



Bright late-type stars - Red Supergiants In the Inner Galaxy

Aprim17

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I like to thank several friends and collaborators

Quingfeng Zhu - USTC

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Valentin D. Ivanov - ESO

Rosie Chen - MPIfR

Harm Habing - Leiden Univ

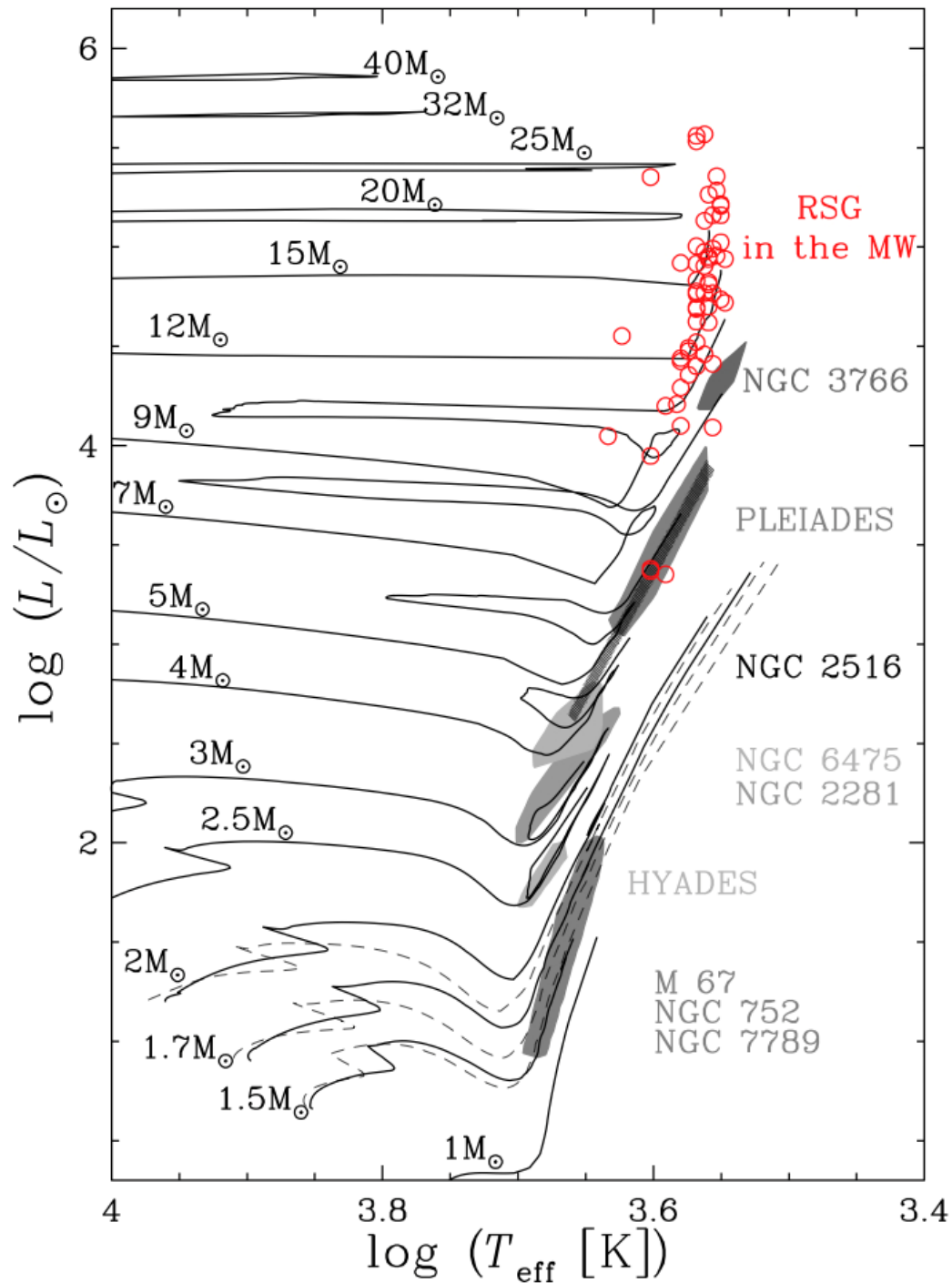
Ed Churchwell - Wisconsin-Madison Univ.

Red Supergiants

Why: Galactic structure (e.g. spiral arms)
ISM-metallicity
ISM-shapers
Distance indicators

What: Stars $> 8 M_{\text{sun}}$
Fate: BH or NS
initial mass, Z, Winds, rotation, B

Where: in Clusters/Associations
isolated ?

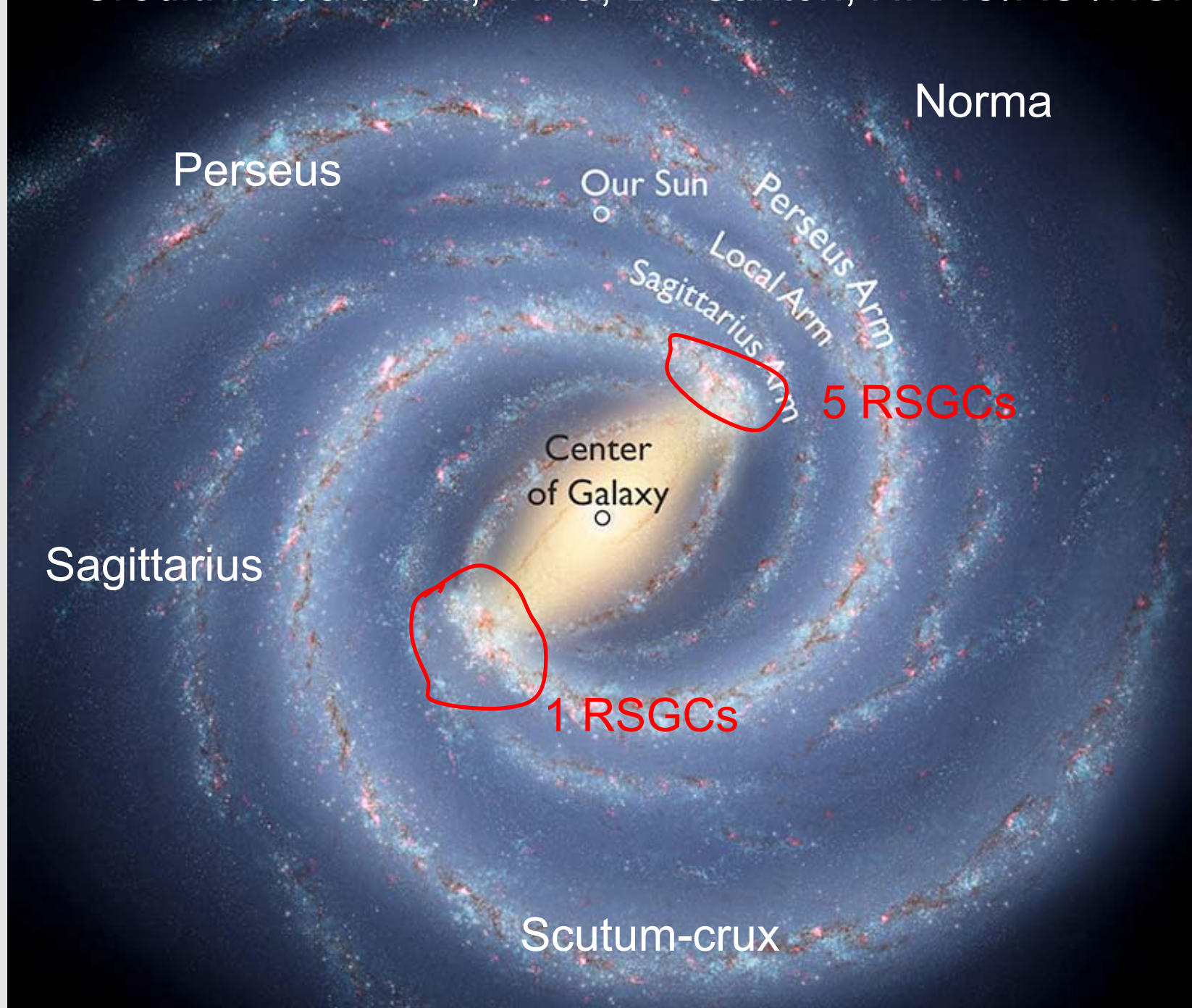


Ekstroem et al. 2012

Levesque et al. 2005

Rotating models

Credit: Robert Hurt, IPAC; Bill Saxton, NRAO/AUI/NSF

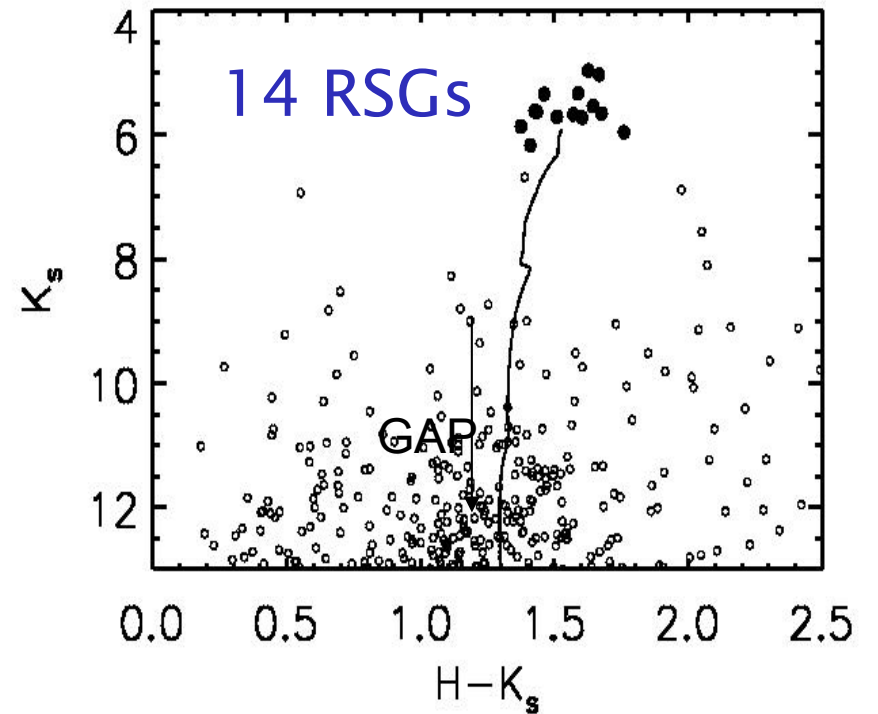


Based on: GLIMPSE & Bessel results

A infrared stellar cluster rich in RSGs: RSGC1



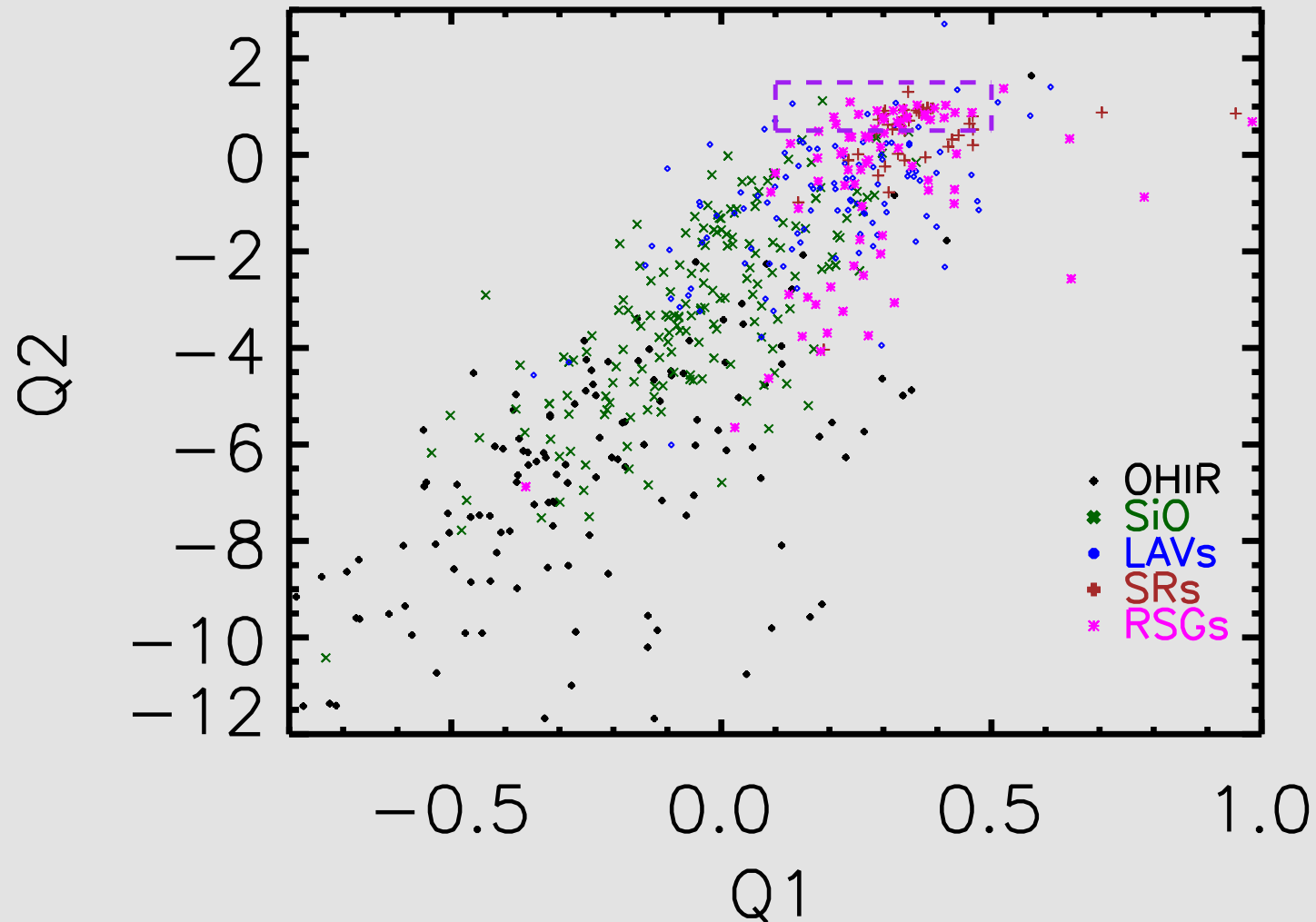
Images: 2MASS



Figer et al. (2006)

Color selection

$$Q1 = (J-H) - 1.8 \times (H-Ks); \quad Q2 = (J-Ks) - 2.69 \times (K-[8.0])$$



Targets for an infrared search

$$Q1 = (J-H) - 1.8 \times (H-Ks); \quad Q2 = (J-Ks) - 2.69 \times (K-[8.0])$$

- $Q1 = 0.1 - 0.5$

- $Q2 = 0.5 - 1.5$

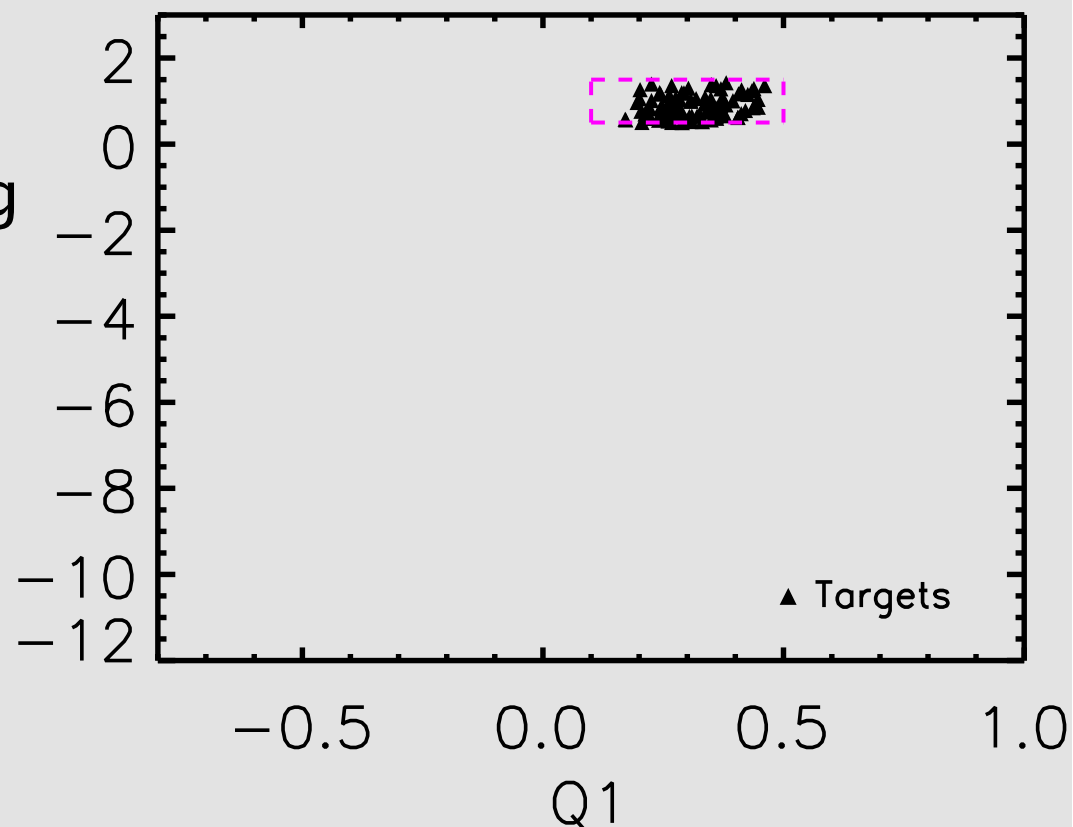
GLIMPSE North1-2MASS catalog

- $Ks < 7$ ~9000 stars

- $Aks > 0.4$ mag

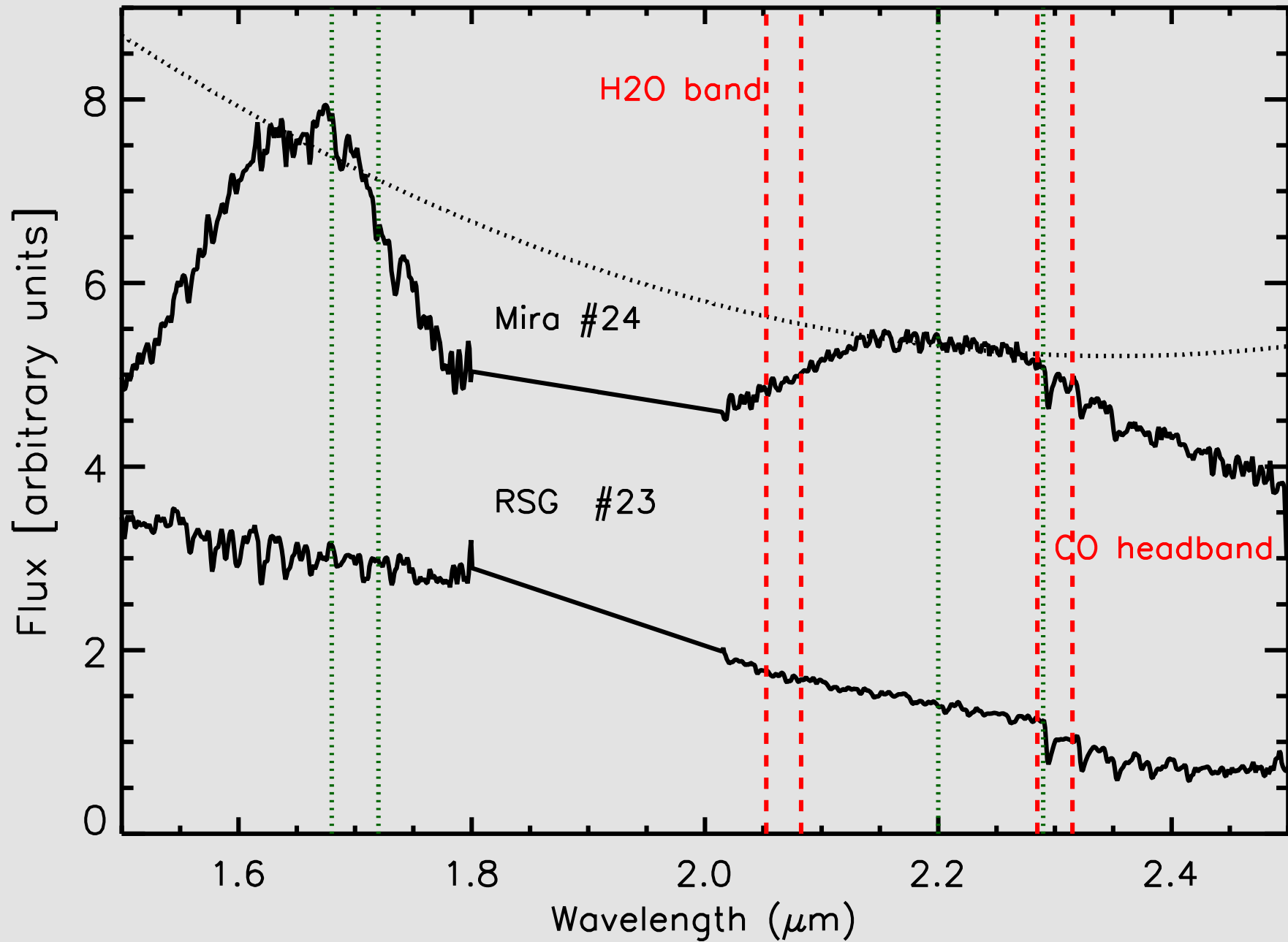
- $Mbol < -6.1$ for 4 kpc
i.e. $Ks < 4 + Aks$

~130 stars of which 94 were spectroscopically observed



Messineo M., Zhu Q., Menten K.M., Ivanov V.D., Figer D.F., Kudritzki R.P., Chen C.-H. R. (2016, ApJ, 822, 5)

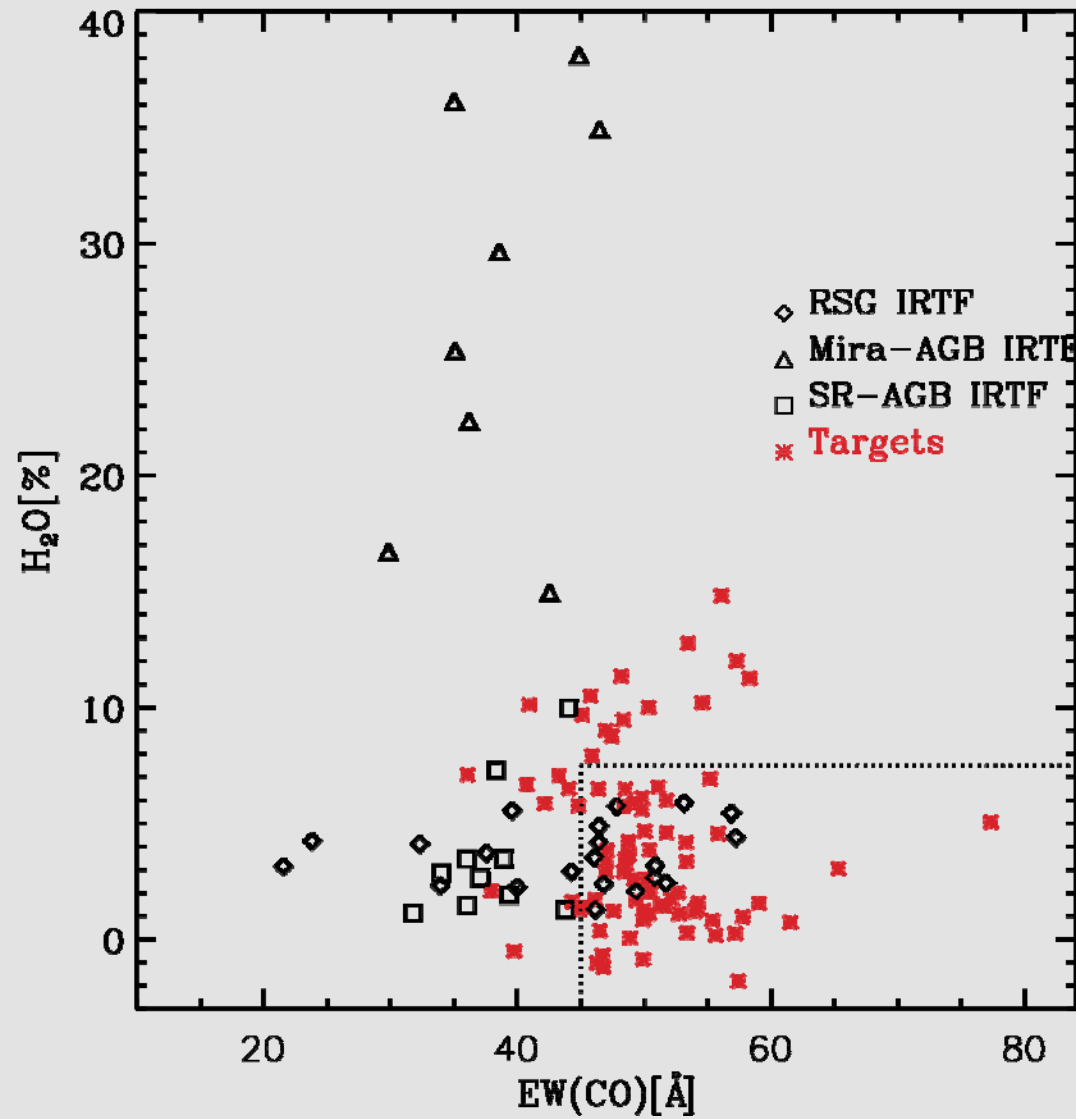
ESO/NTT/SofI R=1000



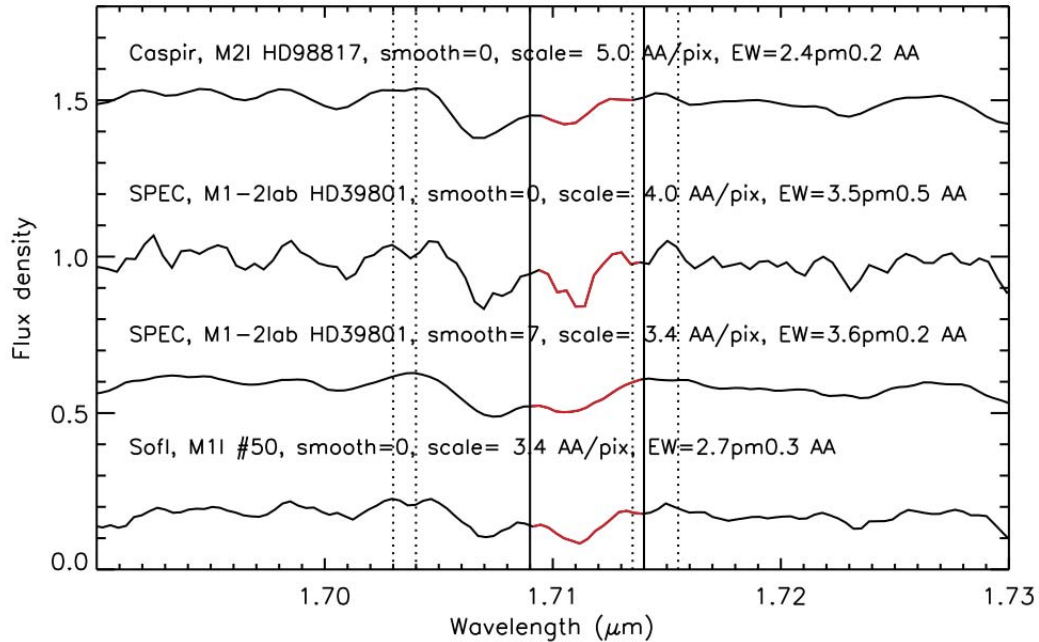
Water index is defined as in Blum et al. 2003, ApJ, 597,323

ID	Center [um]	Width [um]	Cont1 [um]	Wid1 [um]	Cont2 [um]	Wid2 [um]
Na I	2.2075	70	2.2170	60	2.2350	40
Ca I	2.2635	110	2.2510	40	2.2720	40
CO	2.2960	220	2.2850	100		
Si I	1.5890	40	1.5859	15	1.5937	15
CO	1.61975	45	1.6169	15	1.6282	15
Si I	1.6445	40	1.6370	15	1.6470	7
Al I	1.6762	40	1.6700	15	1.6790	7
Mg I	1.7115	50	1.7035	10	1.7145	20

EW(CO) versus H₂O



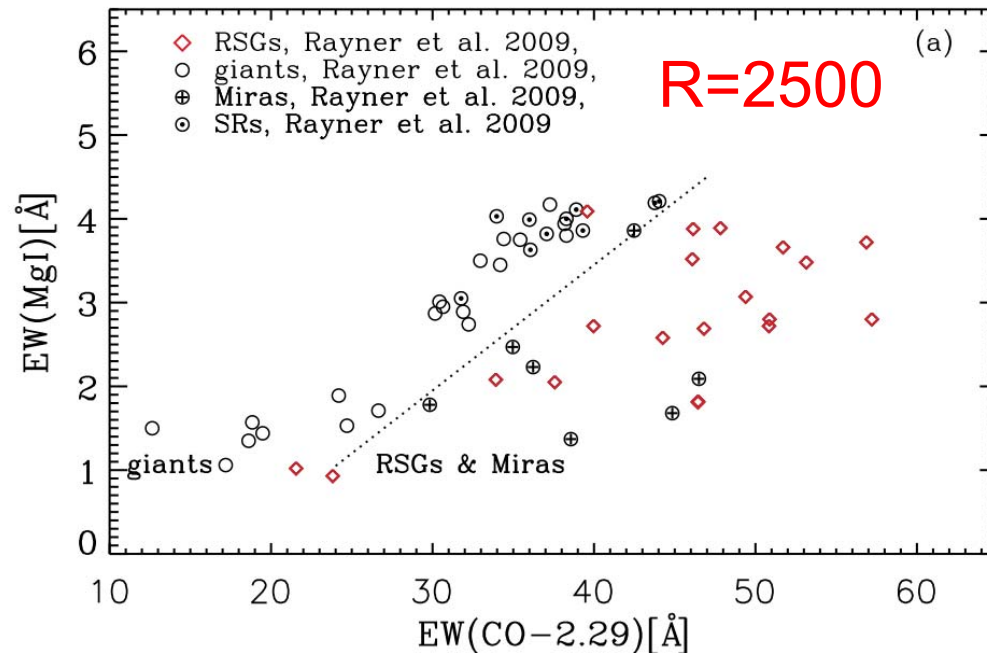
News from Mg I



CASPIR, R=1100-
Lancon et al. 2000

IRTF/SPEC, R=2500-
Rayner et al. 2009

Sofl, R=1500



RESULTS

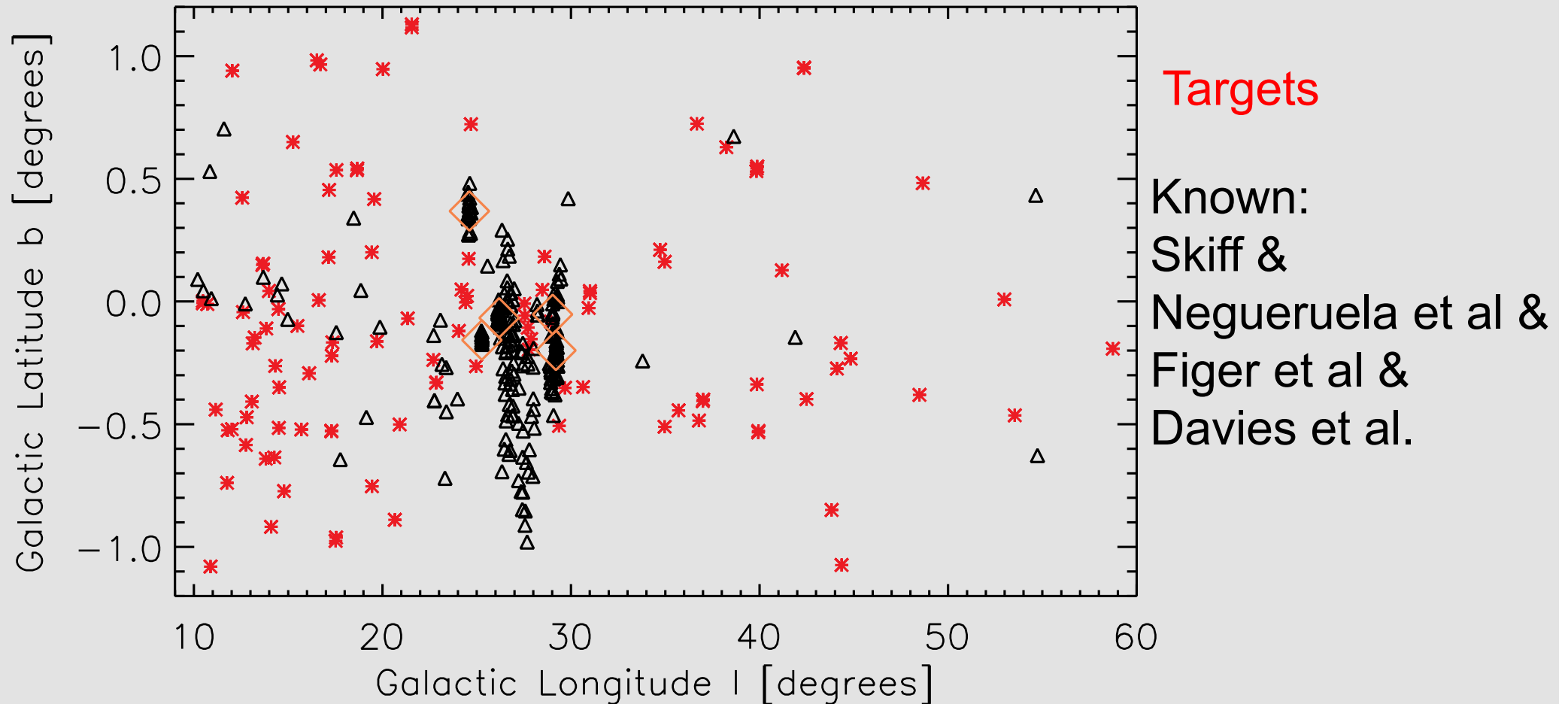
Observed 94 targets ($10 < l < 65$ deg, $|b| < 1$ deg)

- 58 of them are spectroscopic RSGs
(no water and $EW(\text{CO}) > 45$ Angstroms).
- for 68 of them distances are obtained with clump stars.
- Heliocentric distances: 3.6 to 8.6 kpc.
- Galactocentric distances: 2.5 to 7.6 kpc.
- Luminosities: 3.2×10^4 to $13.0 \times 10^4 L_{\text{sun}}$

This is an increase of at least +25% (64) in the number of previously known RSGs in the searched area.

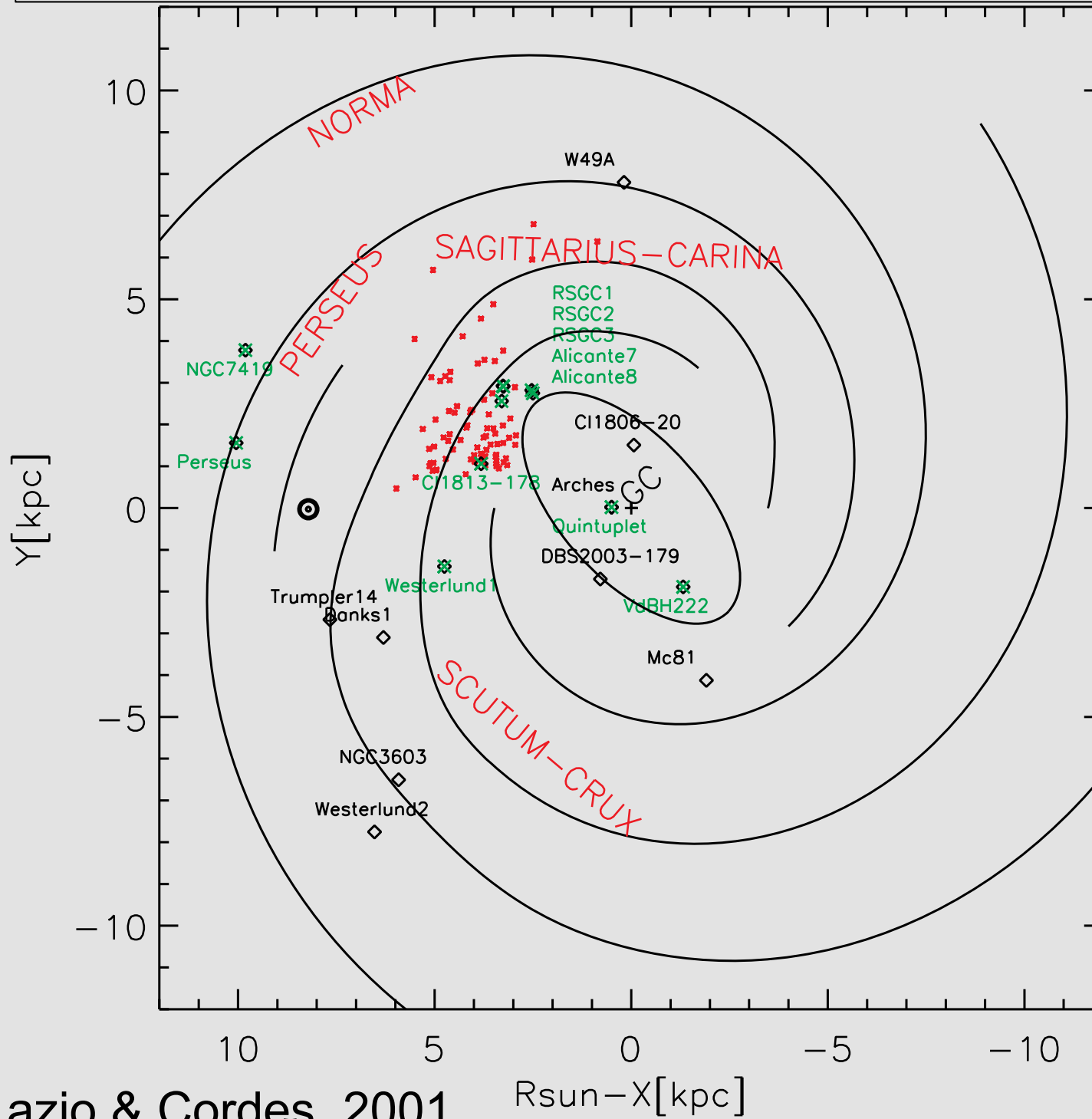
Messineo M., Zhu Q., Menten K.M., Ivanov V.D., Figer D.F., Kudritzki R.P., Chen C.-H. R. (2016, ApJ, 822, 5)

(l,b) distribution



Messineo M., Zhu Q., Menten K.M., Ivanov V.D., Figer D.F., Kudritzki R.P., Chen C.-H. R. (2016, *ApJ*, 822, 5)

Spatial distribution of the sample of RSGs (red dots)



Arms: Lazio & Cordes 2001

$R_{\text{sun}} - X$ [kpc]

THANK YOU
to all of you