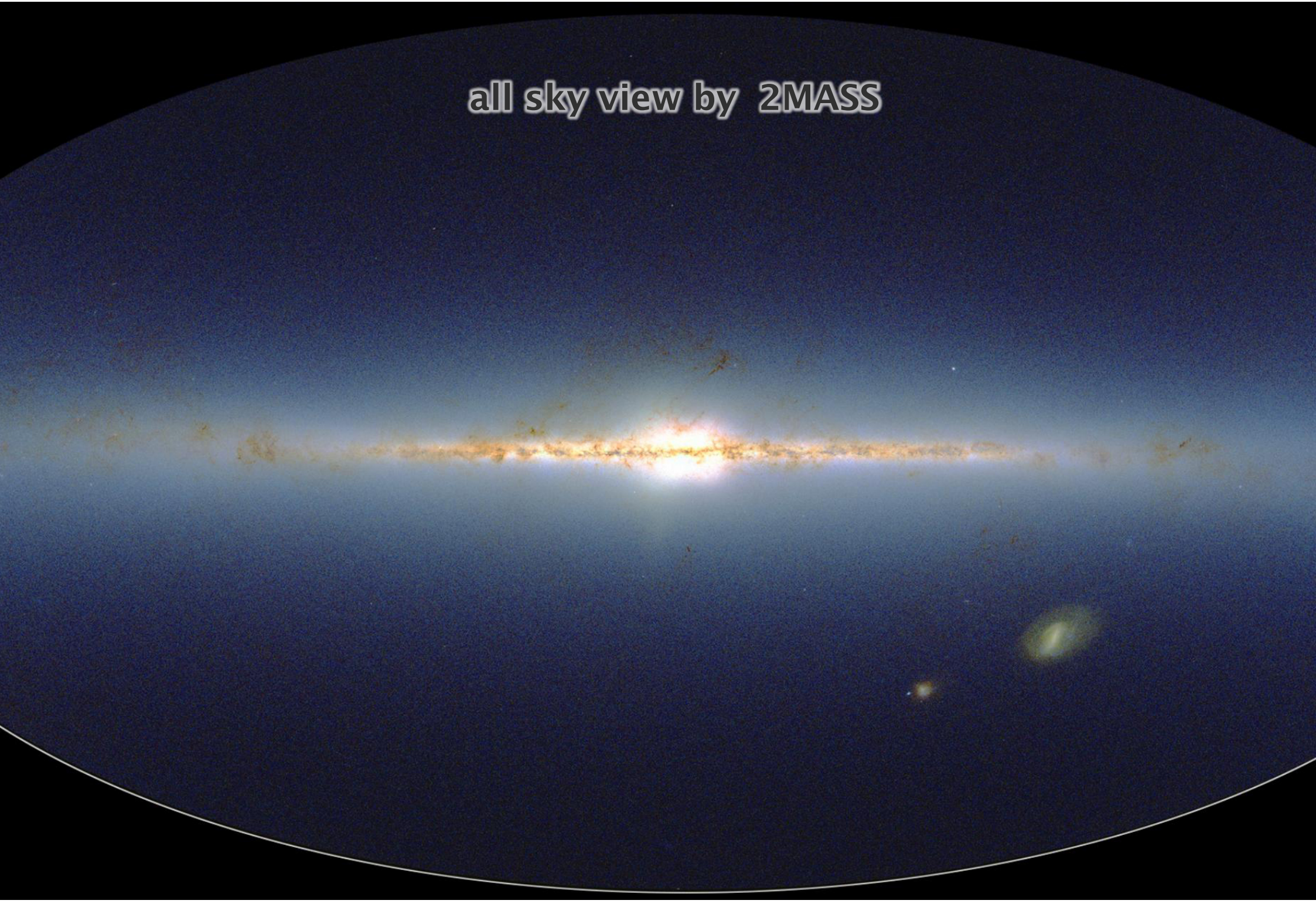

A starred walk in Inner Galaxy
by Maria Messineo (MPIfR)
GLIMPSE image
Bologna, 6-6-13

- Part 1- Structures in the inner Galaxy from kinematics of masing AGB stars and distribution of massive star clusters

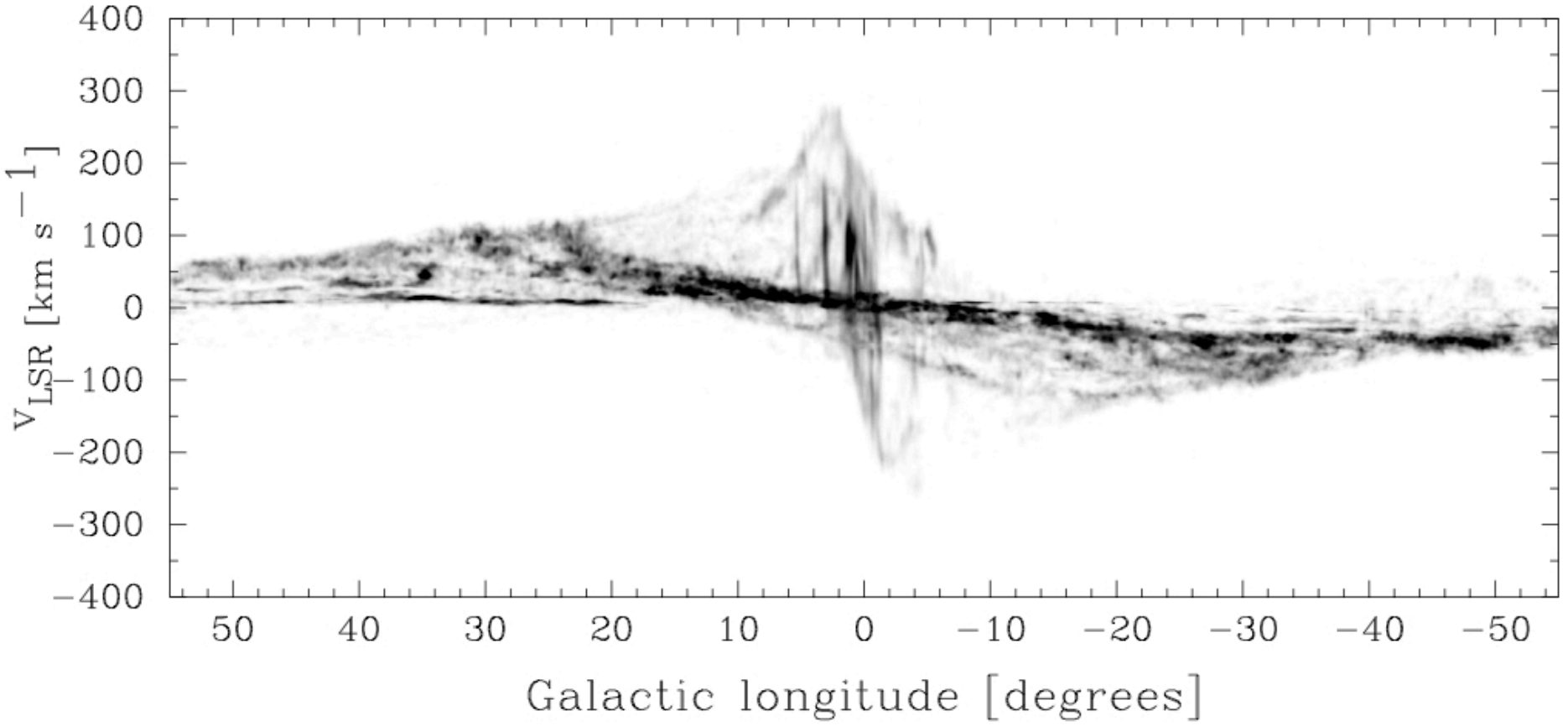
- Part 2- Overview of a few massive clusters

- Part 3- Improved efficiency with new selection criteria

- Part 1- Structures in the inner Galaxy from kinematics of masing AGB stars and distribution of massive star clusters

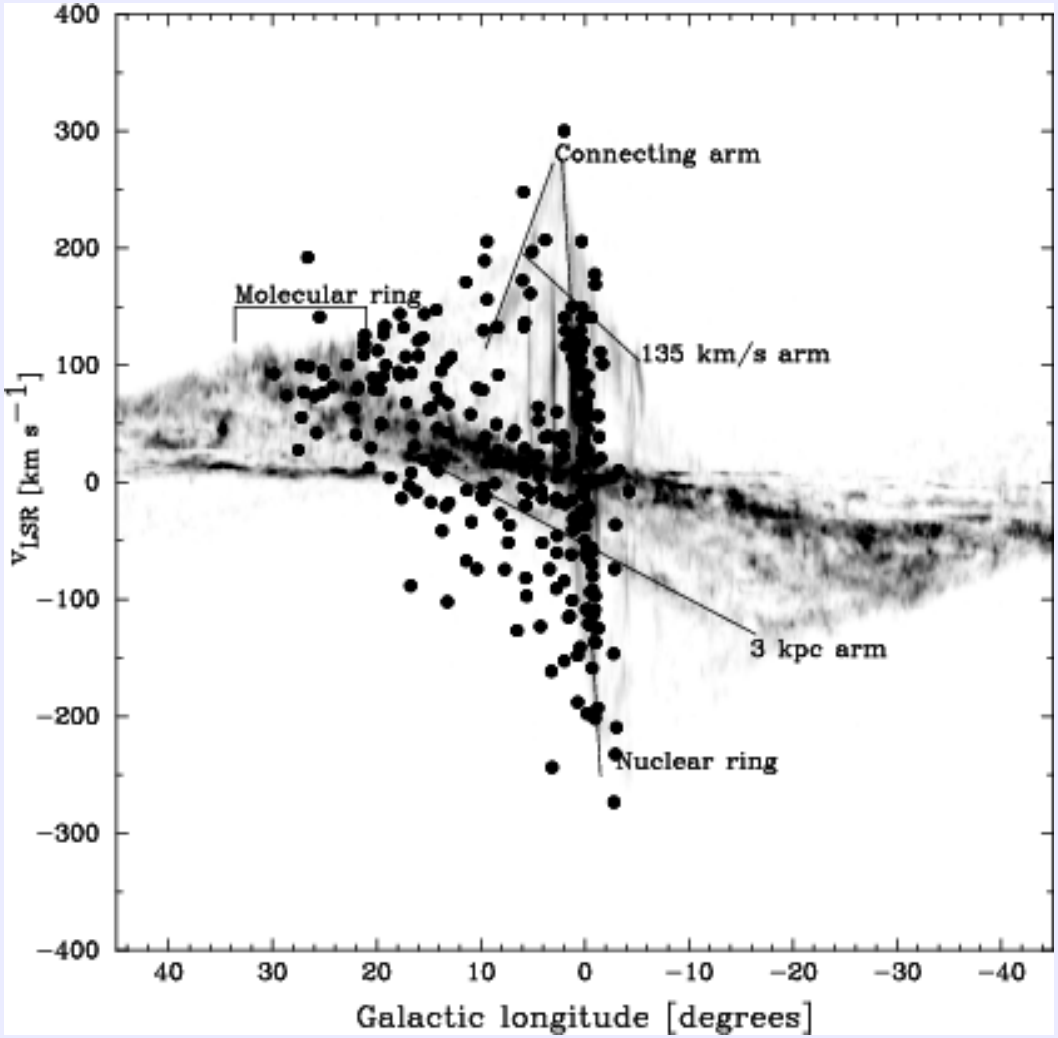

all sky view by 2MASS

Longitude-Velocity diagram from CO

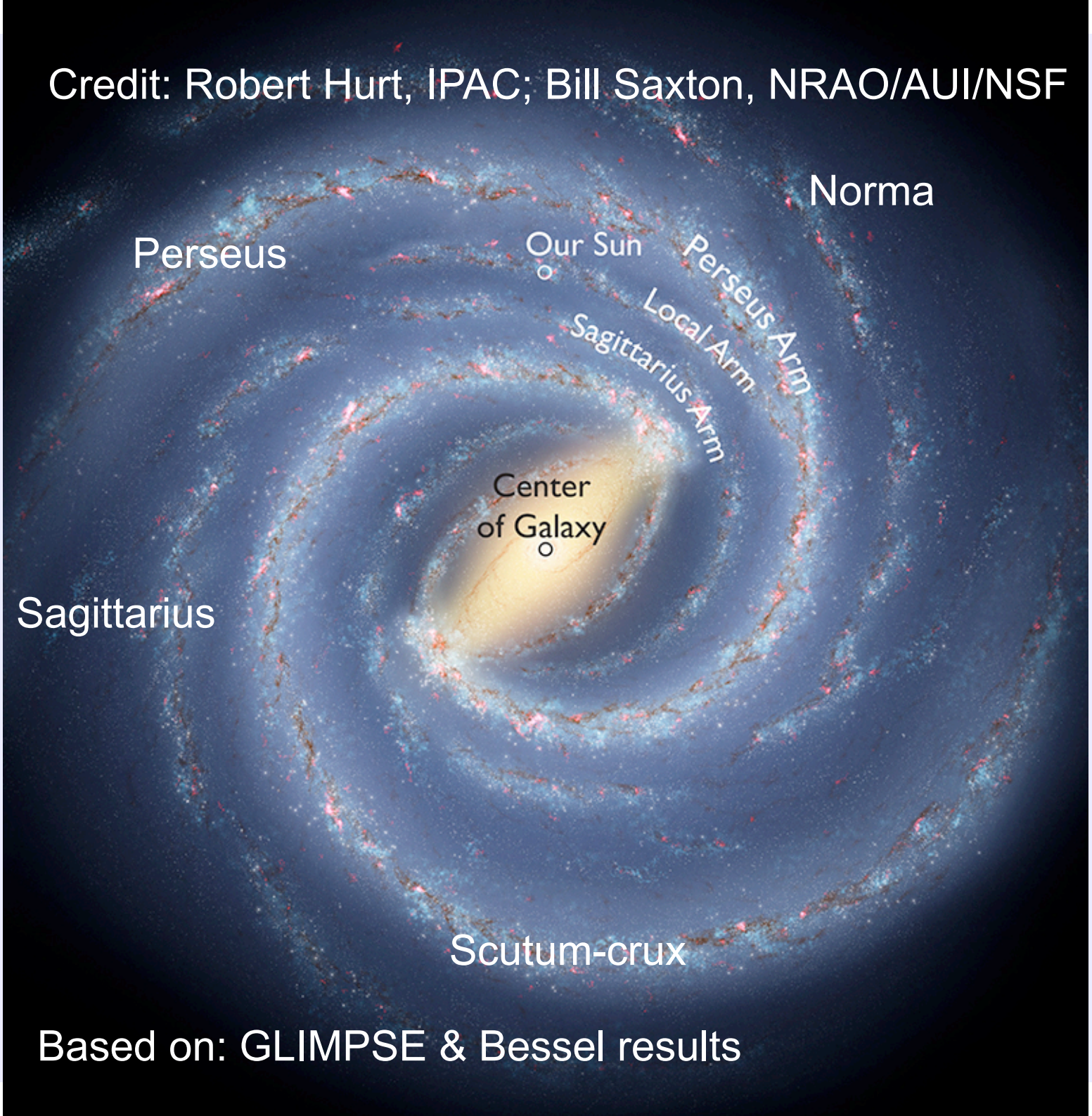


CO data from Dame et al. (2001)

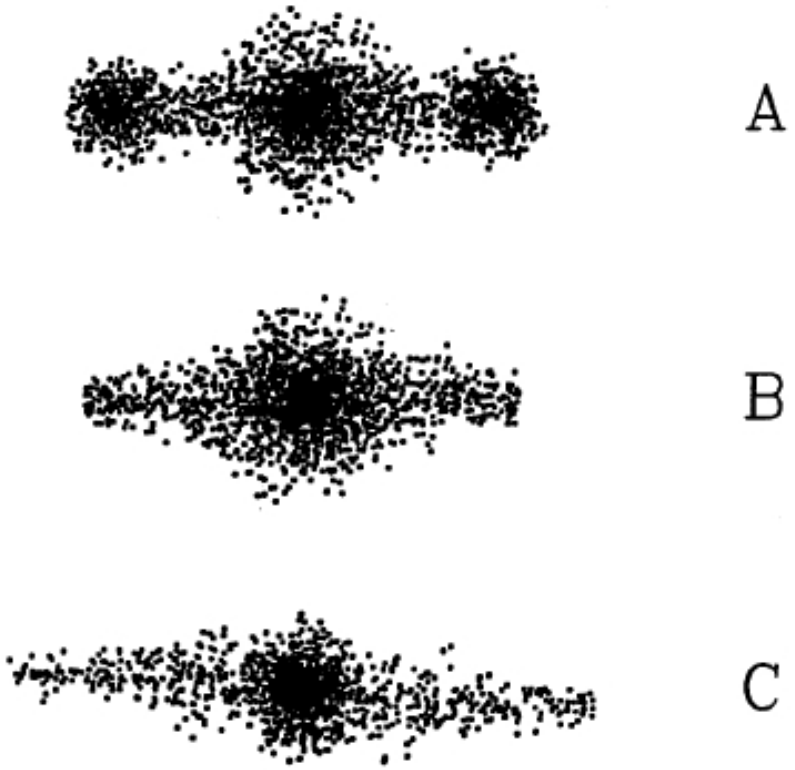
Longitude-Velocity diagram of SiO masing stars
Messineo et al. (2002)



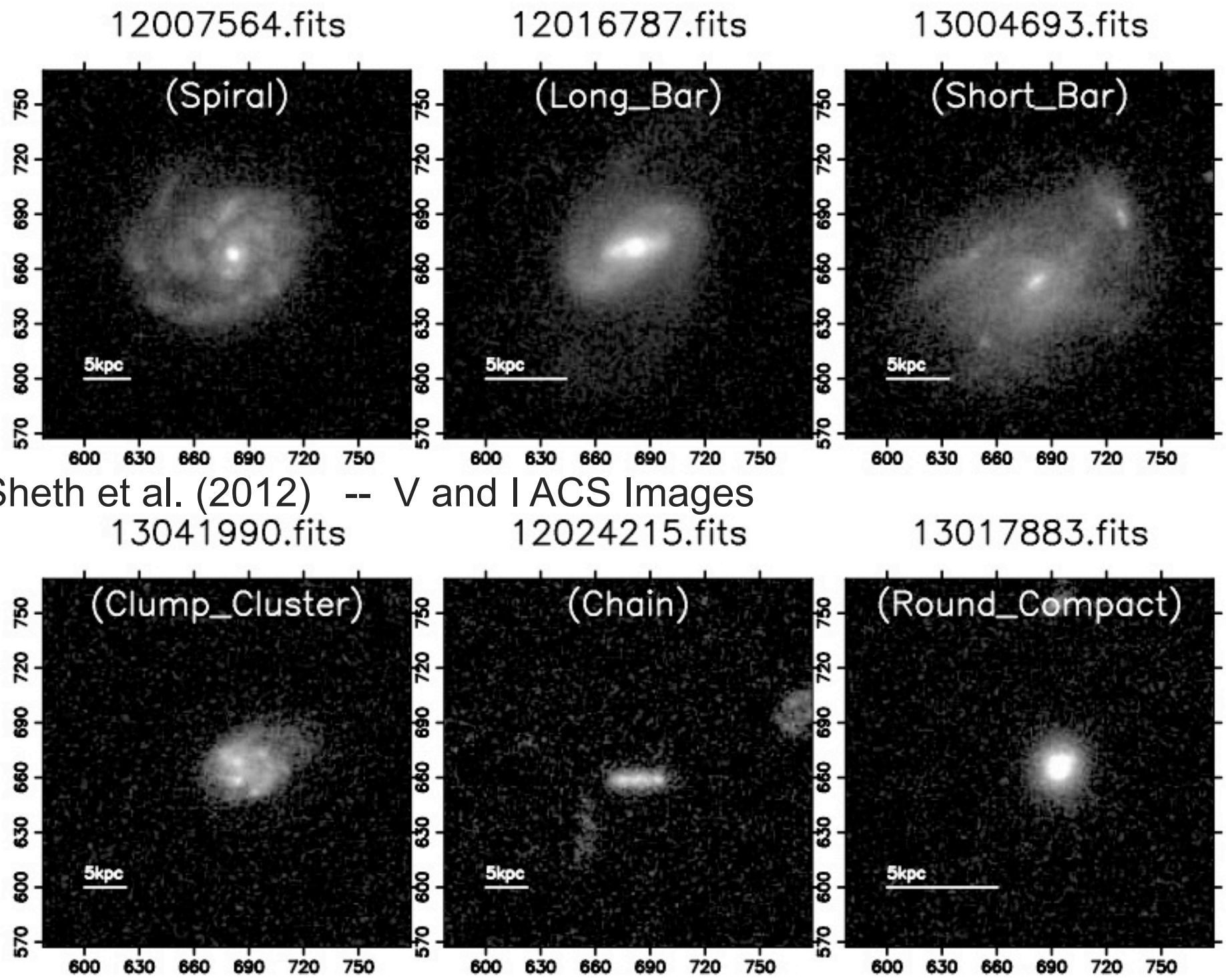
The maser velocities can only be interpreted with a weak barred potential. Habing et al. (2006)


Credit: Robert Hurt, IPAC; Bill Saxton, NRAO/AUI/NSF
Norma
Perseus
Our Sun
Perseus Arm
Local Arm
Sagittarius Arm
Center
of Galaxy
Sagittarius
Scutum-crux
Based on: GLIMPSE & Bessel results

Lepine & Leroy (2000) – Types of bars



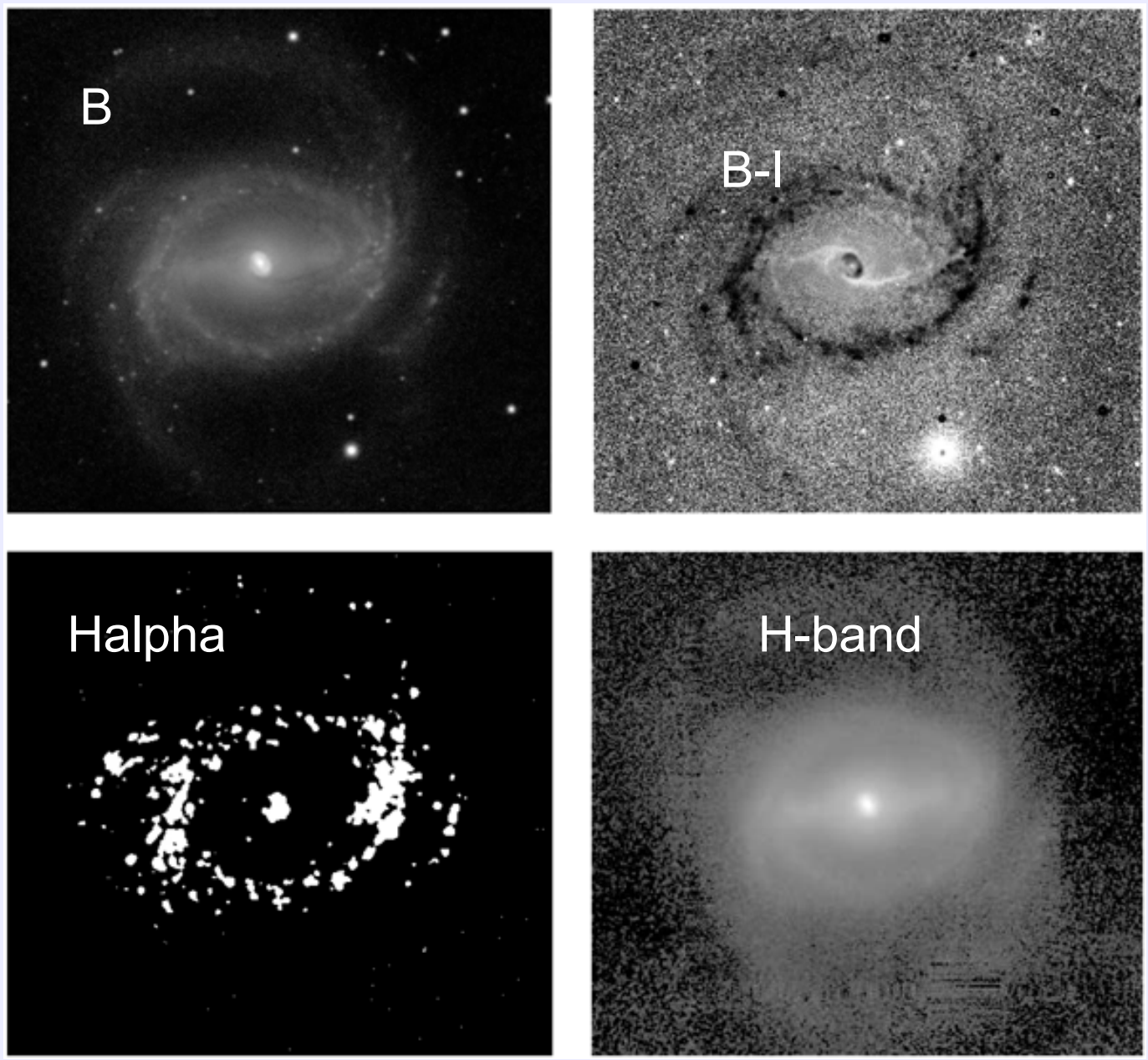
A) Central Disks/Rings and concentration of young massive clusters/ star forming complexes at the end-points are often seen in galaxies of the local universe.



Sheth et al. (2012) -- V and I ACS Images

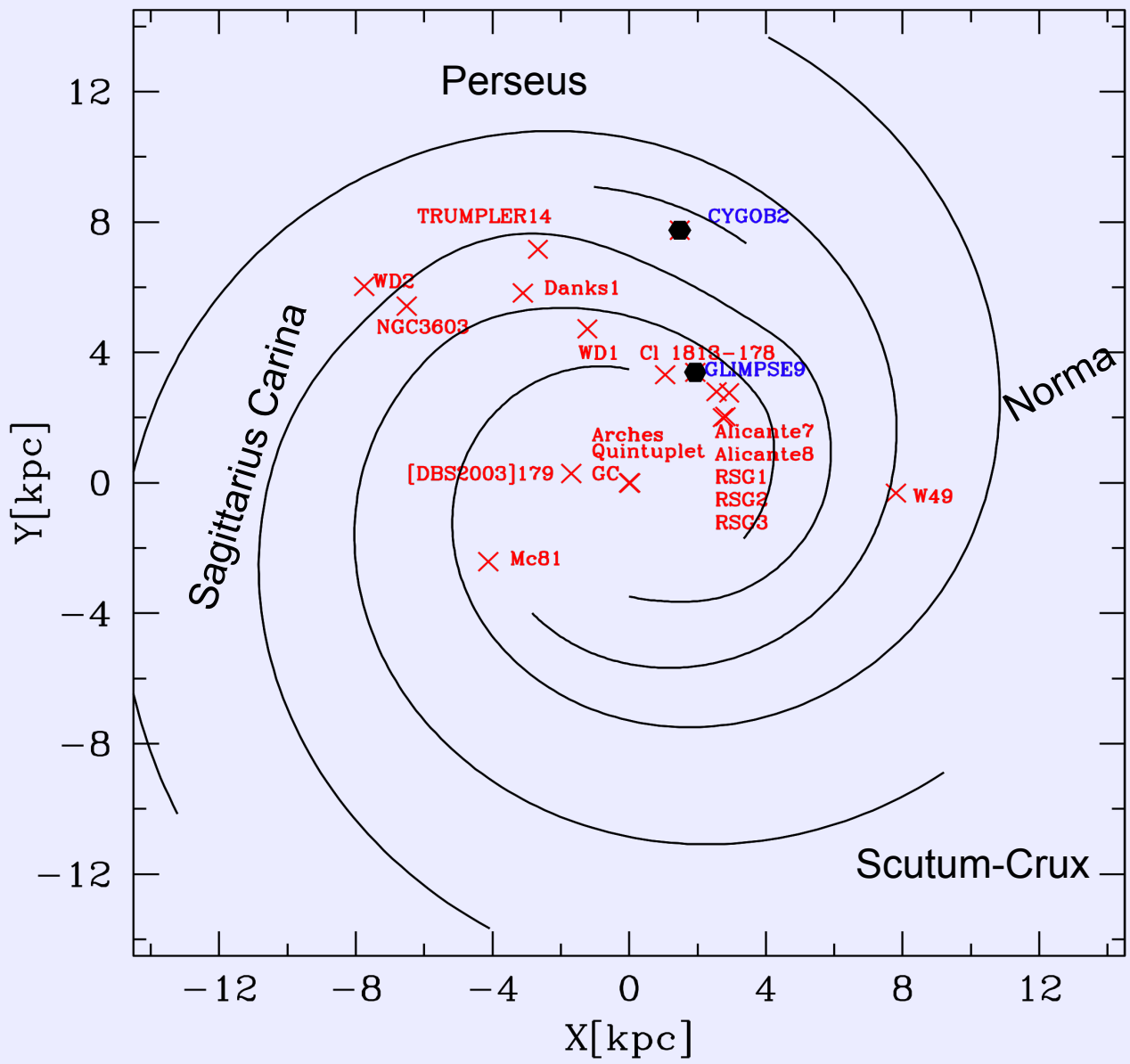
NGC 1433

Bar+rings



Treuthardt et al. (2008), Erwin 2004

Revised version of Fig. 15 in Messineo et al. (2009, ApJ 697, 701)



Cordes & Lazio (2002)

17 MASSIVE CLUSTERS IN THE MILKY WAY.

Revised version of Table 4 in Messineo et al. (2009, ApJ 697, 701)

Table 1. Galactic massive clusters ($> 10^4$ Msun) and $\log(\lambda) > 3$ $M_\odot \mathrm{pc}^{-3}$.

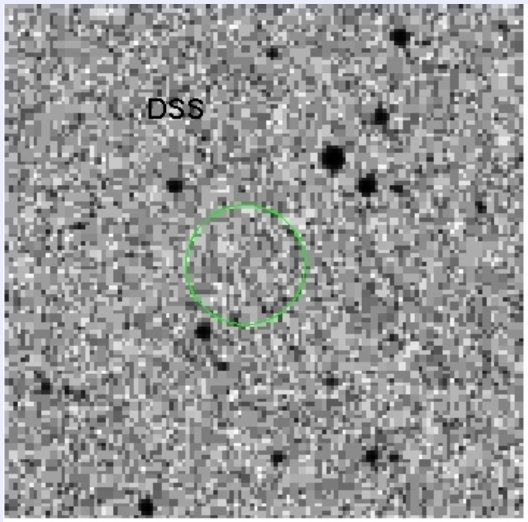
Cluster	Year	Lon [deg]	Lat [deg]	Distance [kpc]	Age [Myr]	Mass [10^3 $M_\odot$]	References
RSGC2		26.2	0.0	$5.8^{+1.9}_{-0.8}$	17 ± 3	40 ± 10	Davies et al. (2007)
Westerlund1	1987	339.5	−0.4	3.6 ± 0.2	3.6 ± 0.7	36 ± 22	Brandner et al. (2008)
RSGC1		25.3	−0.2	6.6 ± 0.9	12.0 ± 2.0	30 ± 10	Davies et al. (2008)
RSGC3		29.2	−0.2	6 ± 1	18.0 ± 2.0	30 ± 10	Clark et al. (2009)
Arches		0.1	0.0	7.62 ± 0.32[a]	2.5 ± 0.5	~ 20	Figer (2008); Figer et al. (19
Quintuplet		0.2	-0.1	7.62 ± 0.32[a]	4 ± 1	~ 20	Figer (2008); Figer et al. (19
GC central		0.0	0.0	7.6 ± 0.3[a]	6.0 ± 2.0	20	Martins et al. (2007)
NGC3603	1965	291.6	−0.5	6.0 ± 0.8	< 2.5	13 ± 3	Harayama et al. (2008)
Mc81		338.4	0.0	11.0	3.7	> 10	Davies et al (2012)
Trumpler14	1973	287.4	−0.6	~ 2.8	3.25 ± 2.75	10 ± 1	Ascenso et al. (2007b)
W49A		43.2	0.0	11.4 ± 1.2	1.2 ± 1.2	~ 10	Homeier & Alves (2005)
Cl1813-178		12.7	0.0	3.6 ± 0.7	4.5 ± 0.5	> 10	Messineo et al. (2008,2011)
Alicante 7-RSGC5		29.2	−0.2	6 ± 1	18.0 ± 2.0	> 10	Negueruela et al. (2011)
Alicante 8-RSGC4		24.6	0.4	6.6 ± 0.9	20	~ 10	Negueruela et al. (2010)
Danks1		305.34	+0.1	3.8 ± 0.6	$1.5 \pm^{1.5}_{-0.5}$	> 8	Davies et al. (2012)
Westerlund2	1973	284.3	−0.3	~ 2.8	2.0 ± 0.3	> 7[c]	Ascenso et al. (2007a)
DBS2003-179		347.6	0.2	7.9	2-5	> 7	Borissova et al. (2008)

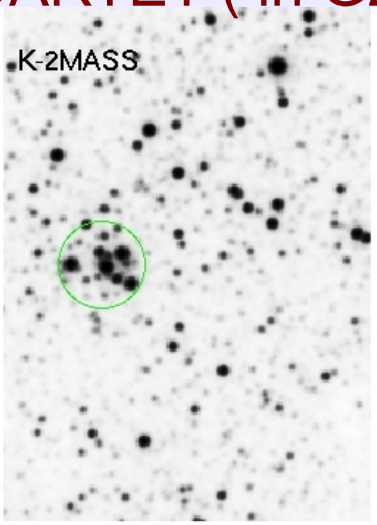
Note. — For each cluster, names and Galactic coordinates are followed by distances, ages, masses, and references.

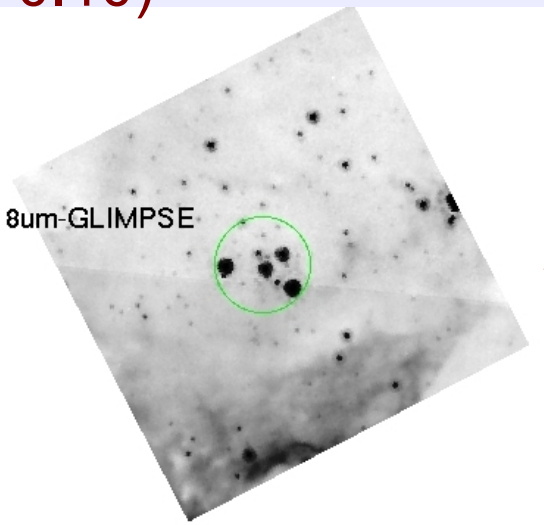
[a]Distance to the Galactic center as given by Eisenhauer et al. (2005).

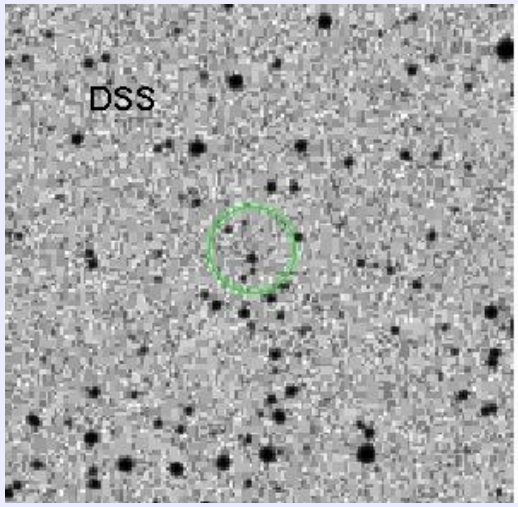
- Part 2- Overview of a few massive clusters

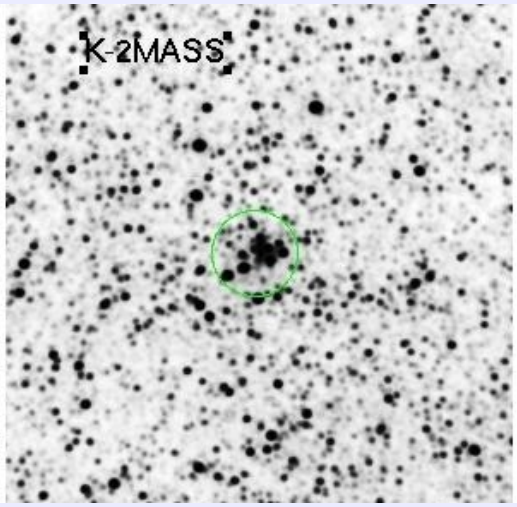
QUARTET (in G24.84+0.10)

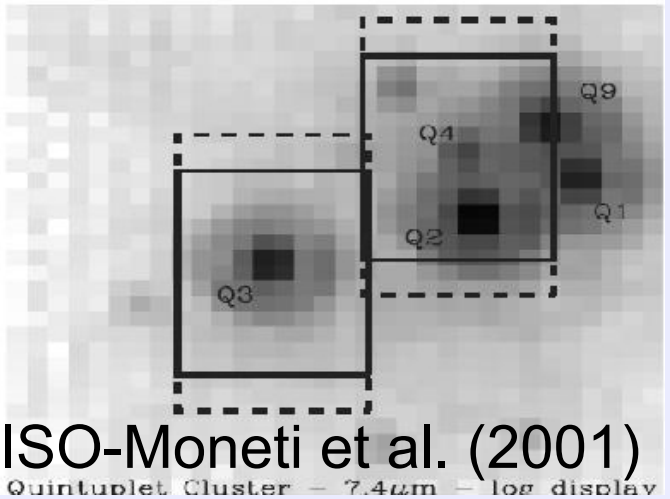












ISO-Moneti et al. (2001)

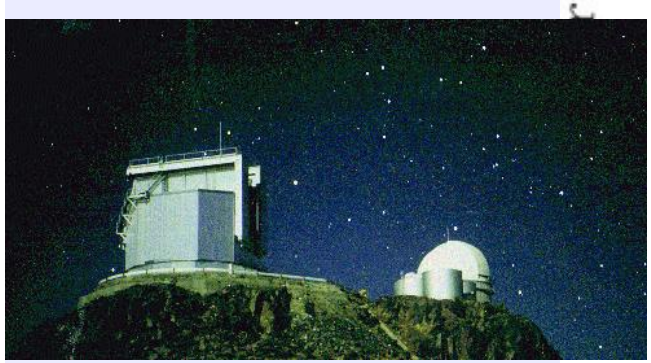
Quintuplet Cluster – 7.4μm – log display

Messineo M., Davies B., Valentin I., Figer D., Schuller F., Habing H., Menten K., Petr-Gotzens, M. (2009, ApJ 697, 701)

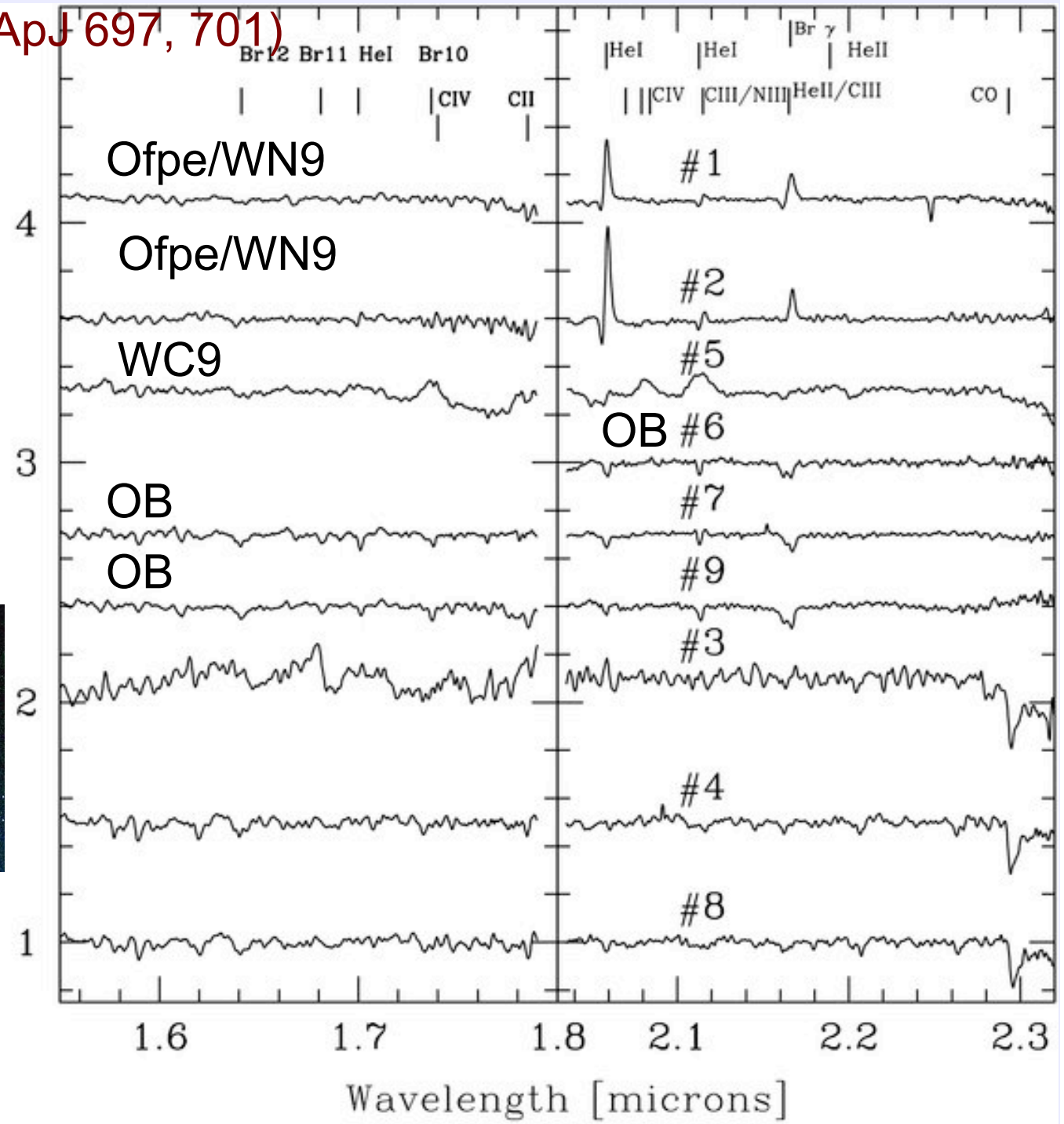
Messineo et al. (2009, ApJ 697, 701)

QUARTET

SofI



Ak=1.6 mag
D=6.3 pm 2 kpc
Age 3-8 Myrs



Cl 1813-178

Messineo M., Figer D., Davies B., Rich M., Valenti E., Kudritzki P.R. (2008),

ApJL, 683, 155

SNR G12.82-0.02
(diam=2.9 pc)

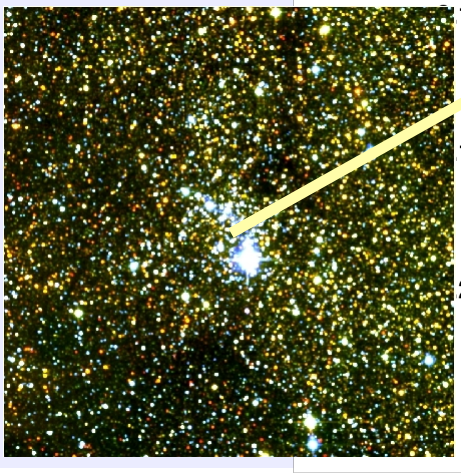
HESS J1813-178

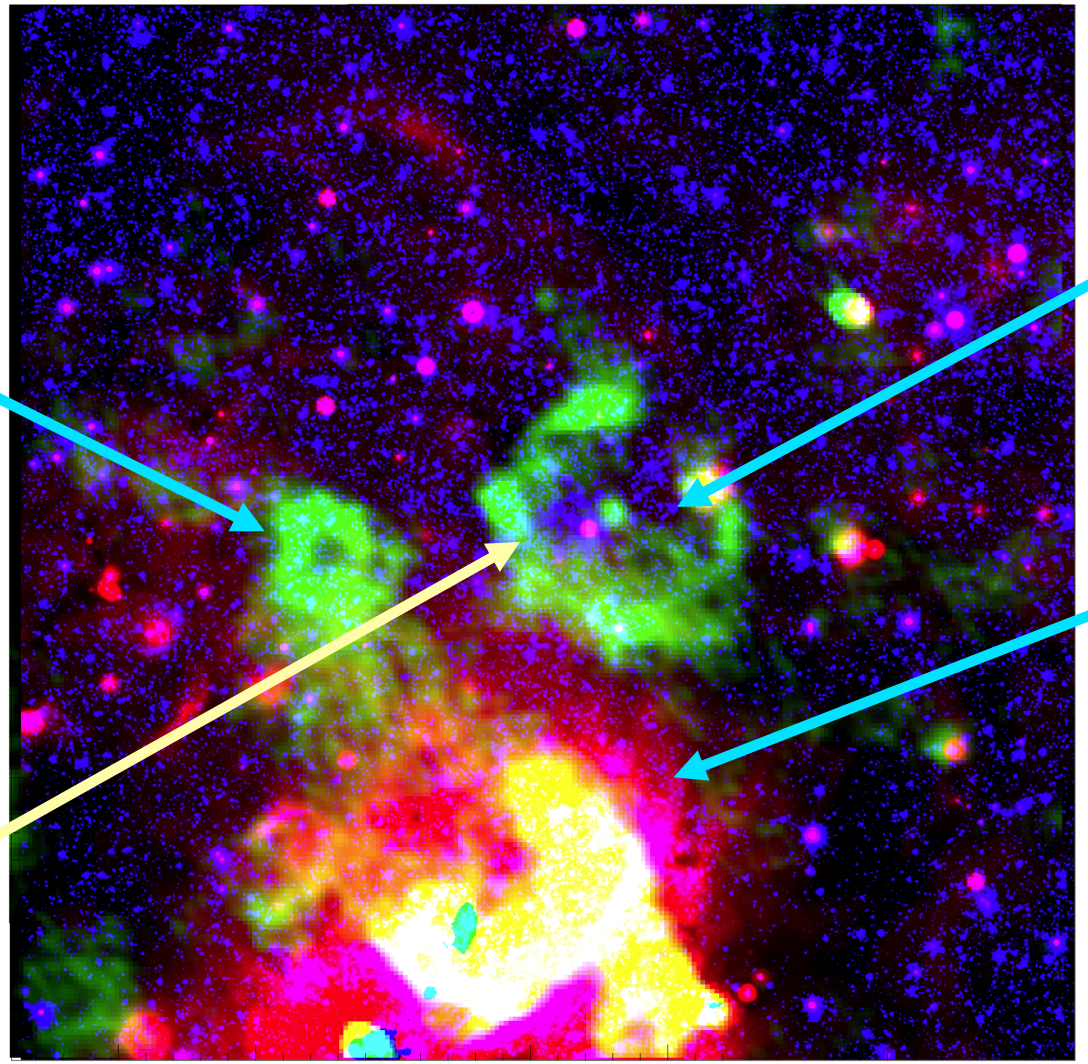
SNR G12.72-0.0

Diam 5.8 pc

W33

2MASS



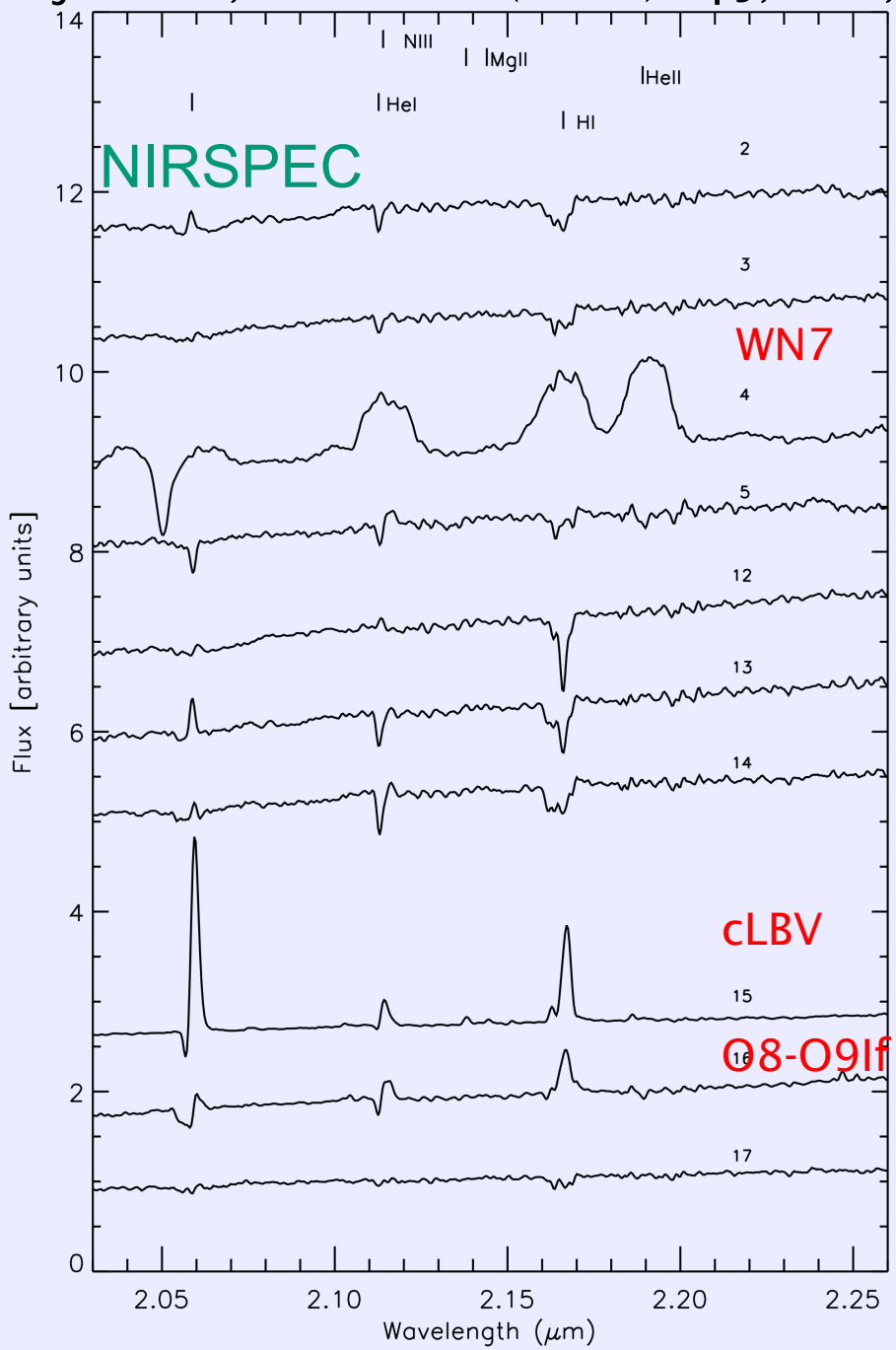


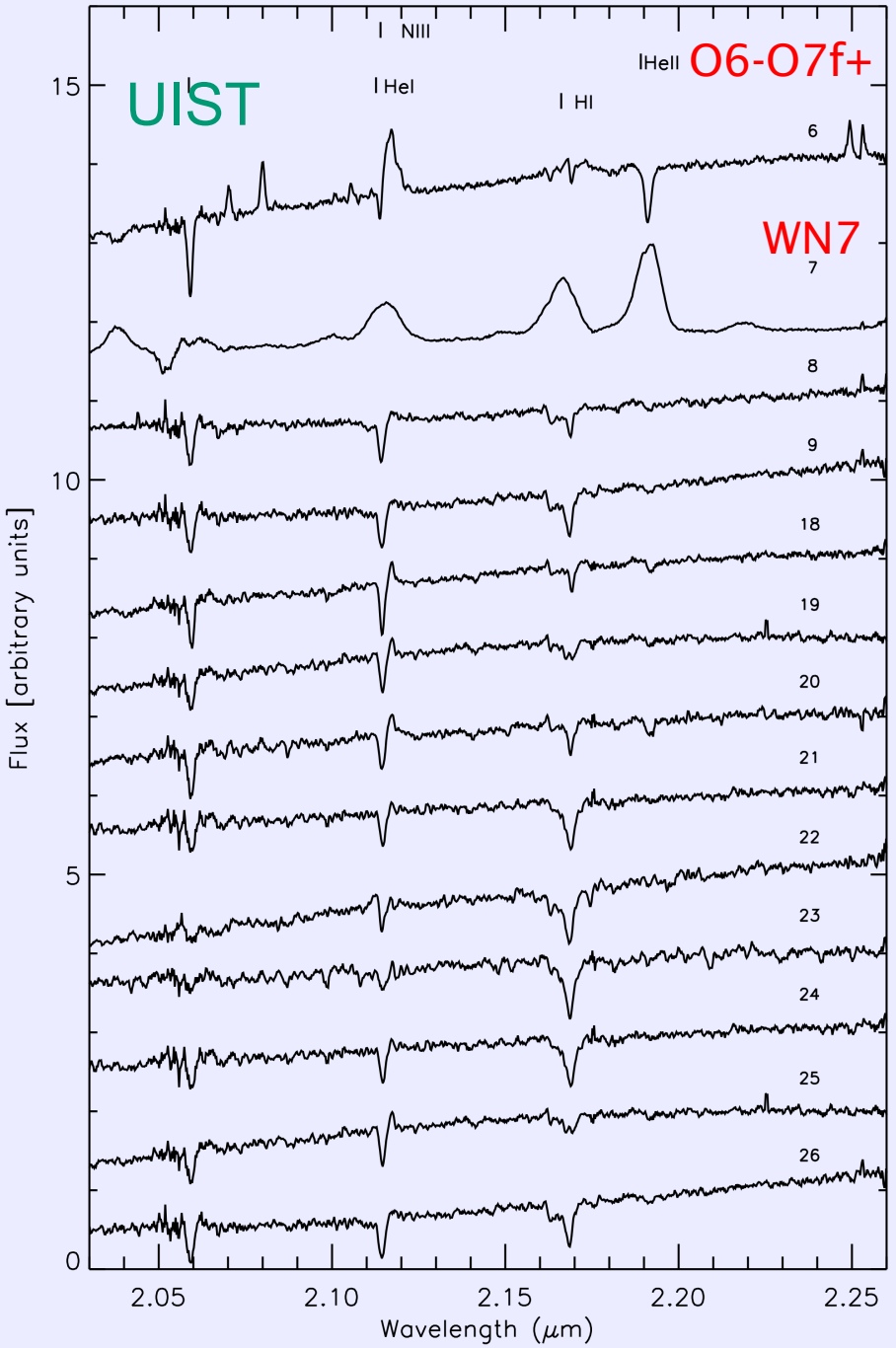
3.6 um

8 um

90 cm

Messineo M., Davies B., Figer D., Kudritzki P.R., Valenti E., Trombley C., Najarro F., Rich Mike (2011) ApJ, 733,41





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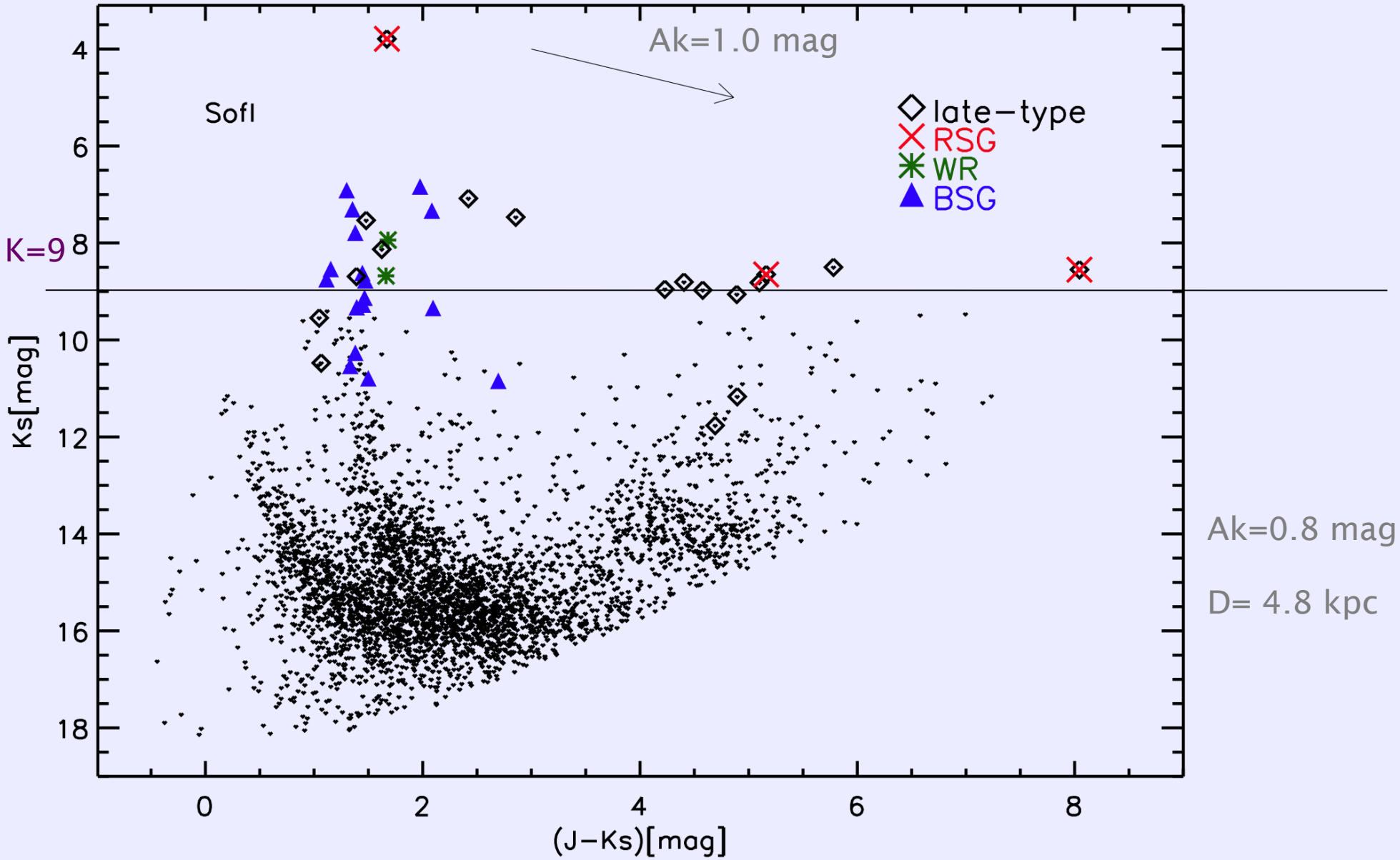

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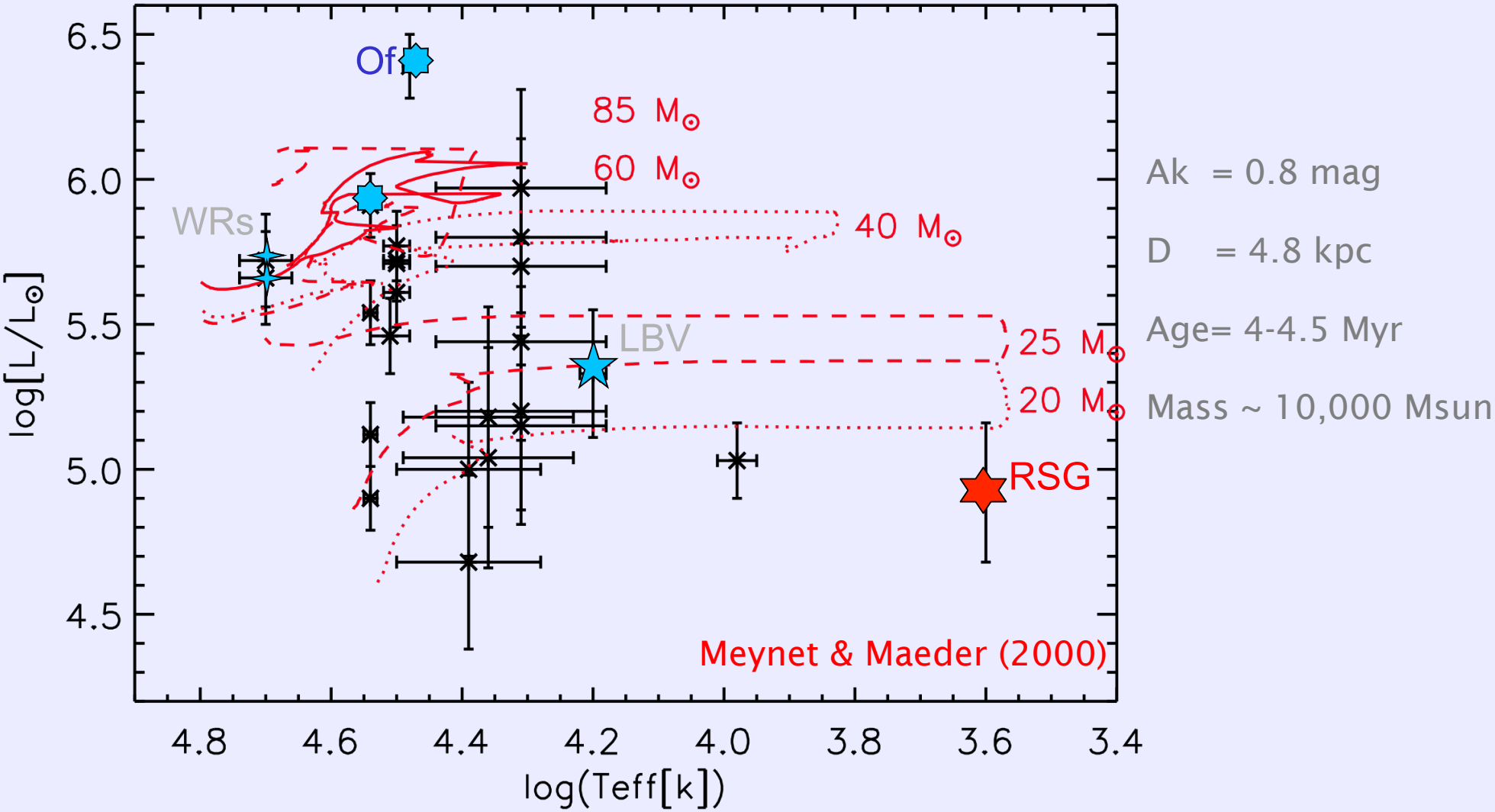


Ak = 0.8 mag

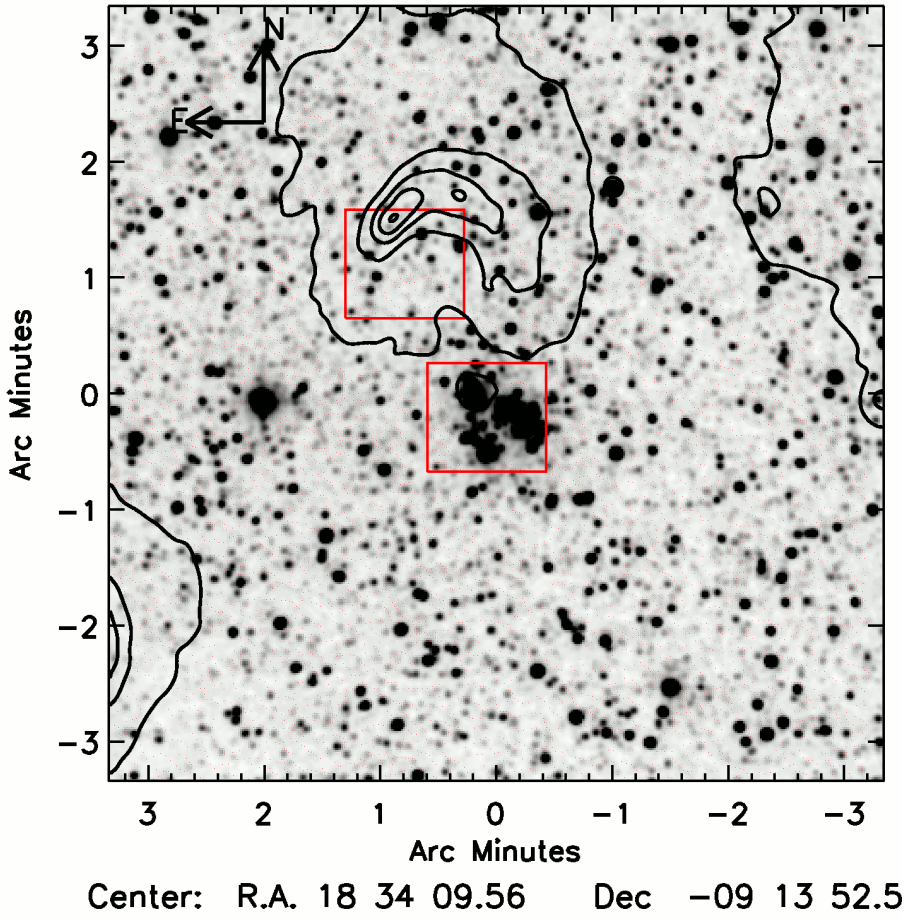
D = 4.8 kpc

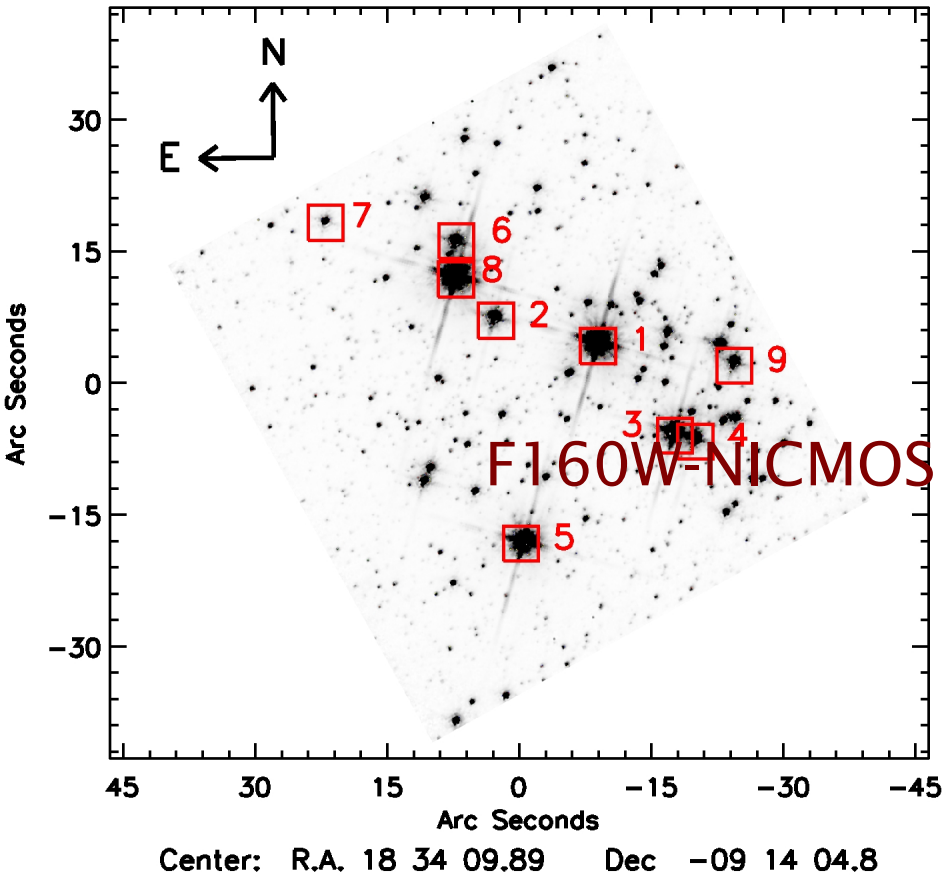
Age= 4-4.5 Myr

Mass ~ 10,000 Msun

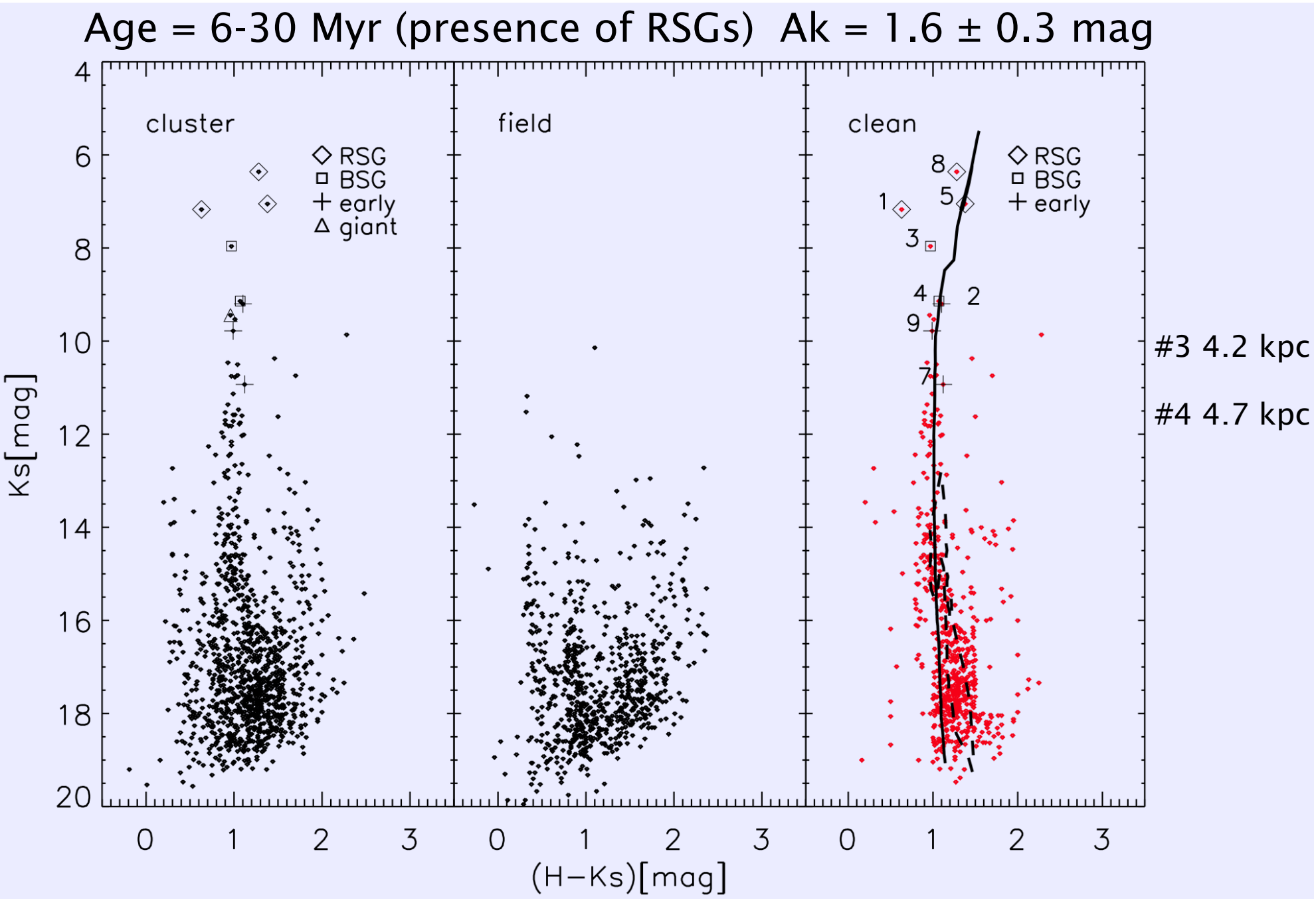
GLIMPSE9: location (l,b)=(22.76°, -0.40°)

4.5 kpc





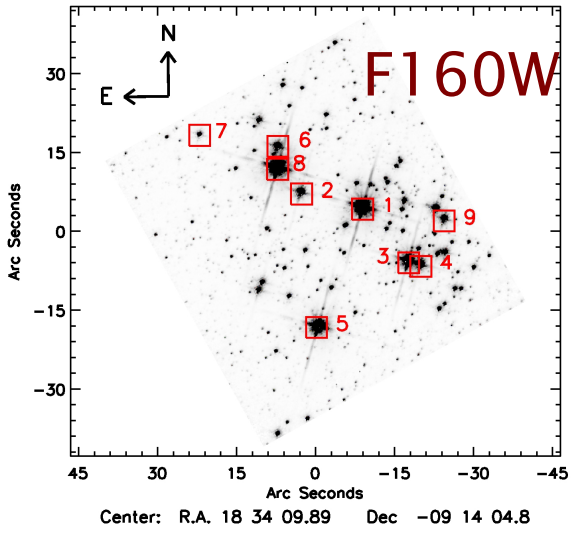
Messineo M., Figer D. F., Davies B., Kudritzki R. P., Rich R. M., MacKenty J. , Trombley C. 2010 ApJ, 708, 124

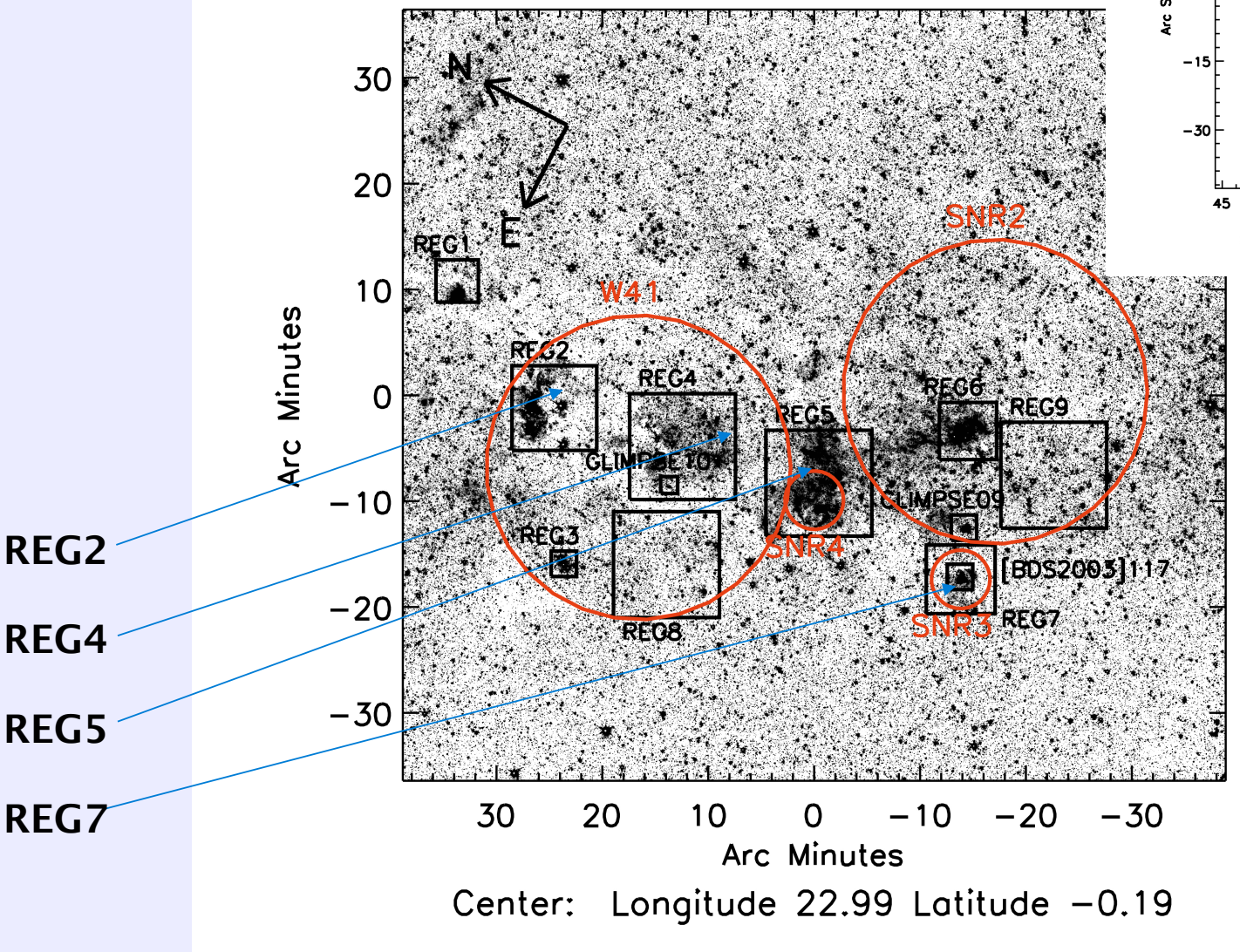


Messineo M., Figer D. F., Davies B., Kudritzki R. P., Rich R. M., MacKenty J. , Trombley C. 2010 ApJ, 708, 124

GLIMPSE9: location (l,b)=(22.76°, -0.40°)

4.5 kpc





Messineo M., Figer D. F., Davies B., Kudritzki R. P., Rich R. M., MacKenty J. , Trombley C. 2010 ApJ, 708, 124

Summary

Quartet, GLIMPSE9, and CL1813-178 are two young clusters, rich of massive stars.

The combination of radio, mid and near-infrared data allowed us to detect massive clusters.

- Part 3- Improved efficiency with new selection criteria

KNOWN stellar clusters in the Milky Way

Census is limited by observational incompleteness

NUMBER OF CLUSTERS	DATABASE
OPTICAL:	
1748	WEBDA Mermilliod & Paunzen (2003)
1766	Dias et al. (2002)
INFRARED:	
647 candidate clusters	from 2MASS search in direction of radio/visual nebulae (e.g. Dutra & Bica 2003)
92	2MASS + GLIMPSE (Mercer et al. 2005)
1021	2MASS (Froebrich et al. 2007)
153	2MASS (Glushkova et al. 2009)
96	VVV Vista Survey (Borissova et al. 2011)

Year	N	Ncl
2012	**128**	**2**
2011	135	2
2010	137	1
2009	139	1
2008	188	1
2007	180	1

N = Number of referred paper listed by ADS with the keywords “Galactic open clusters”

Ncl = number of massive clusters newly discovered

Identification of massive stars and massive clusters are not an easy task.

Spectroscopy is expansive and only possible for a limited number of targets.

New efficient searches based on photometric classification of bright targets are mandatory.

Can we improve the current statistic of massive stars and clusters?

Why?

Galactic structure

Stellar evolution

Extragalactic EVLT preparation

How?

via their massive content

GALACTIC MASSIVE STARS

Predictions by Gehrz 1989

in the Milky Way, we know about:

500 (1000) RSGs (119 in clusters) 5000 M-type RSGs

226 WR stars (van der Hucht 2001) 3000 WR + …

A dozen confirmed LBVs (Clark et al. 2005)

Several thousands of AGBs have been detected via their maser emission, or photometric pulsation properties (e.g. Alard et al. 2001; Glass et al. 2001; Habing et al. 2006; Messineo et al. 2002; Sevenster 2002; Deguchi et al. 2004, and references therein).
(9 millions Miras).

The Q1 and Q2 Parameters

Messineo M., Menten K., Churchwell E., Habing H. (2012), A&A, 537, 10

We study near-infrared and mid-infrared color properties of known Galactic evolved stars and we define some color-criteria for selecting new bona-fida WR stars, RSG stars, and AGB stars.

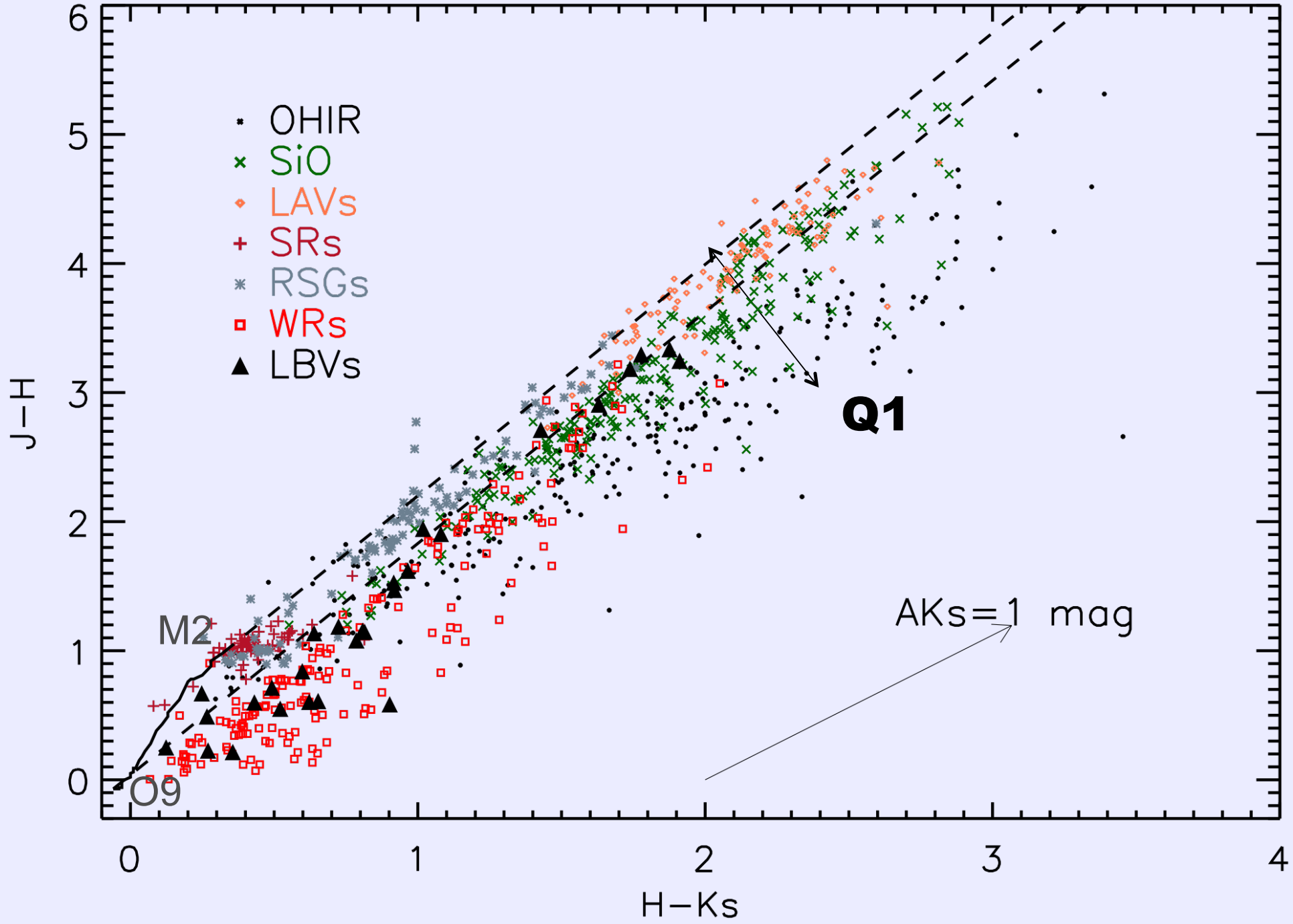
WRs 81 MSX - 226 GLIMPSE

LBVs 24 MSX - 15 GLIMPSE

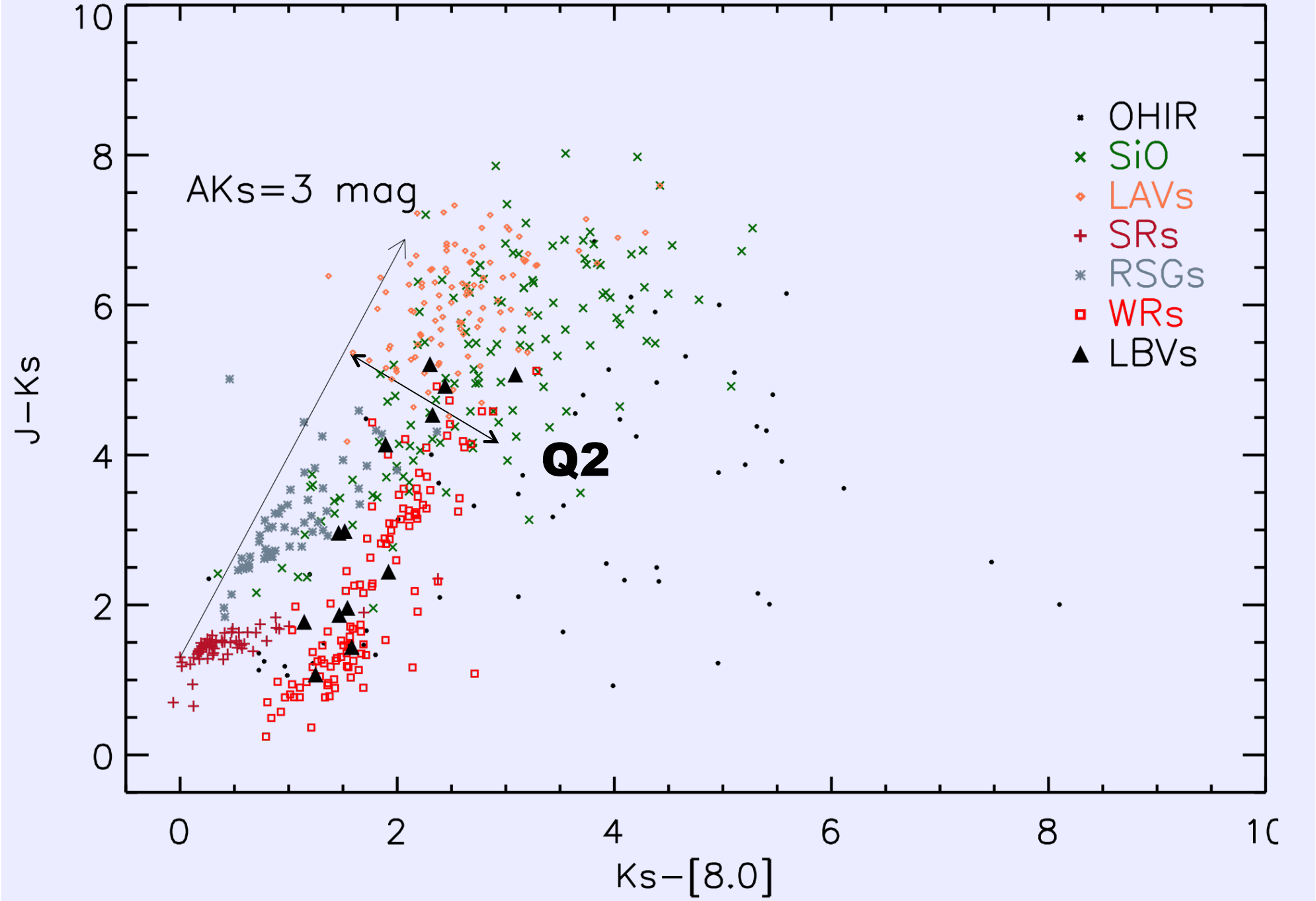
RSGs 79 MSX – 69 GLIMPSE (24% SRs, mostly Lc, rarely Miras)

AGB: SRs (DeltaV<2.5, P <200d)
Miras (DeltaV>2.5mag, mostly P > 100)
SiO stars (SiO maser emission, mostly Miras)
OH/IR stars (1612 MHz OH maser, mostly P>600)

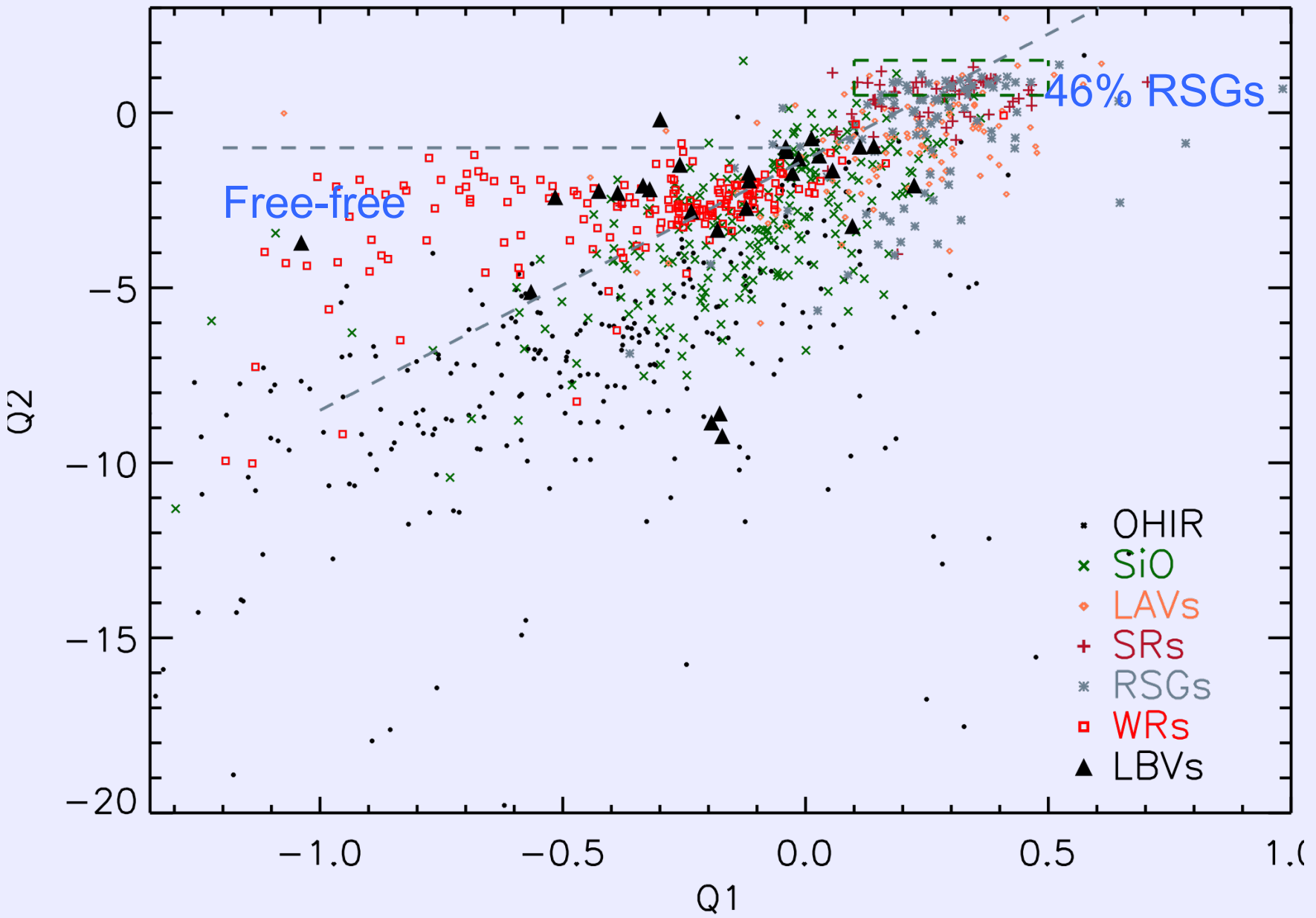
Messineo, M., Menten, K., Churchwell, E., & Habing H. et al A&A, 537, A10 (2012)



Messineo, M., Menten, K., Churchwell, E., & Habing H. et al A&A, 537, A10 (2012)



Messineo, M., Menten, K., Churchwell, E., & Habing H. et al A&A, 537, A10 (2012)



Conclusions:

With the inclusion of color criteria is possible;

--to select massive clusters

--to select candidate RSGs

--to select free-free emitters

This is particular useful to select massive stars in
The inner obscured regions of the Milky Way.

THANK YOU