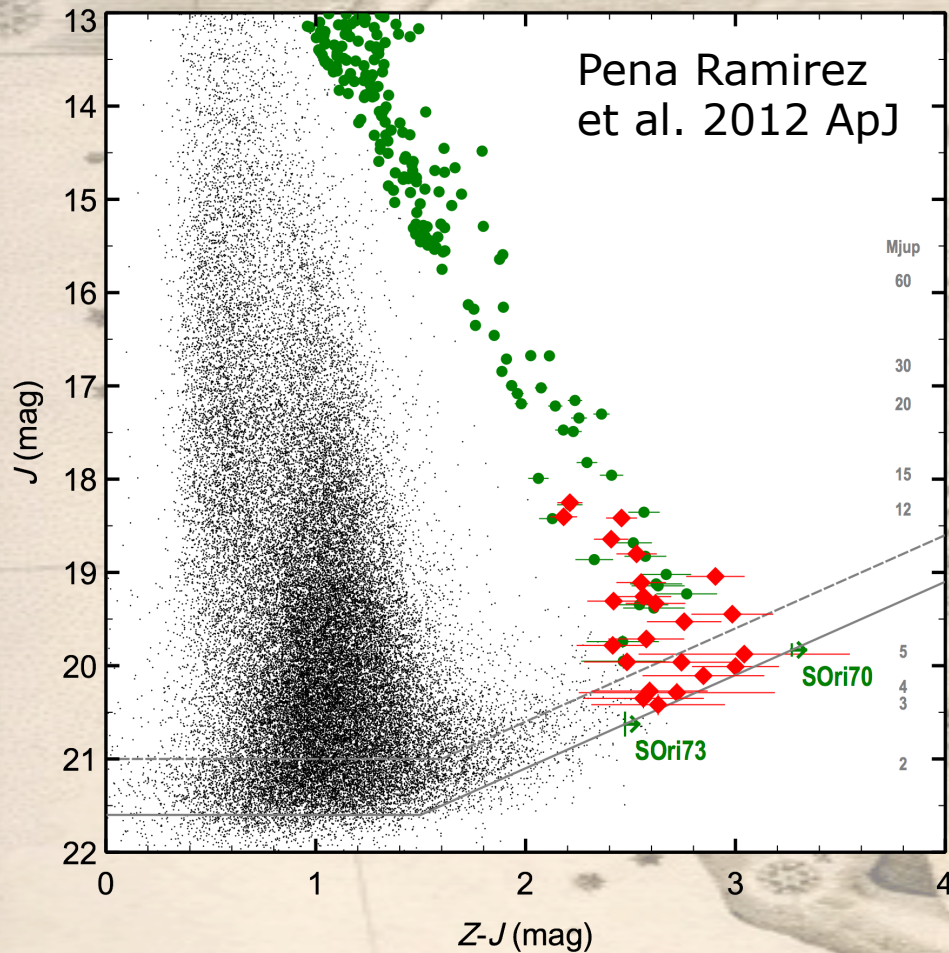


VISTA Orion Survey: sigma Ori Cluster

cluster age $\sim 3\text{Myr}$

VISTA – 1 degree² around sig Ori

~ 1 degree field, UKIDSS

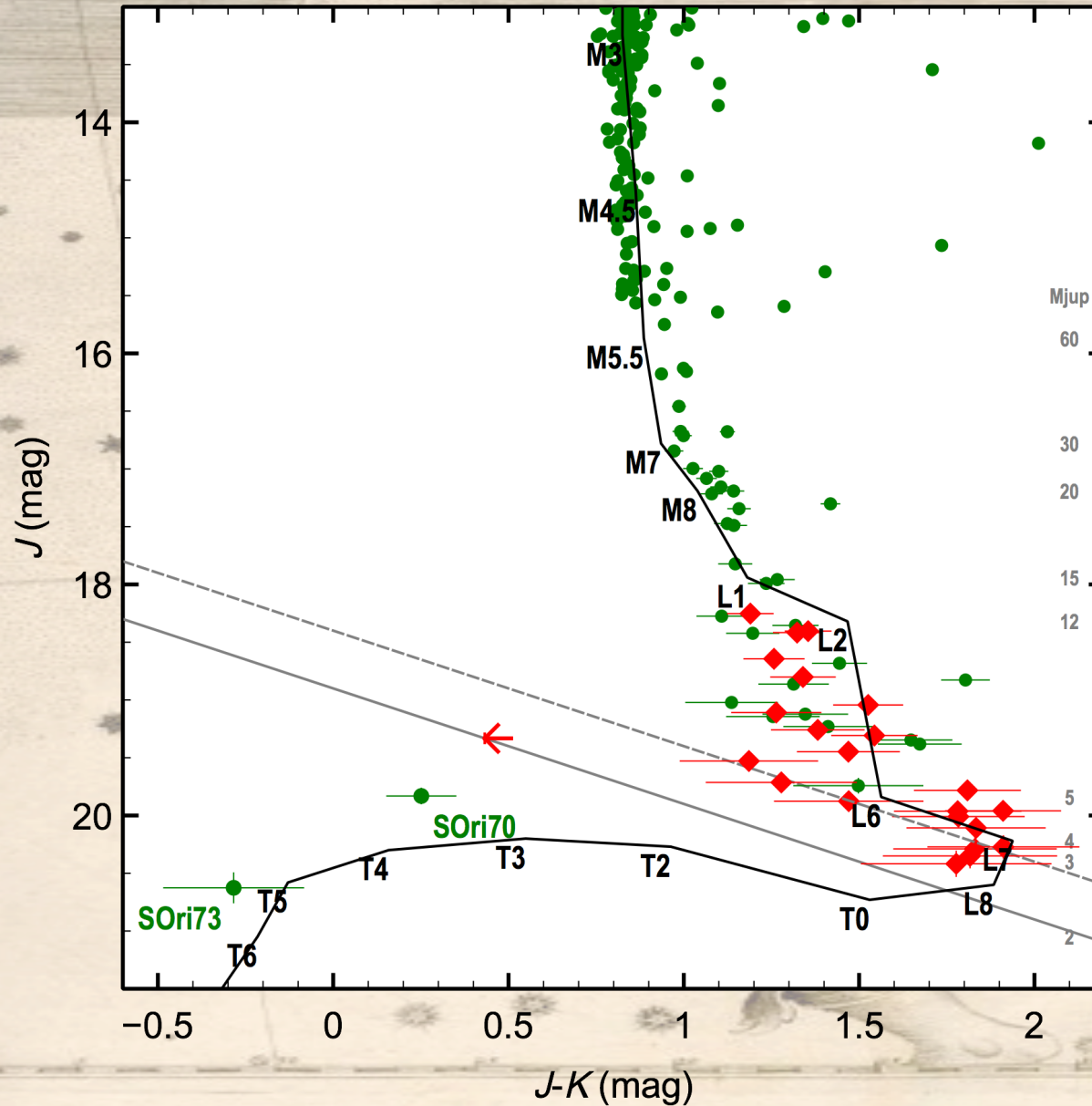


● Previously known members (Bihain et al., Lodieu et al. 2009)

Lodieu et al. (2009)

● VISTA selected objects, 20 new candidates

VISTA Orion Survey: sigma Ori Cluster



Solid line:
sequence
of MLT dwarfs at 3Myr

Most of L-type pop. in
sig Ori detected with
VISTA data

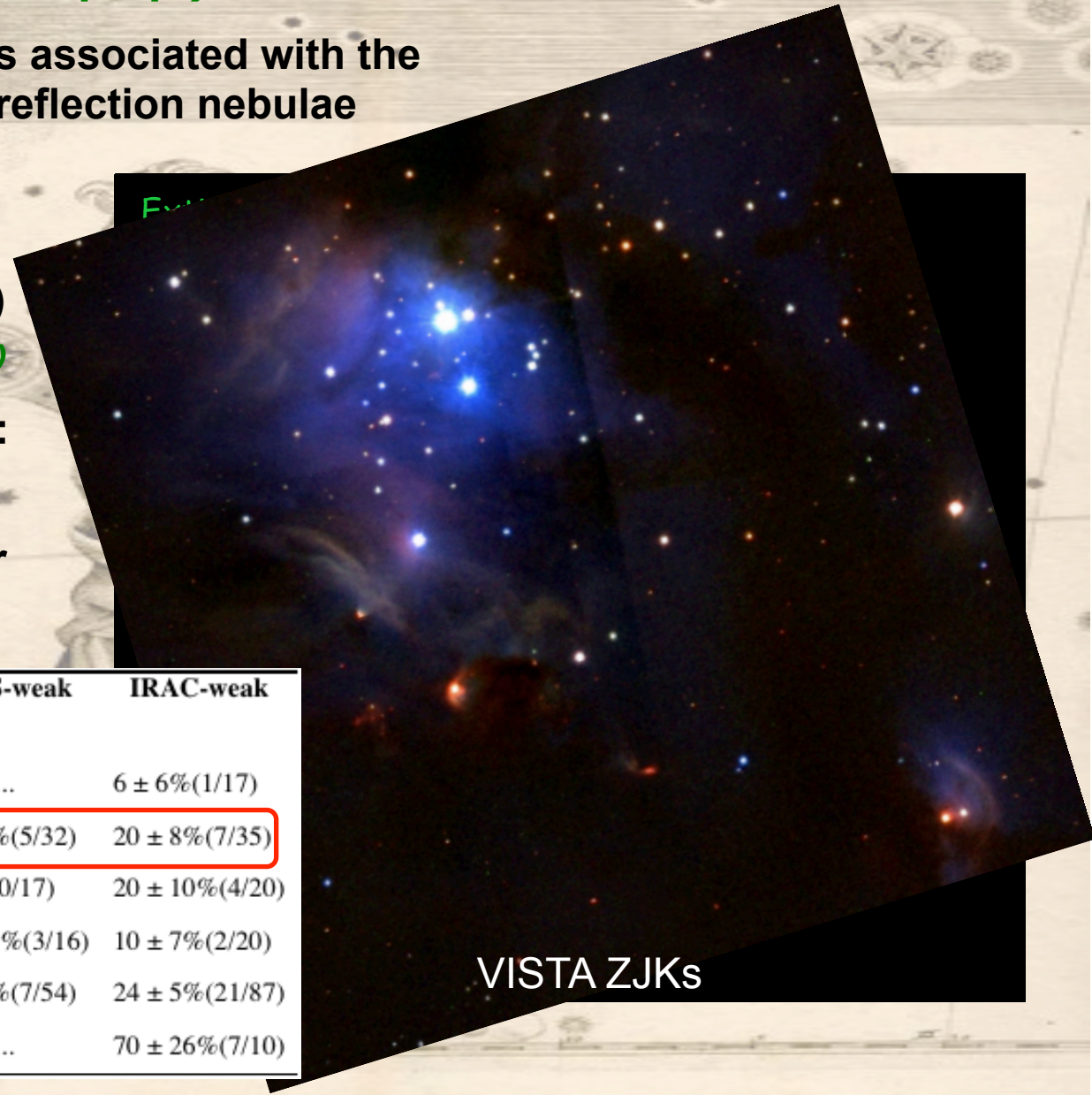
Pena Ramirez et
al. 2012, ApJ 754

VISTA Orion Survey: embedded clusters NGC2068/71

(Spezzi, Alcalá et al. in prep.)

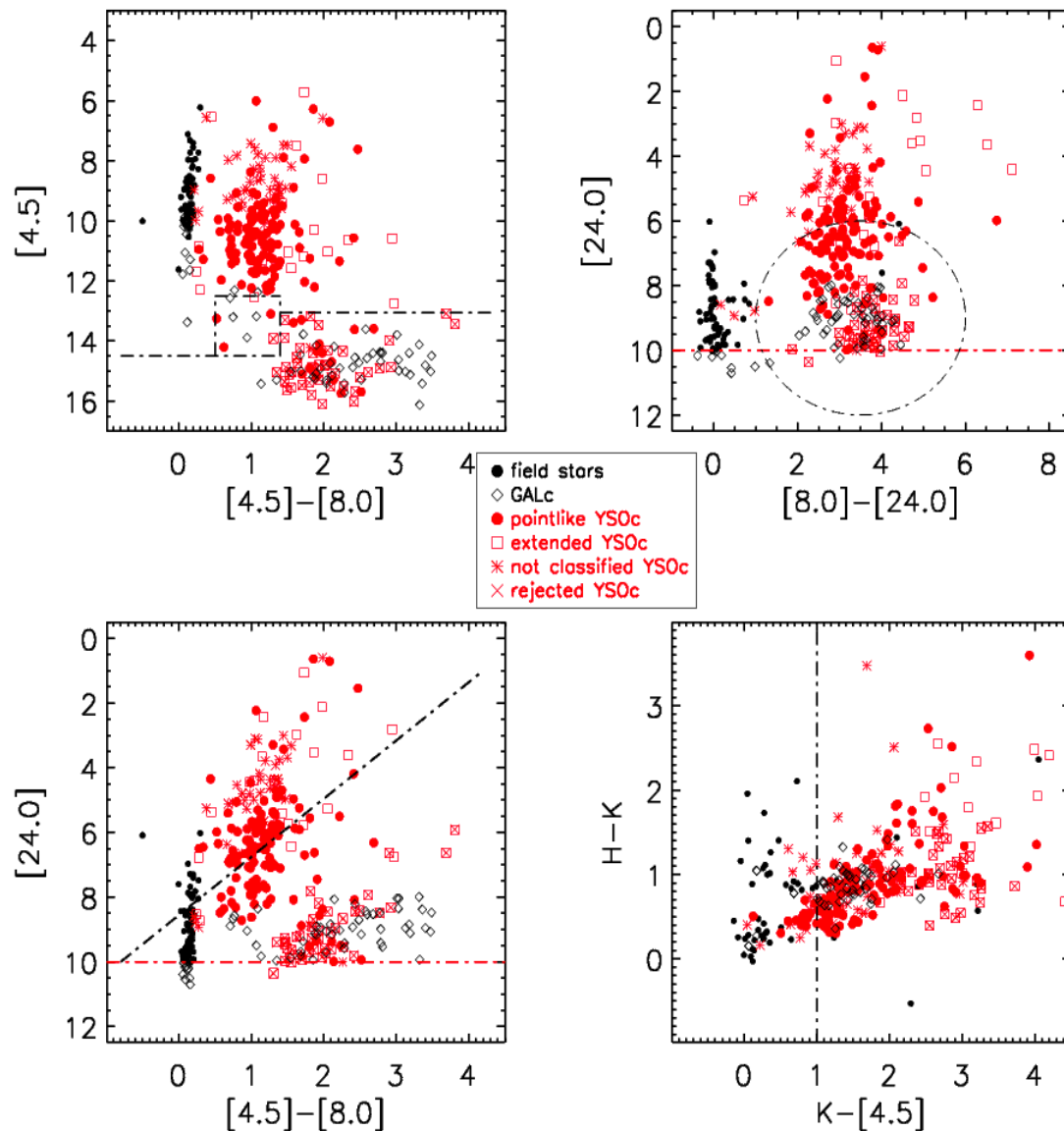
- Young embedded clusters associated with the NGC 2068 and 2071 reflection nebulae
- Age ~ 2 My
- Known members: 69
(43 CTTS and 26 WTTS)
(Flaherty & Muzerolle 2008)
- X-ray sources in the field:
127 (XMM)
- Disk fraction from Spitzer observations:

Cluster	Age	Strong disks K0-M1	MIPS-weak	IRAC-weak
Taurus	1	94 ± 24%(16/17)	...	6 ± 6%(1/17)
NGC 2068/71	2	66 ± 14%(23/35)	16 ± 7%(5/32)	20 ± 8%(7/35)
IC 348	2-3	80 ± 20%(16/20)	0%(0/17)	20 ± 10%(4/20)
σ Ori	3	75 ± 19%(15/20)	19 ± 11%(3/16)	10 ± 7%(2/20)
Tr 37	4	68 ± 9%(59/87)	13 ± 5%(7/54)	24 ± 5%(21/87)
NGC 2362	5	30 ± 17%(3/10)	...	70 ± 26%(7/10)



VISTA ZJKs

Embedded clusters NGC2068/71: selection of YSOs



c2d-like criteria:

- 1) Detection in all IRAC bands, MIPS-24mu and HK
- 2) galaxy/YSO probability assigned on the basis of Spitzer/VISTA colors
- 3) Morphology classification on the basis of VISTA flags

Selection results:

-188 YSO candidates

50 of them were already identified by Flaherty & Muzerolle 2008

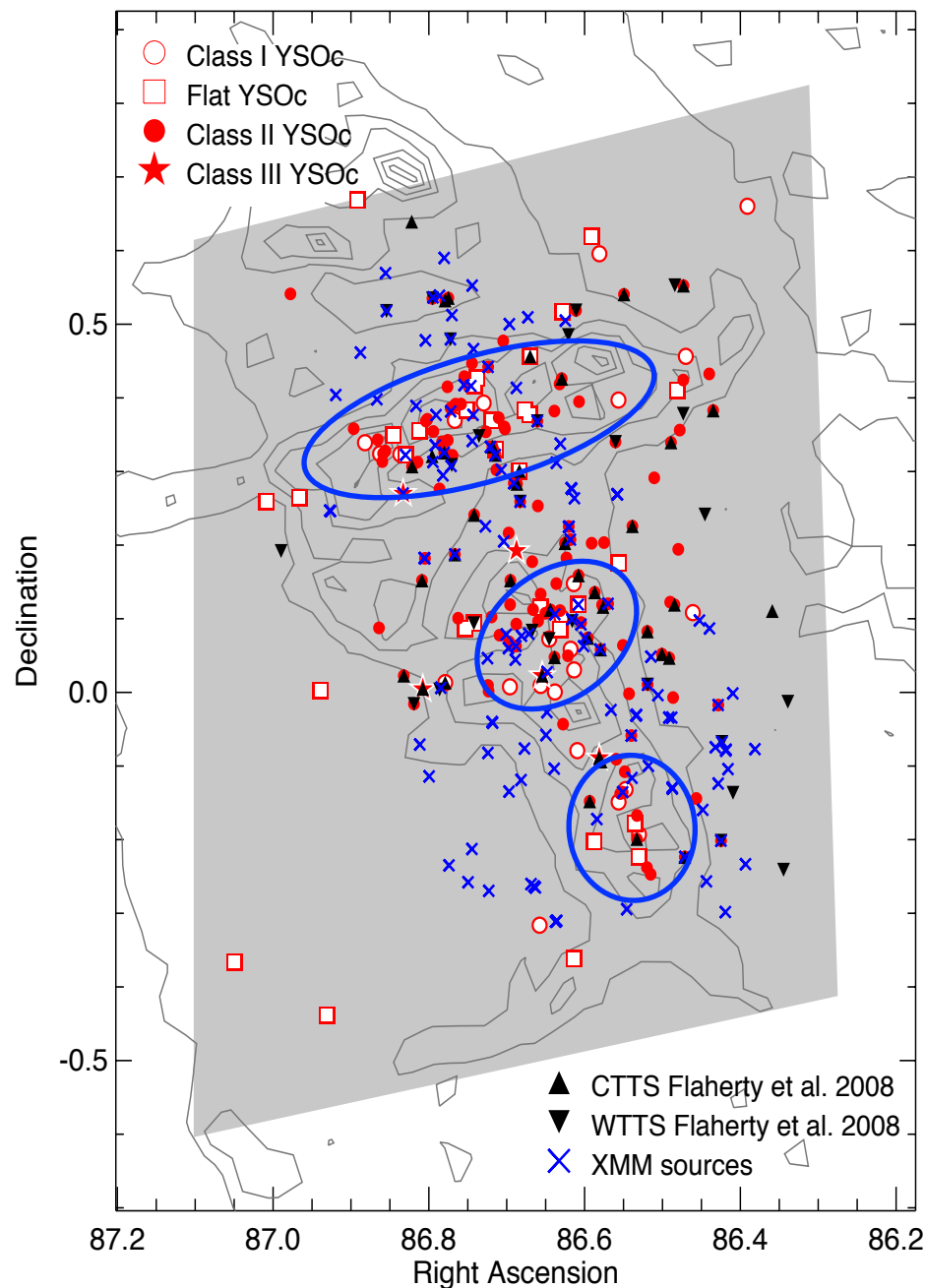
11 out of 50 also detected by XMM

~100 NEW YSOs -> we have doubled the known YSO population in NGC2068/2071

- The c2d criteria might miss objects with no strong IR excess emission (WTTs). How many?

Assuming the F08 sample is complete, we might miss ~6.5% of the WTTs.

Spatial distribution of the young population on the VISTA



1. Three YSO sub-groups associated with the peaks of extinction:
 - 1st group: RA=86.75 DEC=0.35 → NGC2071
 - 2nd group: RA=86.65 DEC=0.1 → NGC2068
 - 3th group: RA=86.55 DEC=-0.15 → **new!**NGC2068/2071 clearly distinguishable and a NEW sub-group
2. XMM and the members identified by Flaherty & Muzerolle 2008 sources are clearly more spread
3. Class I/flat sources far from the peaks of extinction might be contaminants (we expect ~2% contamination ≈ 4 objects)

Thank you!