Young embedded clusters in Cygnus-X

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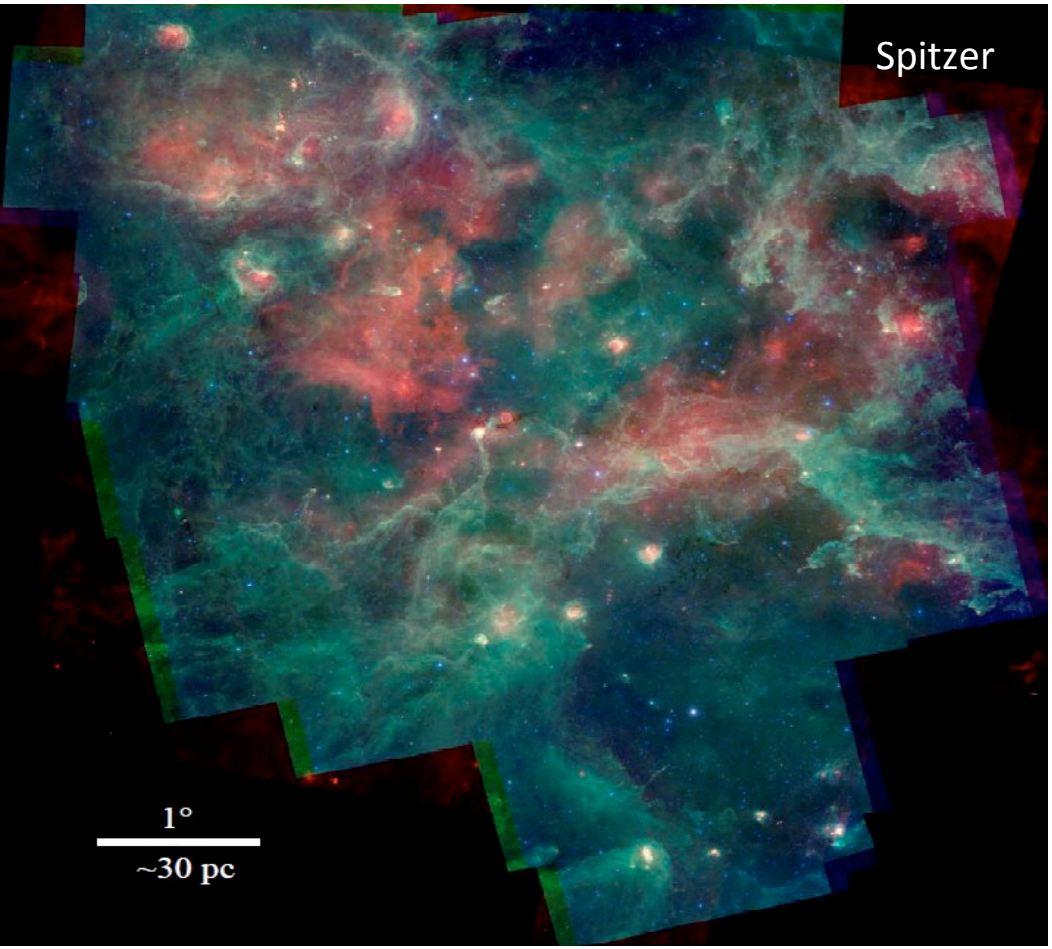
Odyssey

SFM STARFORMMAPPER

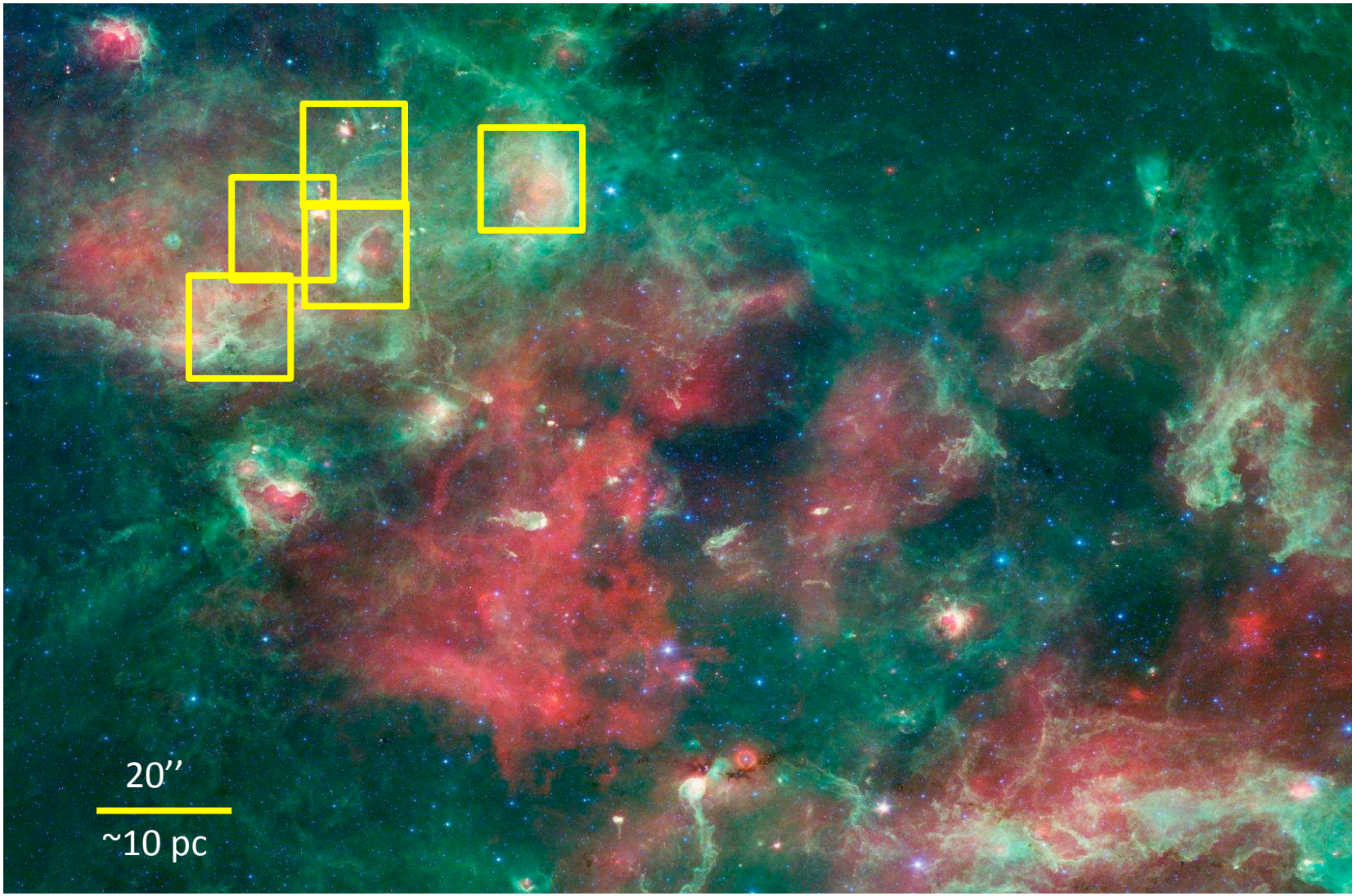
Cygnus X



- One of the richest SFR
- 2 large molecular clouds (Cygnus X North and South)
- Cyg OB2 association in the middle
- Is there any connection ?
- Studies difficult due to high extinction (foreground molecular cloud at 500-800pc)
- In the local spiral arm: structures at different distances
- age spread of ~10 Myr

Previous embedded cluster identification from 2MASS data (Le Duigou & Knödlseder 2002; Bica+ 2003)

→ New deep NIR images of CygX North with WIRCAM (1 sq.deg.) down to K~20

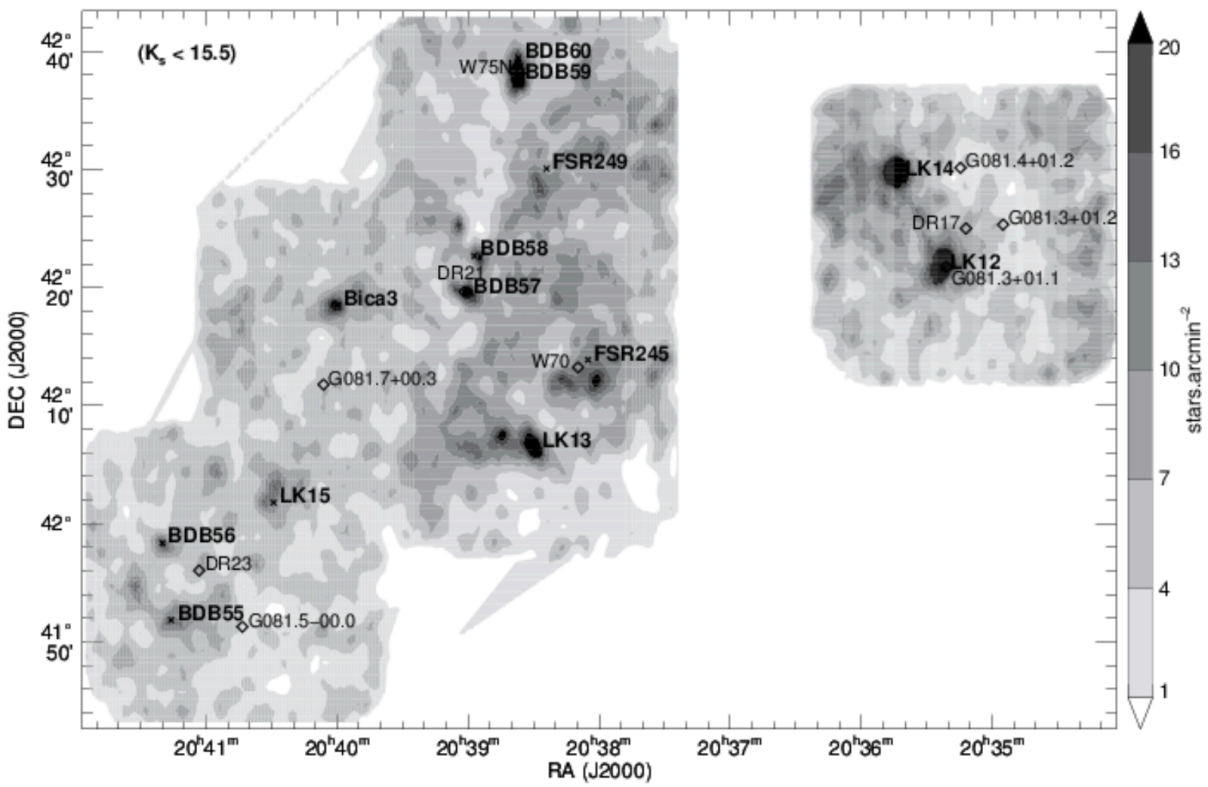


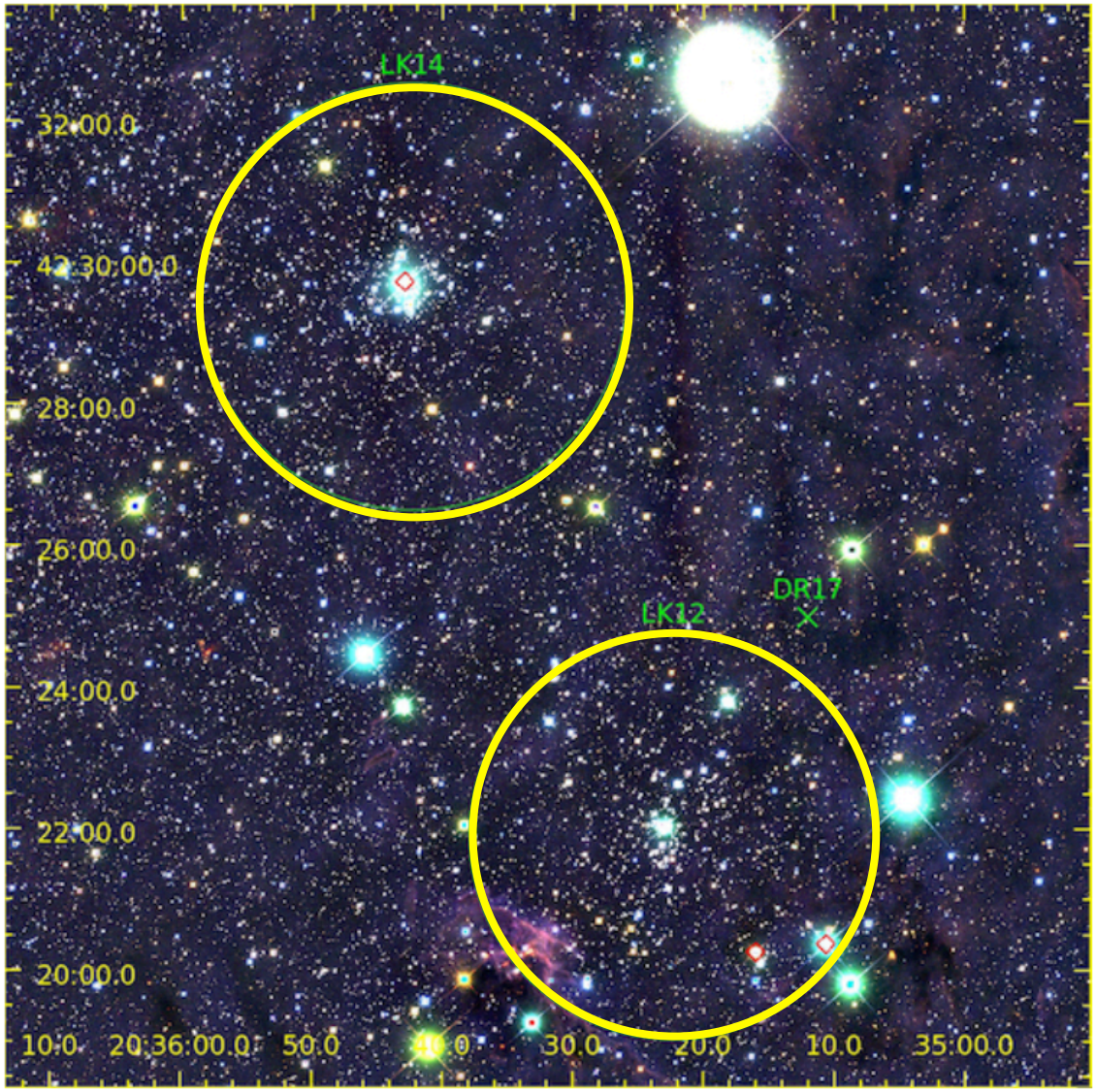
WIRCAM data

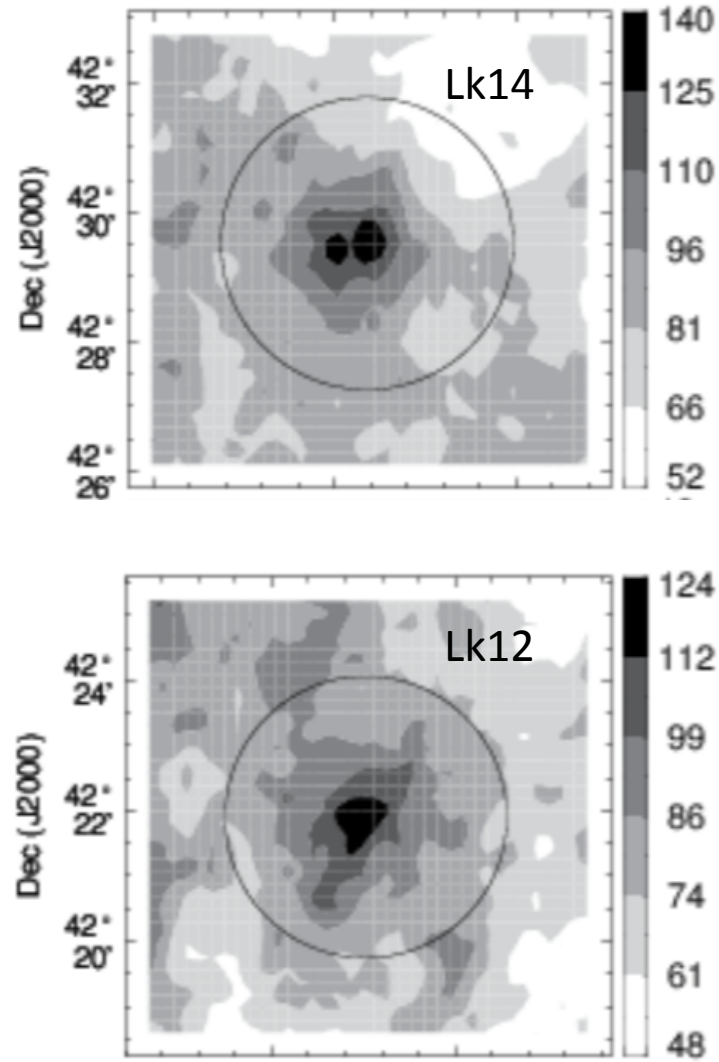
- J, H, K filter
- Photometry calibrated on 2MASS
- Source extraction using SExtractor + PSFEx

- Stellar density maps buit from the K-band catalogue using different kernel sizes and then stacked

- Confirmation of the emerged, more populous clusters




LK14
LK12
DR17
32:00.0
42:30:00.0
28:00.0
26:00.0
24:00.0
22:00.0
20:00.0
10.0
20:36:00.0
50.0
40.0
30.0
20.0
10.0
35:00.0


Lk14
Dec (J2000)
42° 32'
42° 30'
42° 28'
42° 26'
140
125
110
96
81
66
52
Lk12
Dec (J2000)
42° 24'
42° 22'
42° 20'
124
112
99
86
74
61
48

Membership analysis

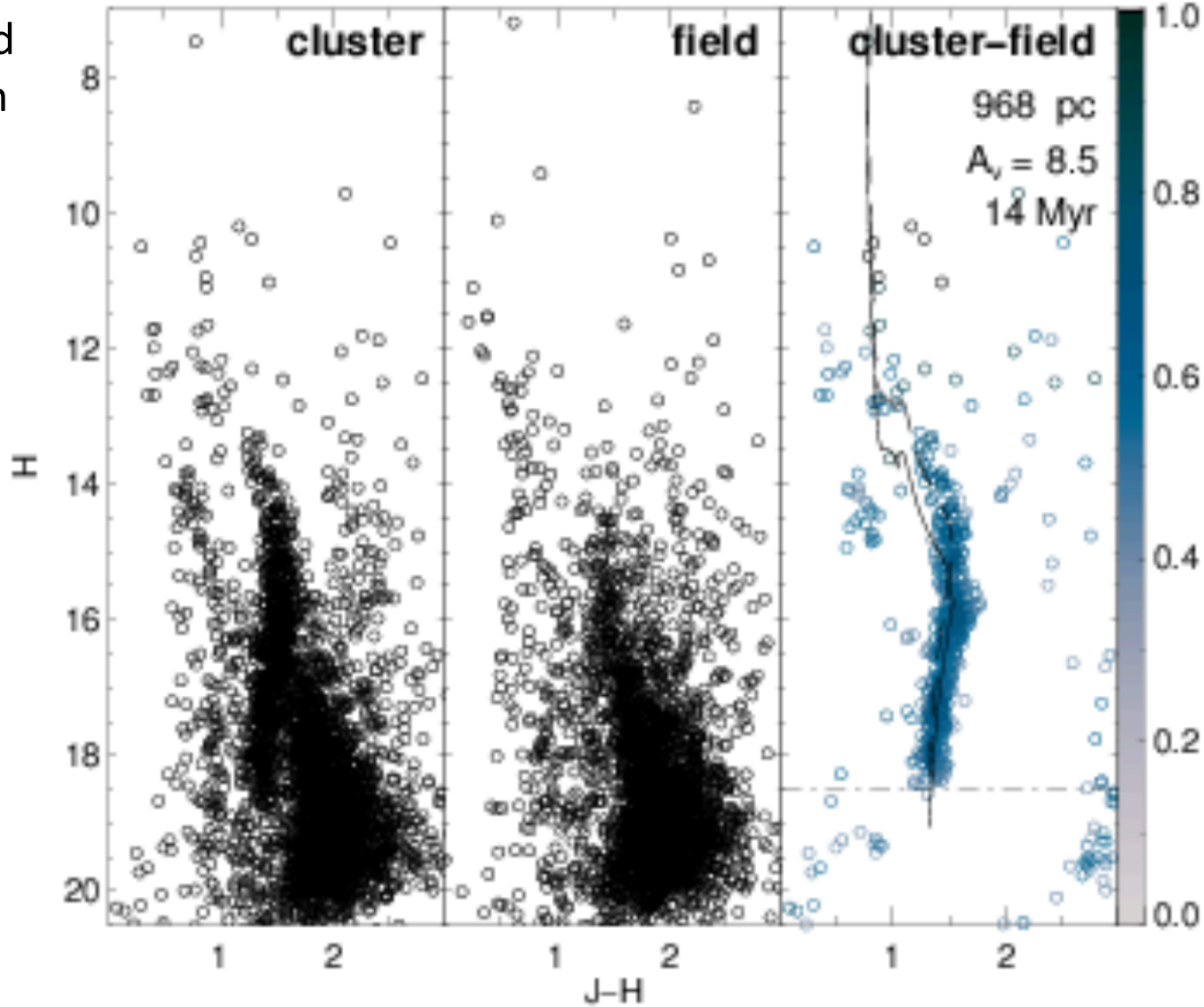
- Cluster CMD obtained from the substraction of control field CMD derived in an area close to the cluster, with same surface.

- Probability using stellar density in multi-colour space:

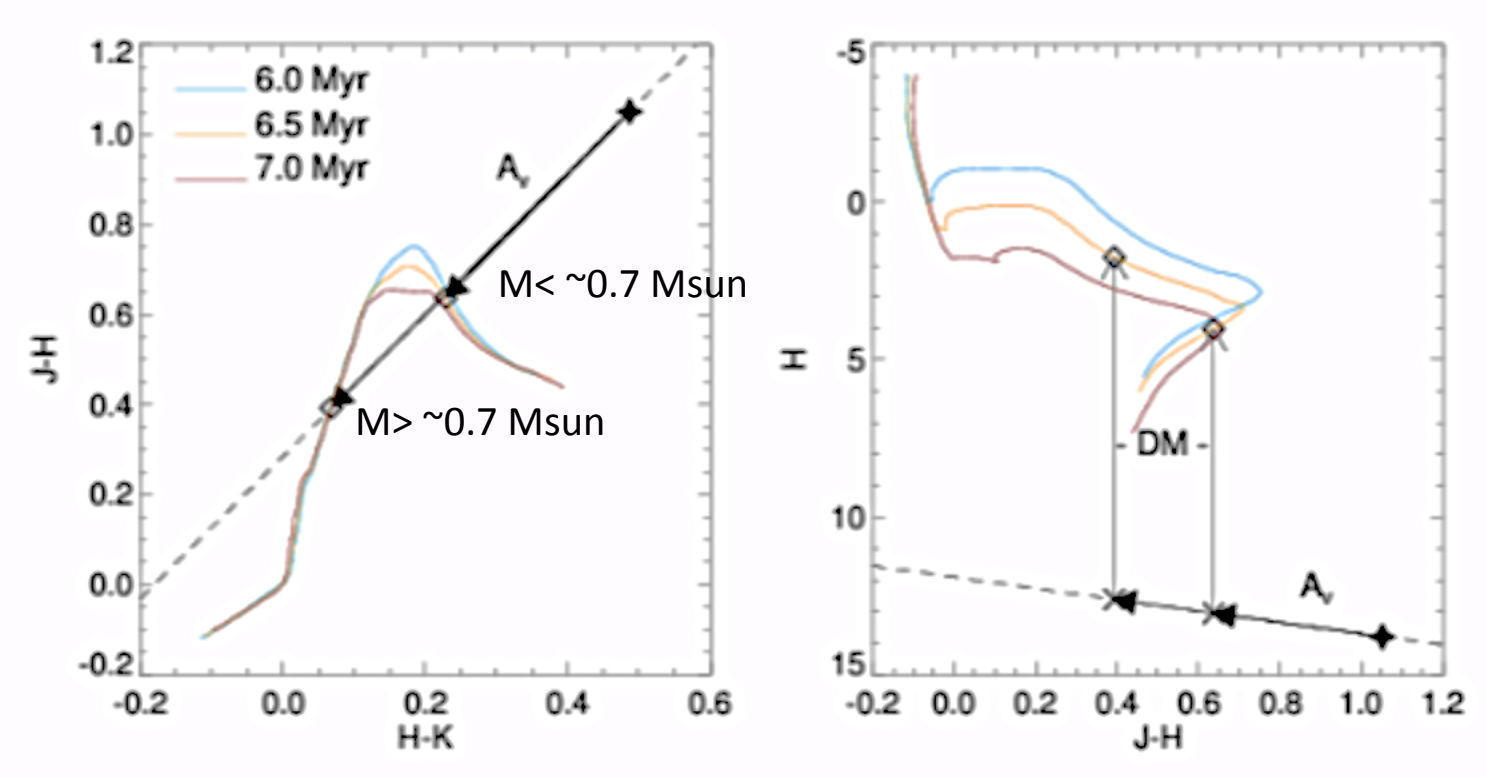
$$P_{phot} = \frac{\rho_{clu} - \rho_{fld}}{\rho_{clu}}$$

- Cutoff at 50%

(Maia+ 2010, 2014)



Extinction and distance



- For a given age, estimation of each stellar extinction minimizing the dispersion of the global extinction distribution.
- Then the distance modulus (DM) for each star is inferred using Av.

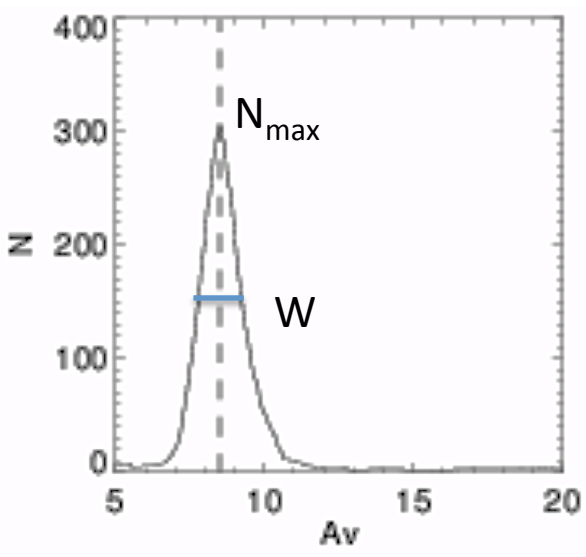
Cluster parameters

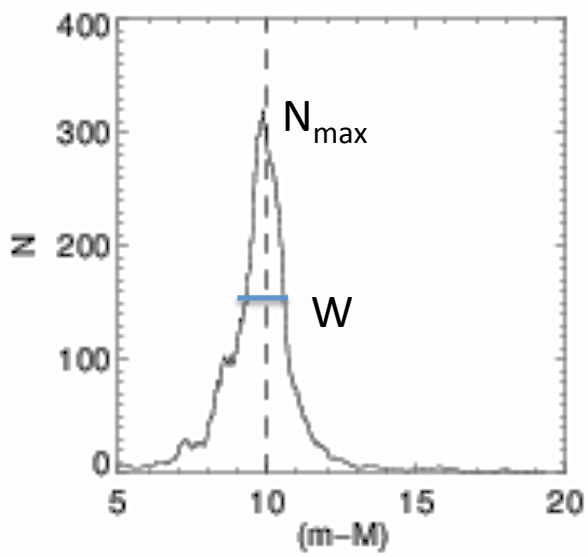
- Maximization of the sharpness S of the Av and DM distributions

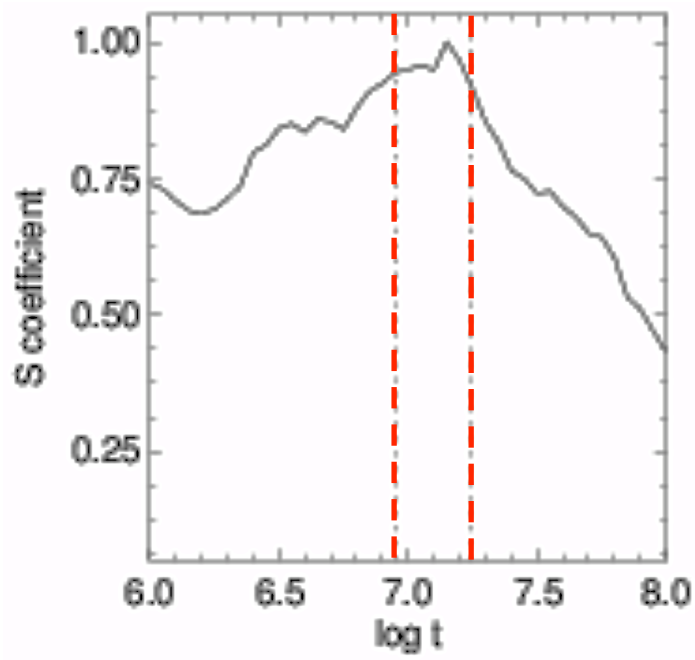
$$S\,(\log t) = \left[\frac{N_{max}}{W}\right]_{Av} \times \left[\frac{N_{max}}{W}\right]_{DM}$$

→ « best » isochrone

→ Most probable age, average Av and DM





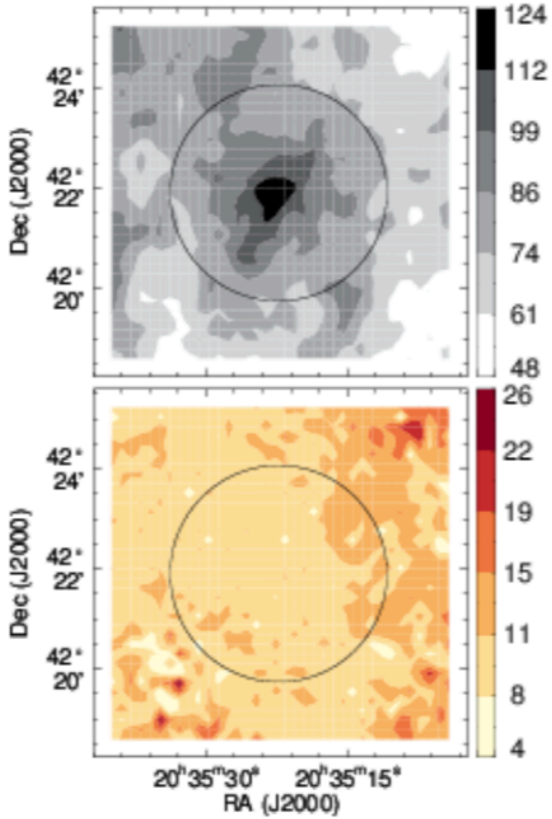


Completeness

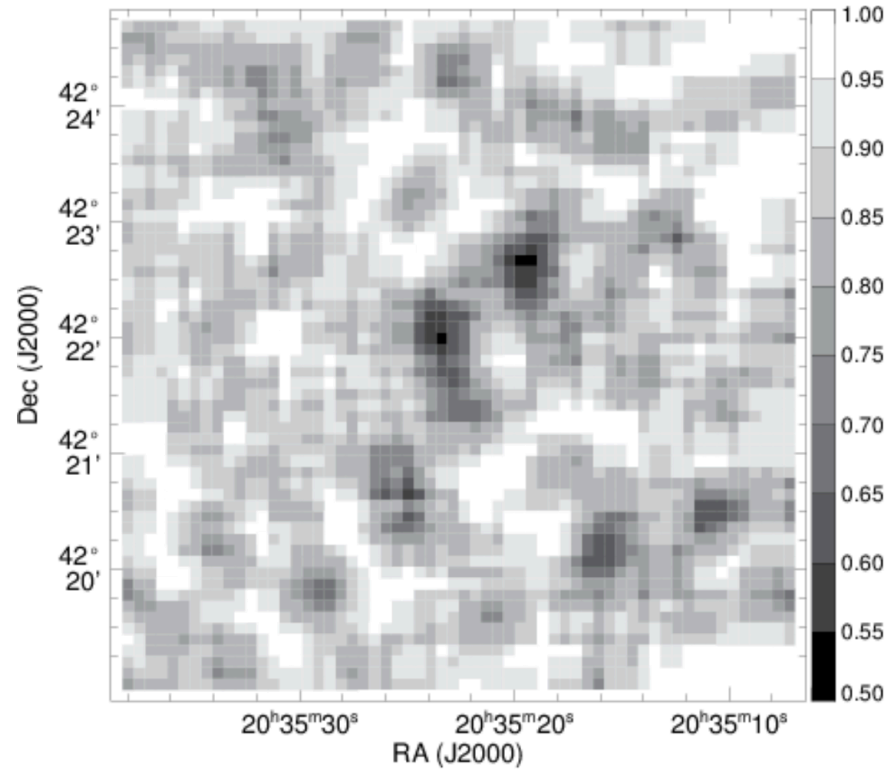
- Incompleteness expected due to crowding in the center and extinction
- Completeness estimated by adding artificial stars into the images and computing the recovery fraction

Stellar density

Av map

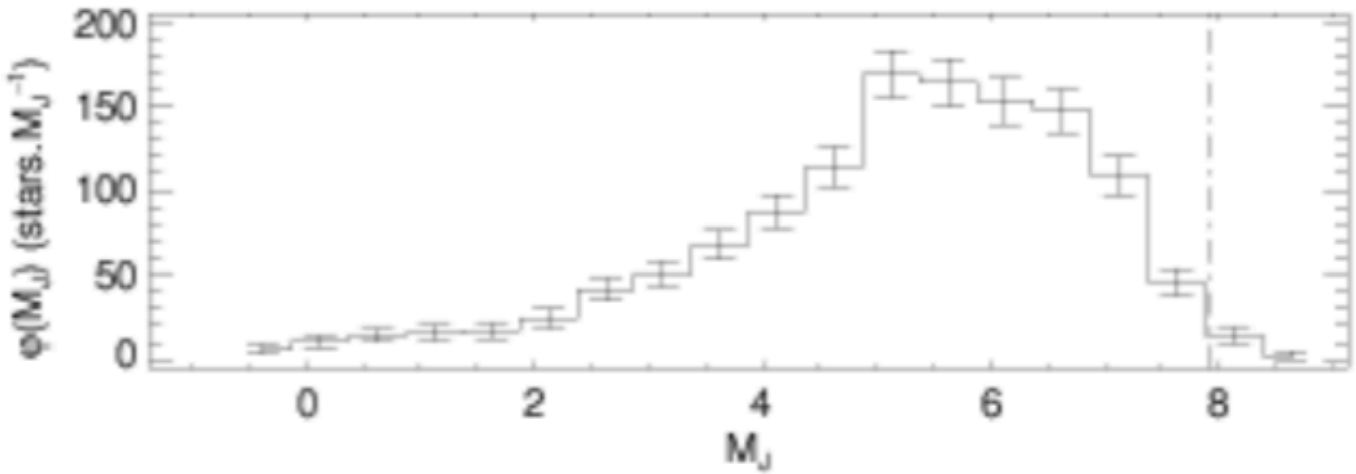


Completeness map for K=18.5 mag stars in LK12



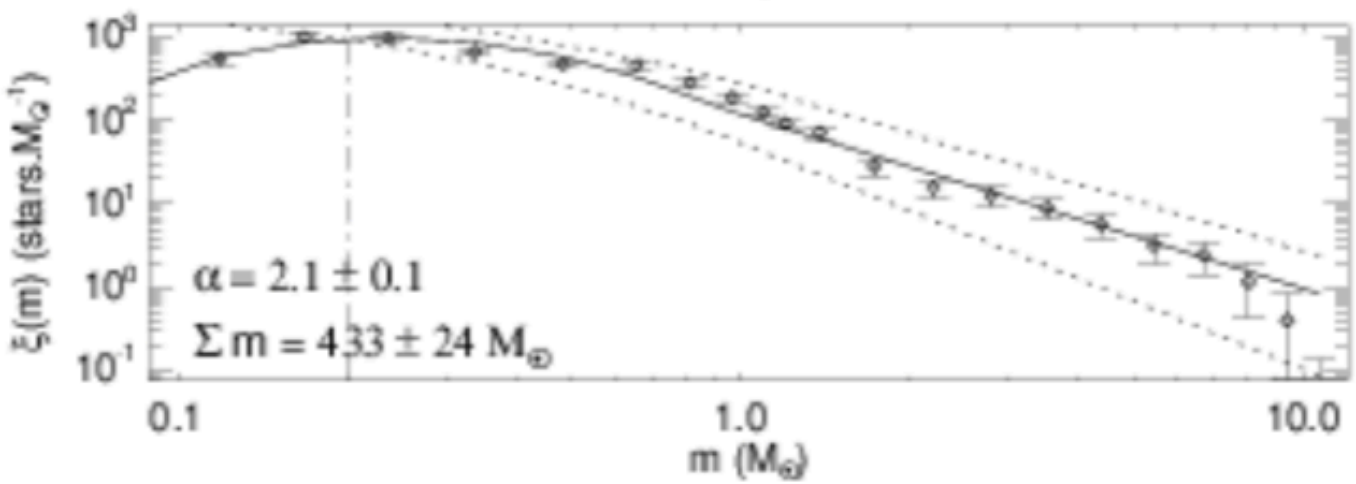
Mass distribution

Luminosity distribution corrected from incompleteness



Mass function (M_J → mass)

Fit by a lognormal + power-law above 1Msun



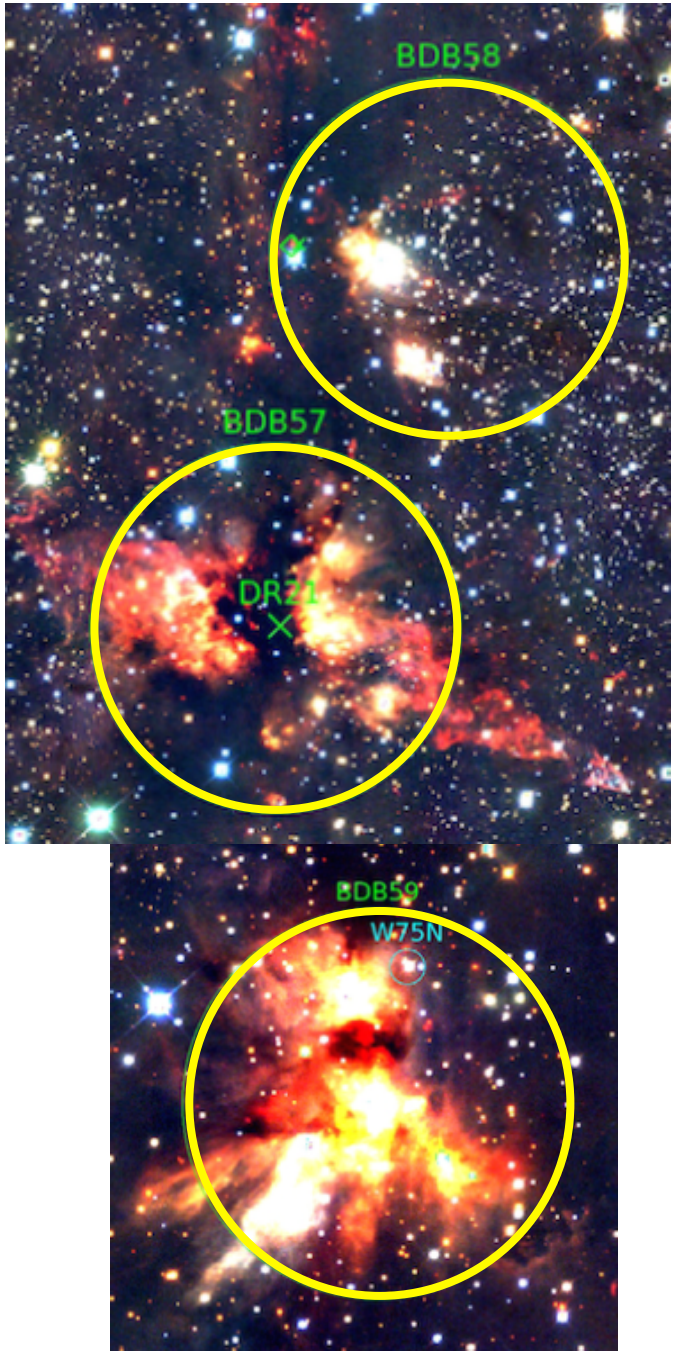
Maia, Moraux, Joncour 2016

Several layers of star formation

The youngest have a top heavy MF

Region	Dist. (pc)	Average Av (mag)	Age (Myr)	Alpha [1-10 Mo]	Total mass (Mo)
BDB57	809	24.4	1.4	1.4 ± 0.1	163 ± 28
BDB59	1367	12.9	1.6	1.4 ± 0.3	197 ± 27
BDB58	2937	13.5	2.0	1.5 ± 0.3	610 ± 56
LK15	1729	11.2	2.2	1.7 ± 0.1	367 ± 31
BDB56	1458	9.8	2.8	1.8 ± 0.1	140 ± 21
LK13	487	7.2	4.5	-	>40
LK12	751	8.7	5.6	2.4 ± 0.1	305 ± 29
FSR249	1690	7.0	10	1.8 ± 0.1	312 ± 30
LK14	968	8.5	14	2.1 ± 0.1	433 ± 24
Bica3	4613	15.1	501	-	>3000

Older background cluster

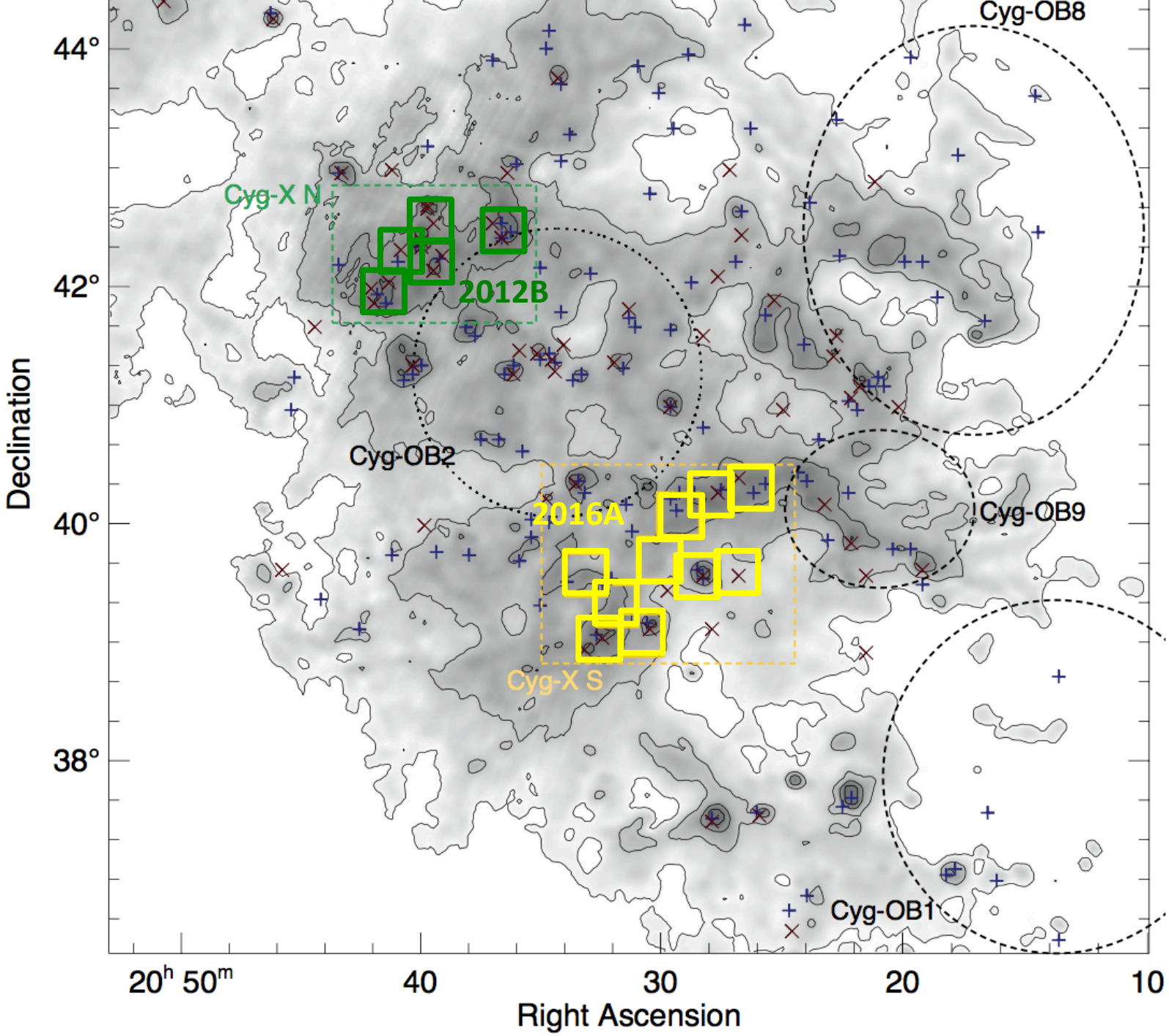


Why is the MF top heavy in younger clusters ?

Have we missed the low mass stars ?

- Confusion ? No
- Extinction ? I don't think so but may be possible
- Star formation still ongoing ? But low mass stars would form last…
- Mass segregation ?

→ Need to look at larger areas and other regions to confirm the trend


Cyg-OB8
Cyg-X N
2012B
Cyg-OB2
2016A
Cyg-OB9
Cyg-X S
Cyg-OB1
44°
42°
40°
38°
Declination
20h 50m
40
30
20
10
Right Ascension