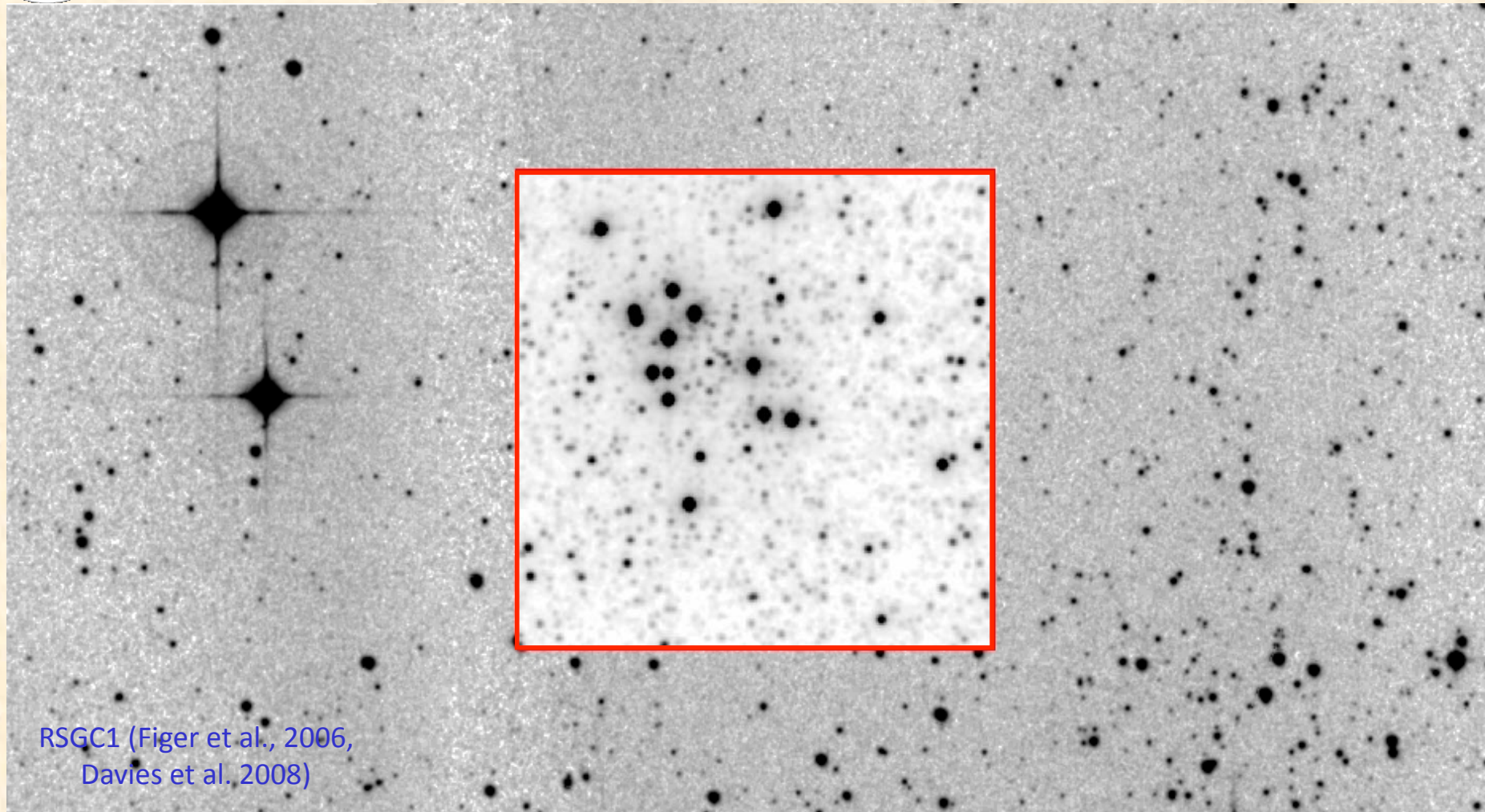# MASGOMAS Project:
Two new obscured, massive and young Galactic clusters

Most work by
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With the collaboration of
A. Marín-Franch (CEFCA, Teruel, Spain)
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Artemio Herrero (IAC, Tenerife, Spain)
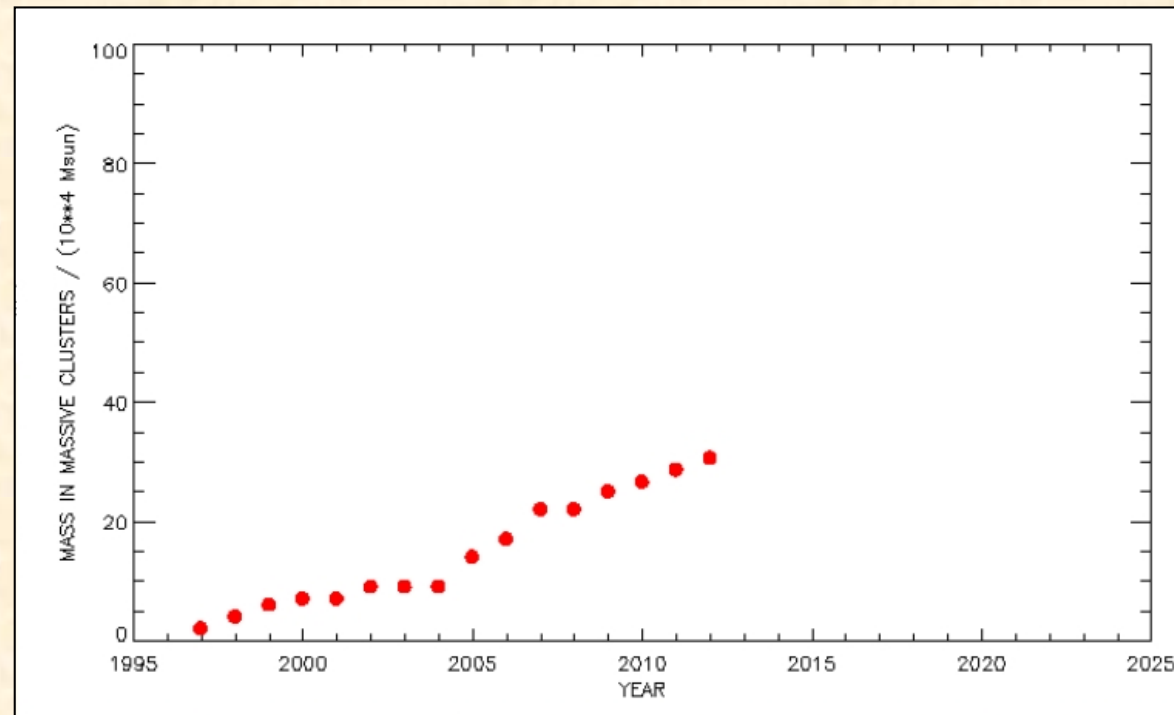   IAU GA Beijing, August 2012

RSGC1 (Figer et al., 2006,
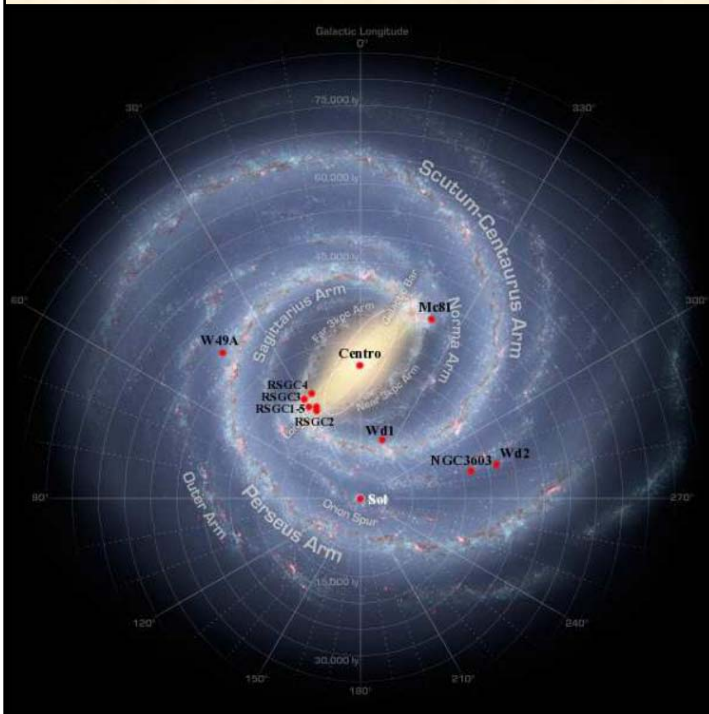Davies et al. 2008)

Massive clusters

- Catalogues such as 2MASS, DENIS, UKIDSS or VVV have boosted the search for massive clusters in the MW

- However, we still expect a larger number of massive clusters (Hanson, 2008; Ivanov, 2010)

- And an even larger number of intermediate mass clusters

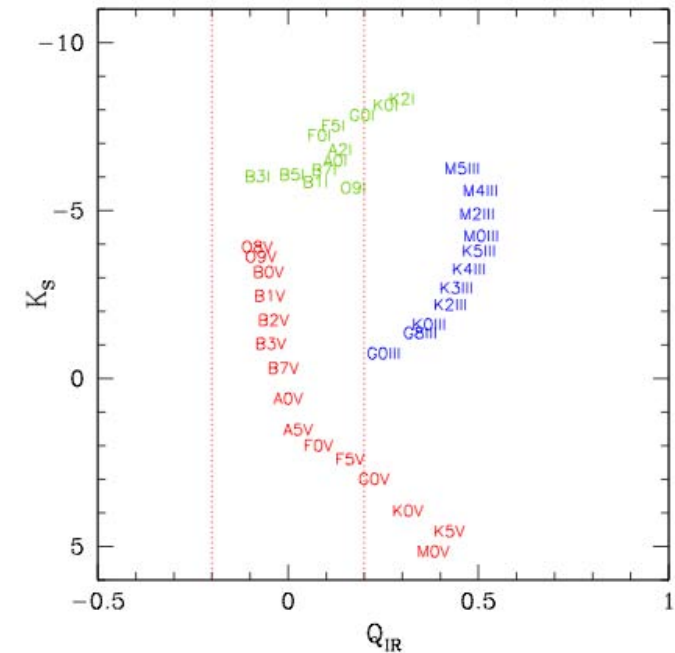- *MA*ssive *S*tars in *G*alactic *O*bscured *MA*ssive cluster*S*

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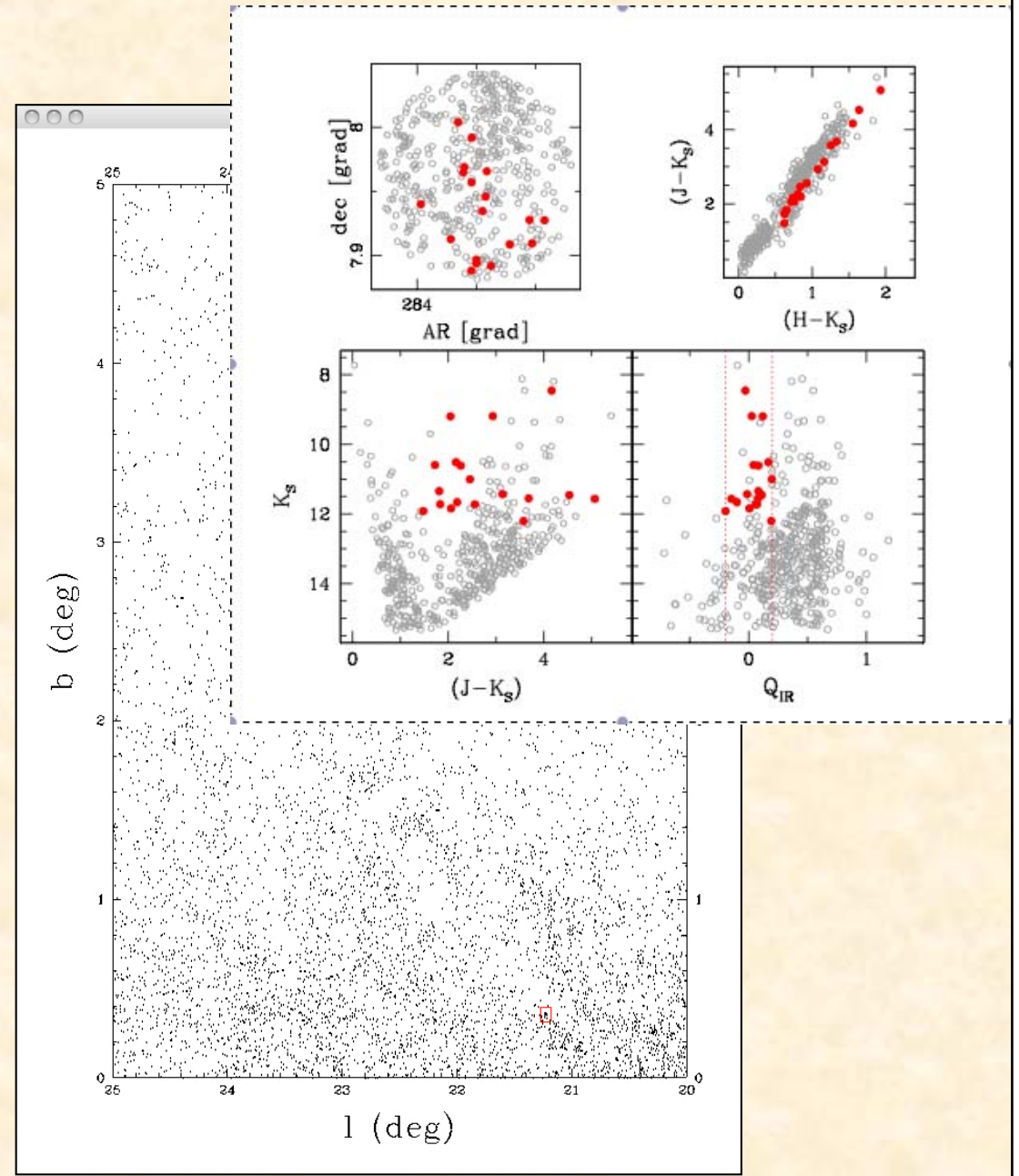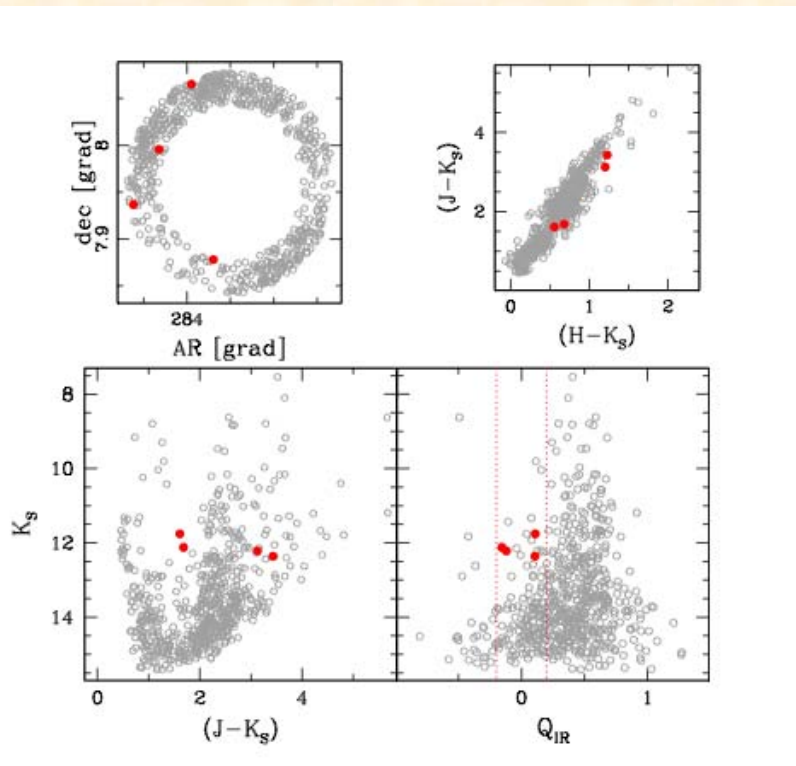photometry.

uts to favour OB-ty...

free parameter Q_{IR}

star candidates. We adopt Rieke's law, resulting in

$$Q_{IR} = (J - H) - \frac{E_{J-H}}{E_{H-K_S}}(H - K_S) = (J - H) - 1.7(H - K_S)$$

- $(J-K_S) > 1.3$: Clear foreground stars.

- K_S: Threshold magnitude to allow over-density detection + LIRIS@WHT spectroscopic limit ($Ks < 12.5$, empirical).
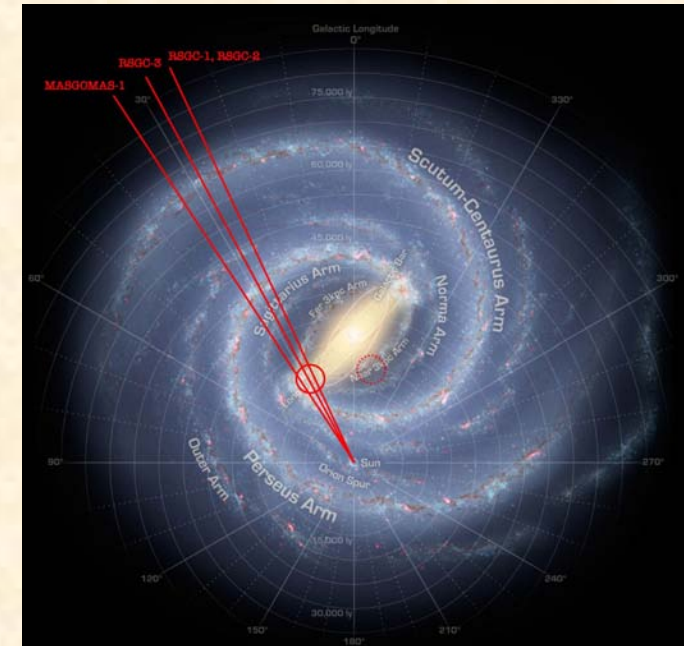
MASGOMAS search

- Once we have filtered the 2MASS catalogue, we looked for over-density of OB-type candidates.

- The number of OB-candidates is compared with that of the surrounding control field.

Masgomas-1

(Ramírez-Alegría, Marín-Franch & Herrero, 2012, A&A 541, A75)

- RA=282.568°, dec=+0.352°

  l =33.11°, b=0.422°

- Once we have our candidate we use LIRIS@WHT (FoV: 4x4 arcmin^2 ; 0.3´´ pix^{-1}

  - NIR photometry of the candidate and control field

  - Target selection (mask design)

  - Target MOS (and LS) spectroscopy

Masgomas-1

- Object undetectable using visual photometry.

LIRIS NIR photometry

ÓPTICO (DSS)

INFRARROJO
LIRIS@WHT (IAC)

$(J-K_S)$

Q_{IR}

Masgomas-1

- Object undetectable using visual photometry.

LIRIS NIR photometry

Masgomas-1

- Spectroscopic follow up for 28 stars with LIRIS; R~2500
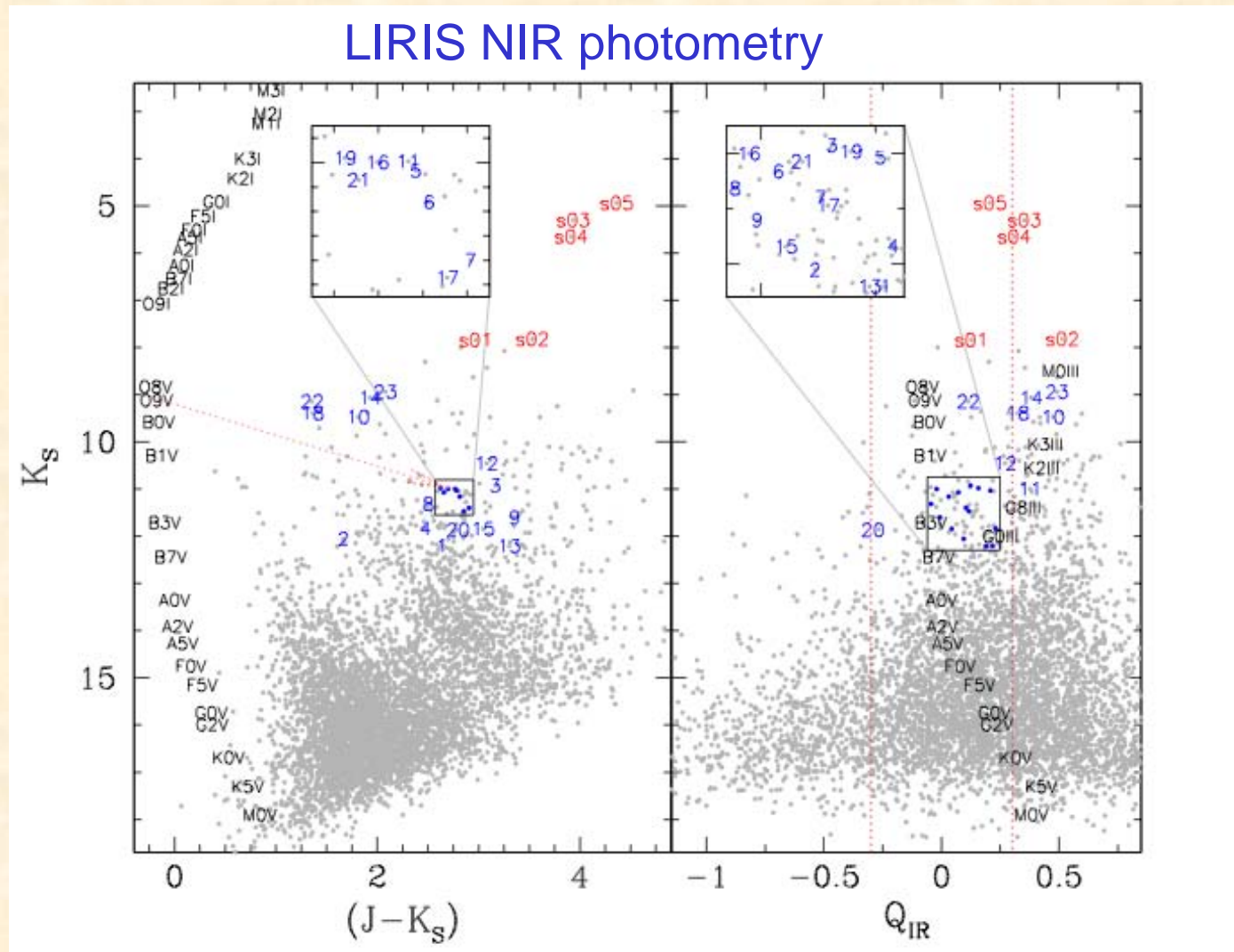
  - OB-type candidates observed with MOS.

  - RSG candidates observed with LS.

  - Stars grouped by magnitude.

- Spectral clasification comparing with similar resolution near-IR spectral catalogues (Hanson et al, 1996, 1998; Meyer et al., 1998; Wallace & Hinkle, 1997)

- 17 stars classified as O9-B1V, 4 as SGs (3 M SGs, 1 A2I), 1 AV, 6 RG
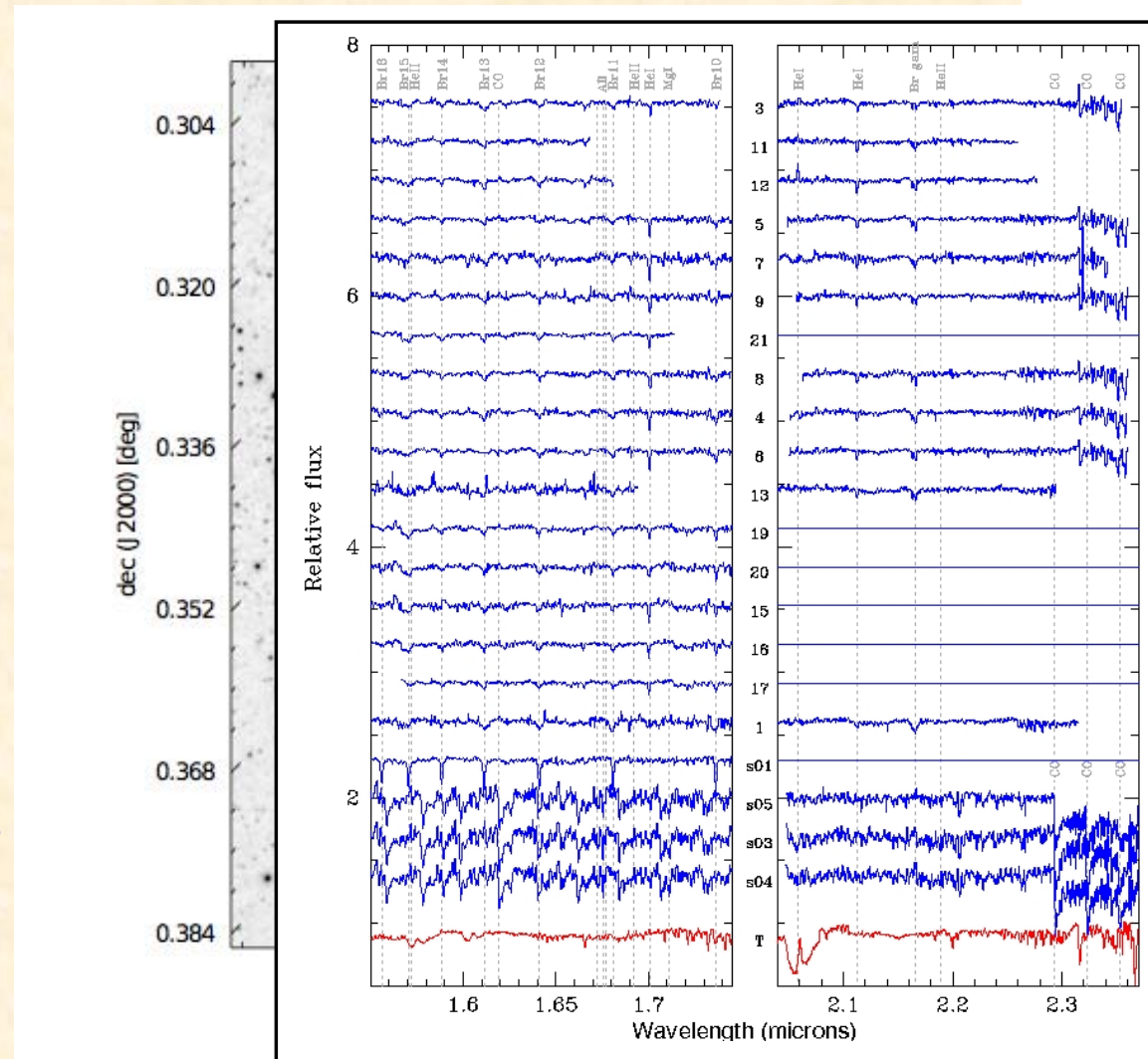
Masgomas-1

- Spectroscopic follow up for 28 stars with LIRIS; R~2500

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Masgomas-1

- 17 were classified as OB-type stars between O9V and B1V.

- 4 as supergiants (1 A2I, 3 MI).

- 1 as an A-type dwarf (foreground)

- 6 as late type giant stars (foreground)

- We have estimated individual distances and extinctions by comparison of observed and intrinsic colors and absolute magnitudes (Cox, 2000) using the spectral types we determined.

- Individual distances of massive stars are compatible with a single cluster distance of 3.53 ± 1.48 kpc.

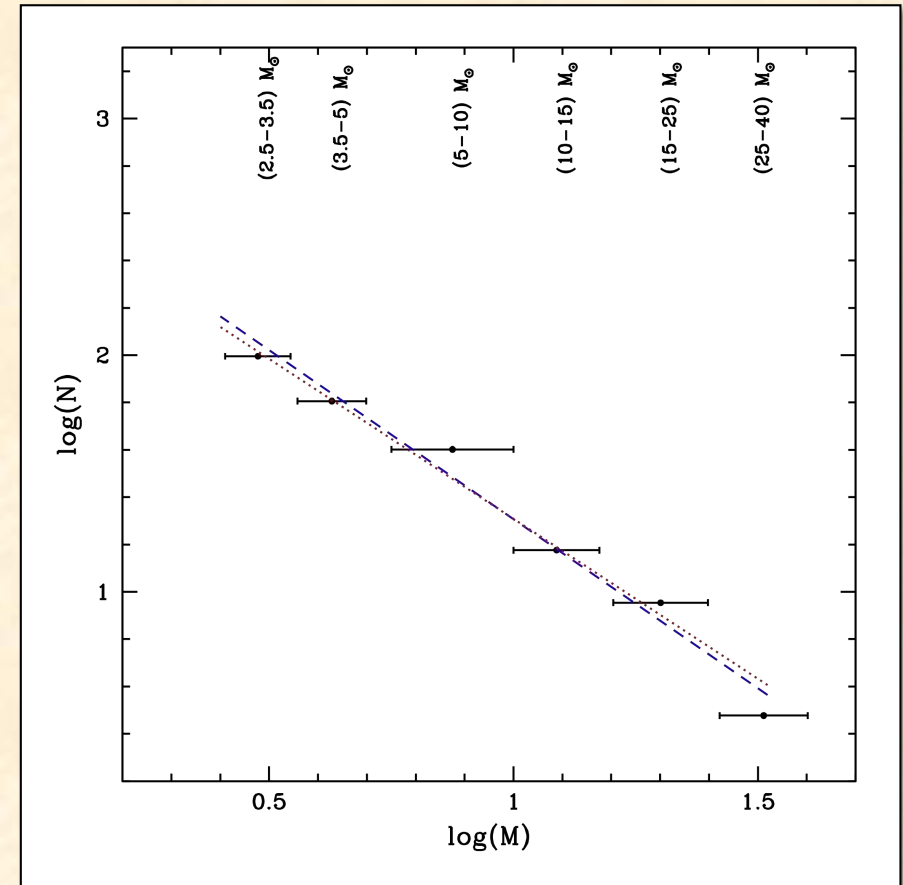| ID	Spectral type	A_K [mag]	Distance [kpc]
1	B1 V	1.83	3.69
3	O9 V	2.21	2.95
4	B0 V	1.74	4.50
5	O9.5 V	1.95	3.14
6	B0 V	1.96	2.98
7	O9.5 V	2.03	3.58
8	O9.5–B0 V	1.76	3.70
9	O9.5 V	2.33	3.43
11	O9 V	1.95	3.43
12	O9 V	2.15	2.44
13	B0 V	2.29	4.15
15	B0 V	2.12	3.79
16	B0 V	1.90	3.51
17	B0 V	2.00	3.39
19	B0 V	1.84	2.90
20	B0 V	2.00	4.23
21	O9.5 V	1.87	3.32
s01	A2 I	1.89	3.58
s03	M2 I	1.99	4.00
s04	M2 I	1.98	4.72
s05	M1 I	2.25	2.74

Masgomas-1

Distance, mass and age

(Ramírez-Alegría, Marín-Franch & Herrero, 2012, A&A 535, A8)

- Individual distances and extinctions were derived from intrinsic colors and magnitudes (Cox, 2000; Tokunaga, 2000) for the spectral types we determined

  - Individual distances are consistent with a cluster distance of 3.53±1.48 kpc

- Mass estimate using the CMD (Hidalgo et al. 2008):

  - Kroupa fit to the stellar population, after substraction using a control field.

  - Total mass estimated of $1.94 \cdot 10^4$ M$_\odot$ (lower limit)

- Cluster's age estimate:

  - RSG's population indicates an age between 6.5 and 10 Myr.

  - Earliest dwarf star in the cluster (O9V), sets an upper age limit of 10 Myr.

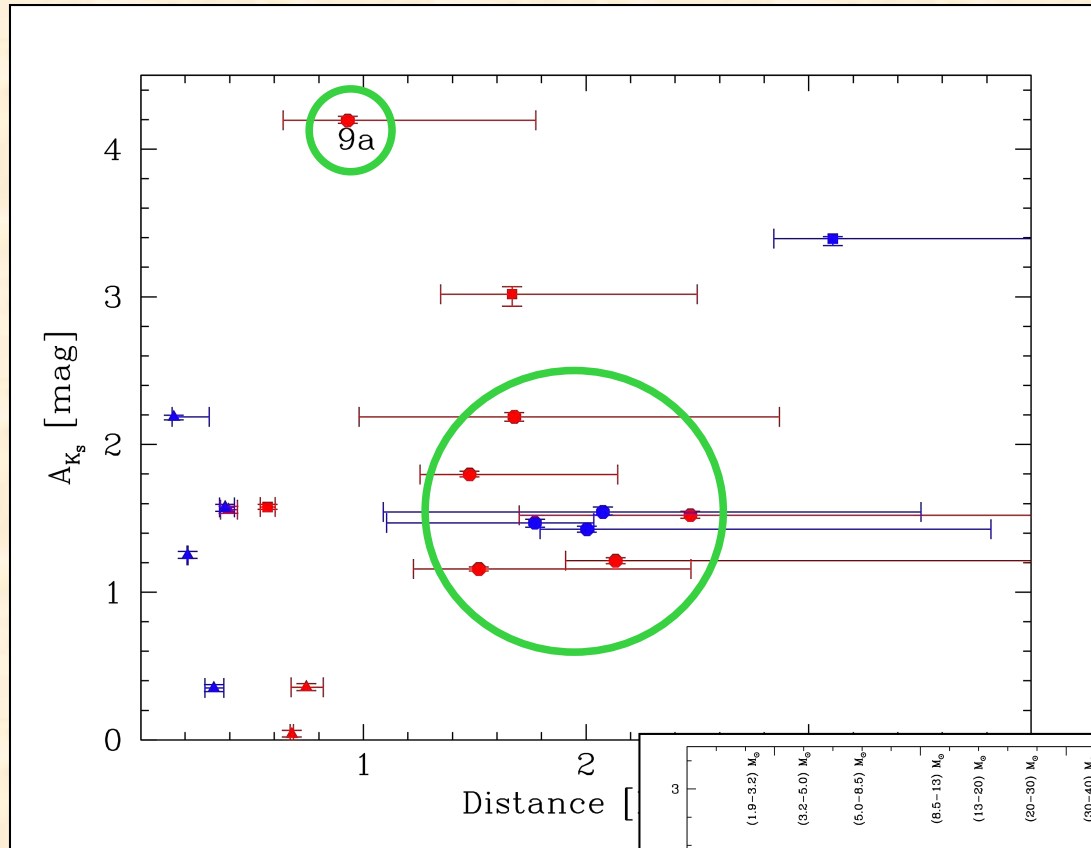 - Masgomas-1 age is estimated in 8 Myr.
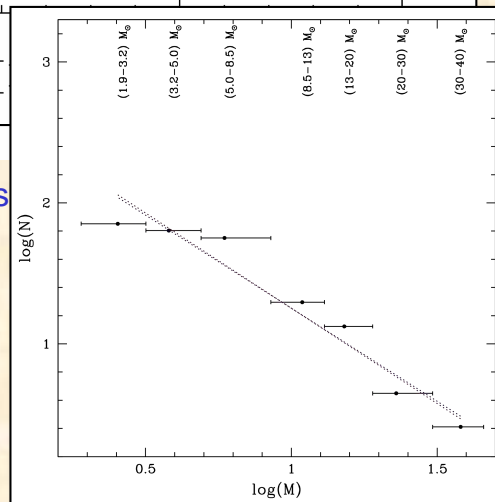
Masgomas-4

(Ongoing work)

- Located in the same direction as Masgomas-1 (i.e. Scutum-Centaurus arm's base).

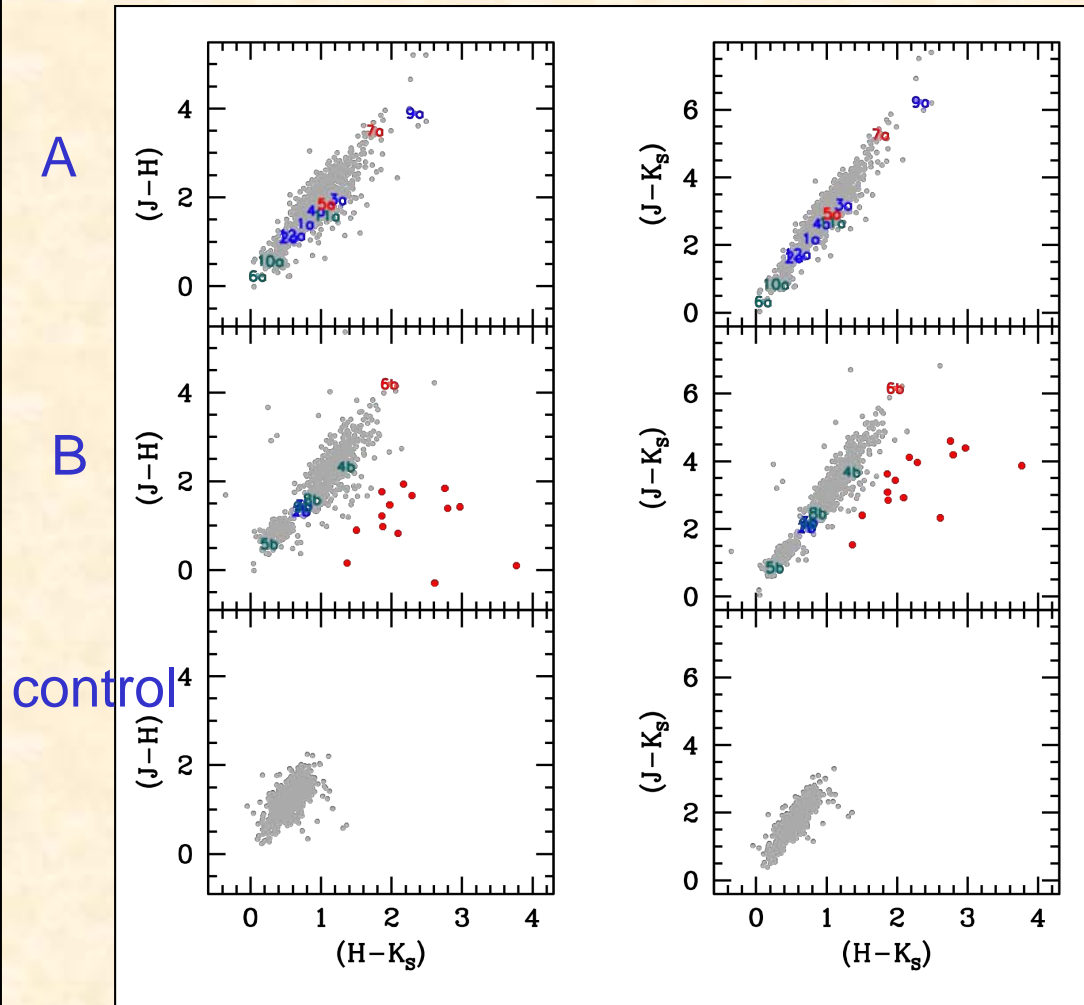- Angular extension of 5x10 arcmin^2. Twice LIRIS FOV.

Masgomas-4

9a

Red: field A; blue: field B
Circles: OB type; triangles: AFG type; s

- 21 stars observed with MOS
  - 10 classified as OB type
  - 8 as AFG dwarf stars.
  - 3 as giant stars.
- We have estimated individual distances and extinctions as done for Masgomas-1.
- Mean distance values of:
  - 1.8 kpc (field A)
  - 2.0 kpc (field B)
- The earliest star (with spectral classification) sets an upper age limit of 10 Myr.
  - Kroupa fit (and integration) sets a lower mass limit of $2.19 \cdot 10^3$ M$_\odot$

Masgomas-4

- C-C diagrams show the same extinction law for both field A and B
- Rieke extinction law
  - BUT... field B has an excess of red sources(stars in formation).
  - Methanol and ammonia masers reported for field B.
  - This suggests that star formation started later in B or that extends more over time
  - No evidence (for the moment) of induced SF

Conclusions

- As part of the beta version of our systematic search of massive, young and obscured galactic clusters, we have discovered Masgomas-1 and Masgomas-4.

- Masgomas-1 is an spectroscopically confirmed massive stellar cluster. It has a coexisting population of OB and RSG stars.

- The estimated distance of **3.5 kpc** place the cluster closer than the Scutum-Centaurus arm's base. Therefore, there is no association with the RSGC-complex.

- Age of **8 Myr**, derived from the presence of RSGs and O9V star.

- Masgomas-4 has two nuclei located at a common distance of **1.9 kpc**. At this distance, Masgomas-4 would have a size of **5.5 pc.**

- Masgomas-4 presents evidence of on-going massive star formation and stars evolving to the ZAMS, but only in nuclei B. The reason for the difference is unclear

- Estimated total mass of $\mathbf{1.94 \cdot 10^4}$ $\mathbf{M_\odot}$ for Masgomas-1 and $\mathbf{2.19 \cdot 10^3}$ $\mathbf{M_\odot}$ for Masgomas-4.