

The HII Region Discovery Survey (HRDS)

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Star Formation in the Galaxy

Most recent surveys of high-mass star formation focused on the earliest phases of star formation.

(RMS, ATLASGAL, BGPS, CHaMP, MALT90...)

Before we began the HRDS (10 years ago!), there were only ~800 known Galactic HII regions. Extragalactic observations suggested our sample was severely incomplete.

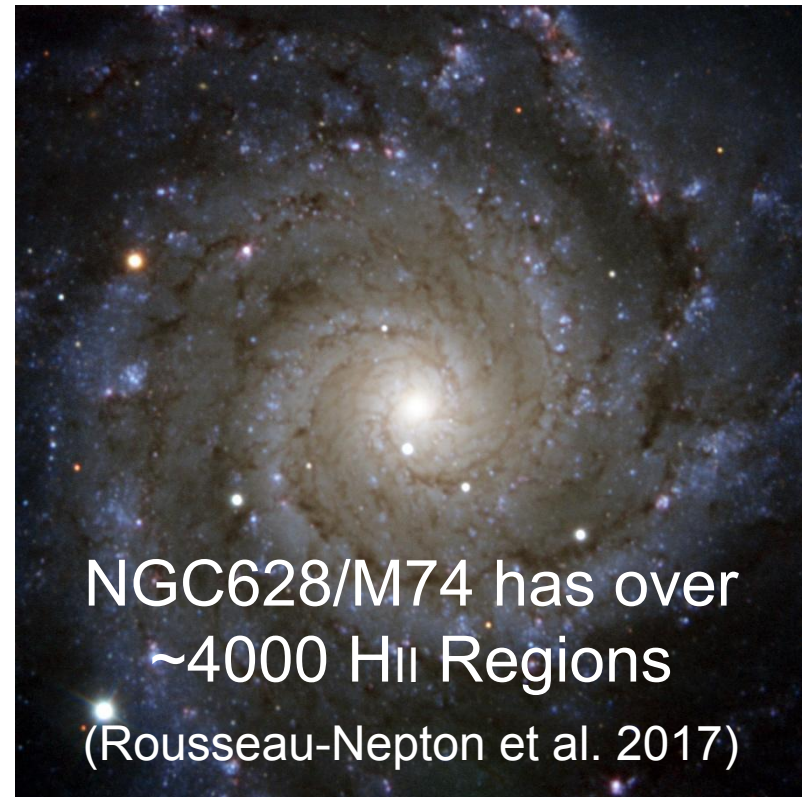
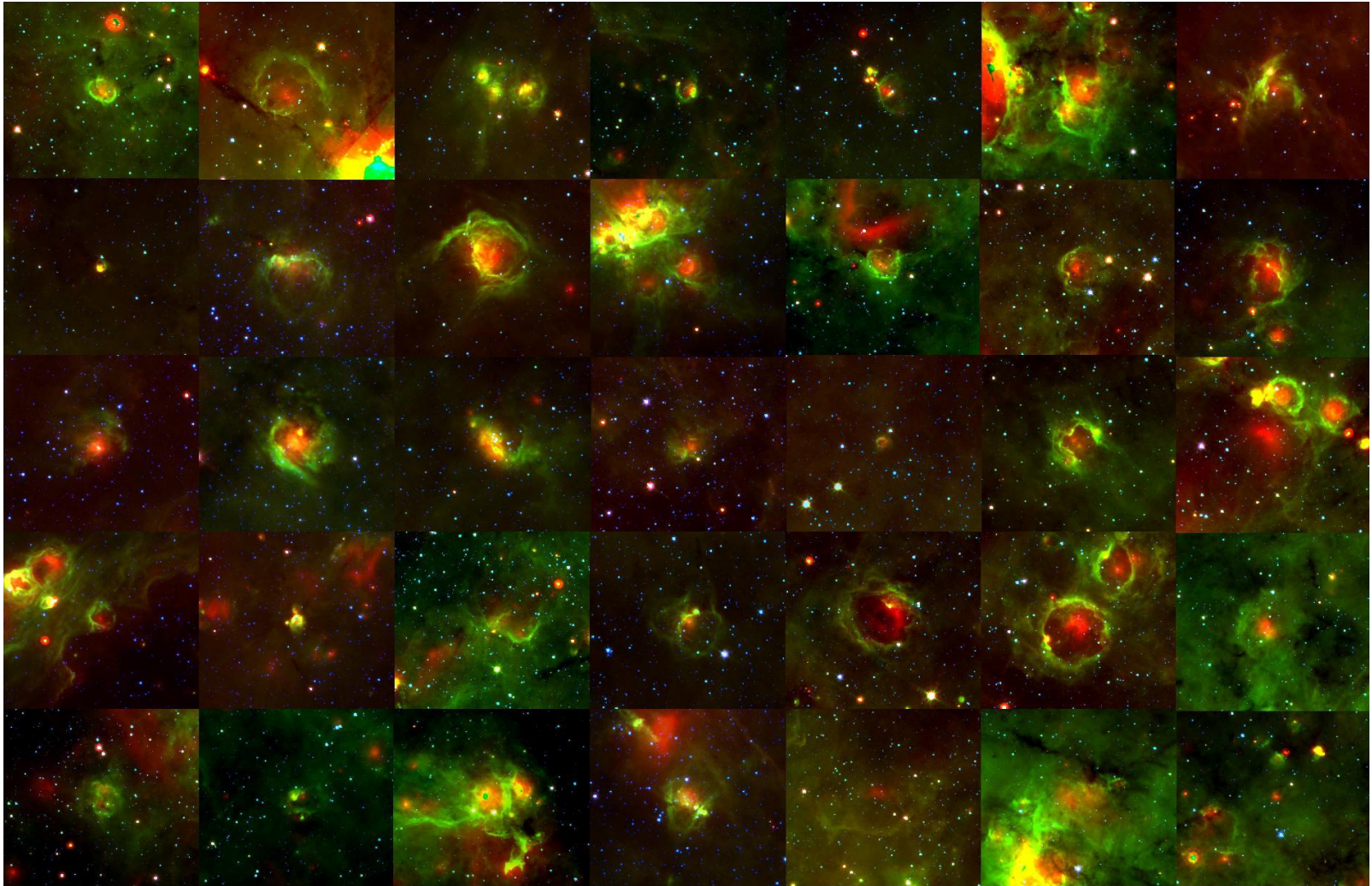


Image Credit: ESO PESSTO

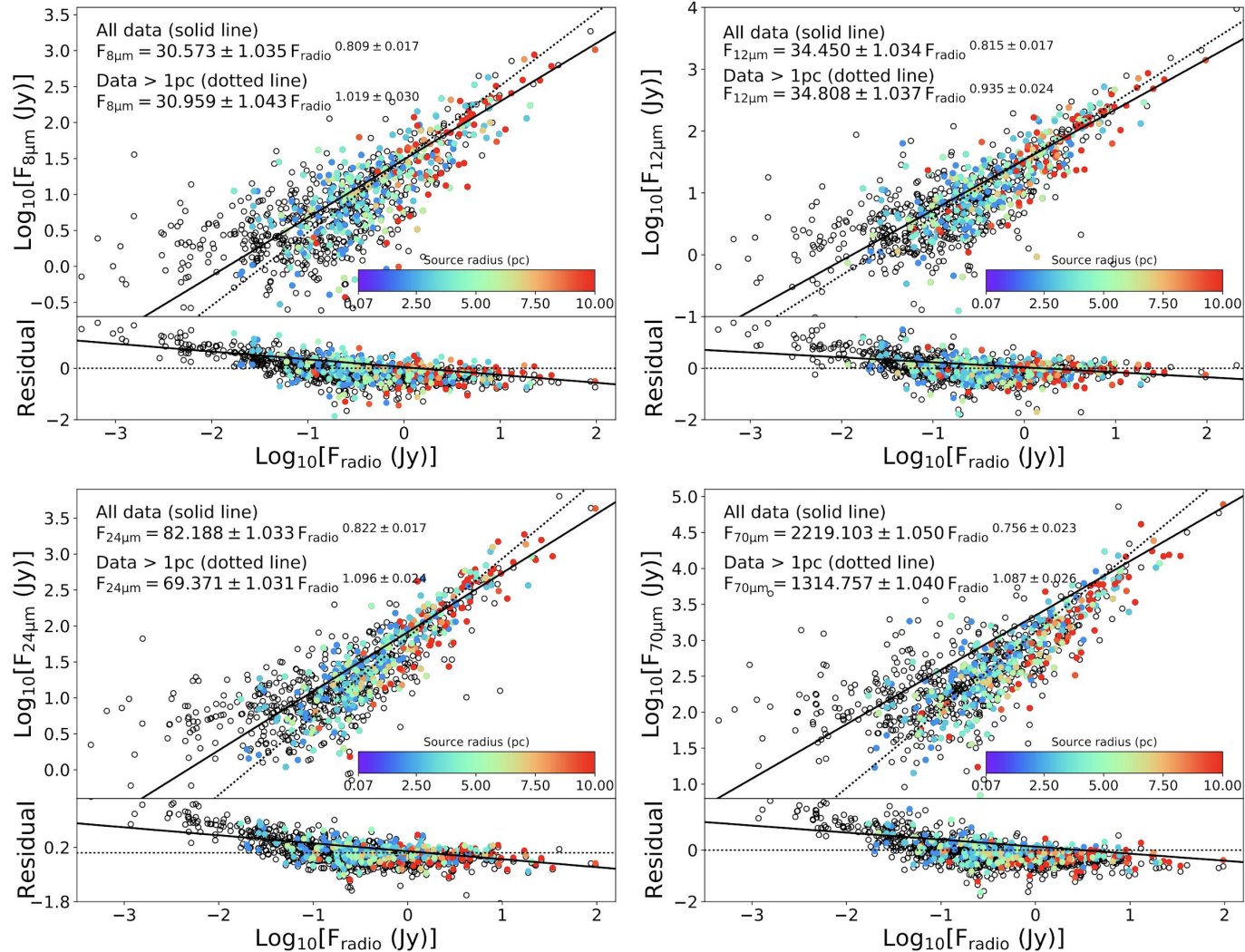
All HII regions have the same mid-infrared morphology

$\sim 10\mu\text{m}$ emission (from PAHs) surrounding $\sim 20\mu\text{m}$ emission (from stochastically heated small grains).

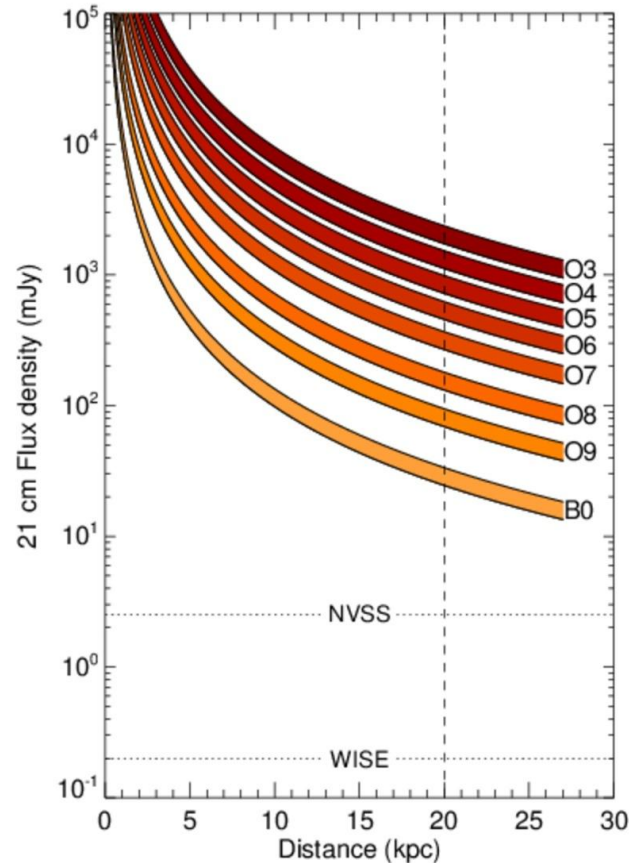




We can use the Mid-Infrared Flux to Predict the Radio Flux



We Can See Mid-Infrared Emission from HII Regions Across the Entire Galaxy



Anderson+ (2014)

We can find all Galactic HII regions!

The HRDS

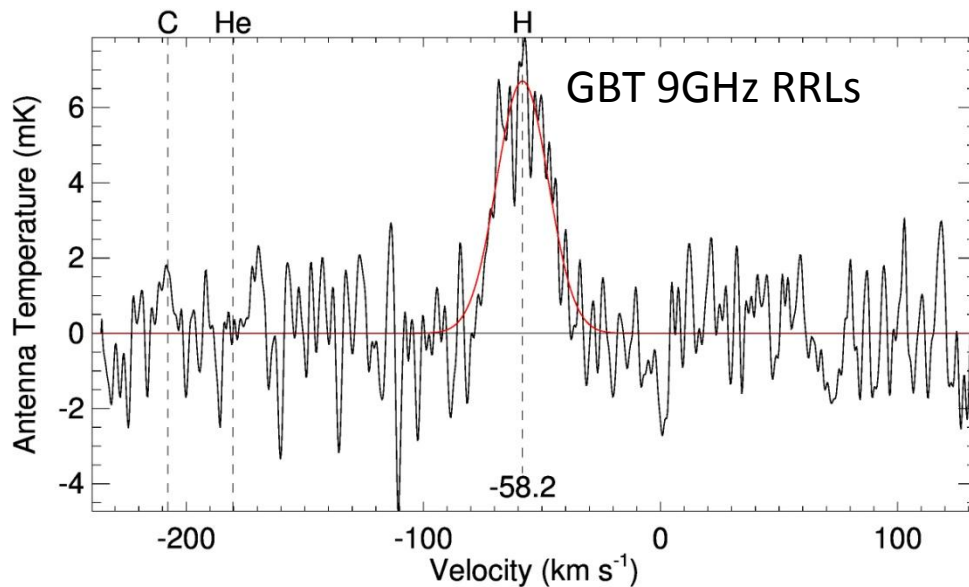
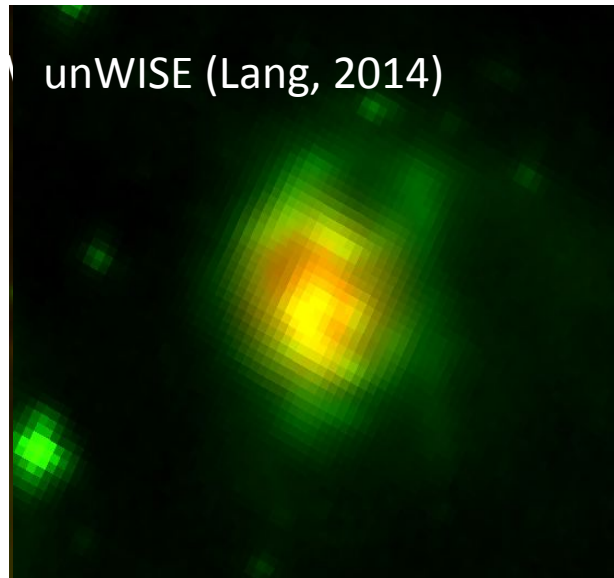
The HII Region Discovery Survey (HRDS) aims to discover all Galactic HII regions ionized by O-stars by measuring their radio recombination line (RRL) emission.

To date, we have published the discovery of >900 HII regions. There were ~800 HII regions known before we started.

These surveys are:

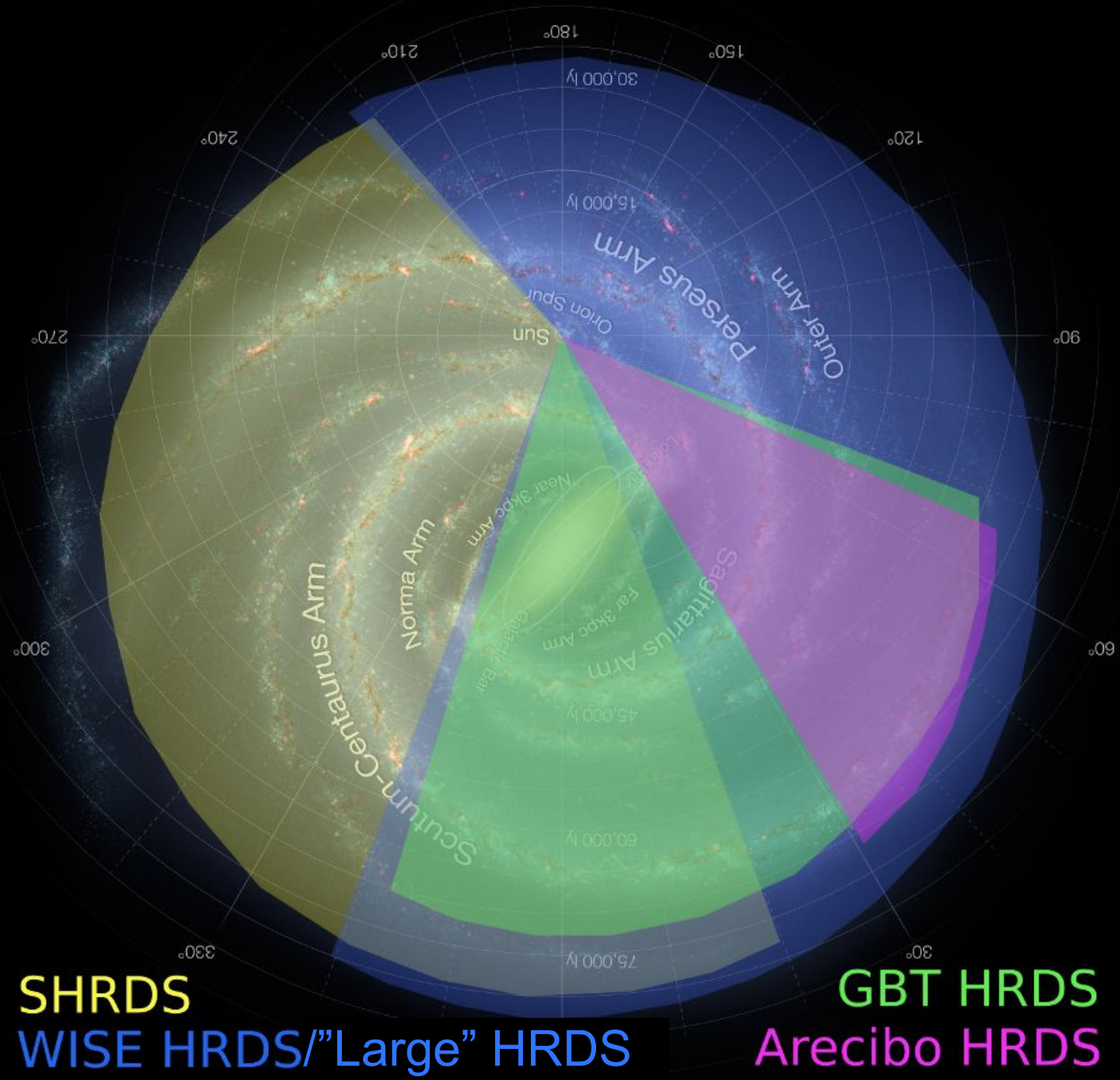
- Original GBT HRDS - 448 HII regions (GBT; Anderson+ 2011)
- Arecibo HRDS - 37 HII regions (Arecibo; Bania+ 2012)
- WISE HRDS - 302 HII regions (GBT; Anderson+2015)
- “Large” HRDS - 148 HII regions (GBT; Anderson+2018)
- [Southern HRDS (SHRDS) - ~500 regions (ATCA; Brown+ 2017, Wenger+2018, in prep.)]

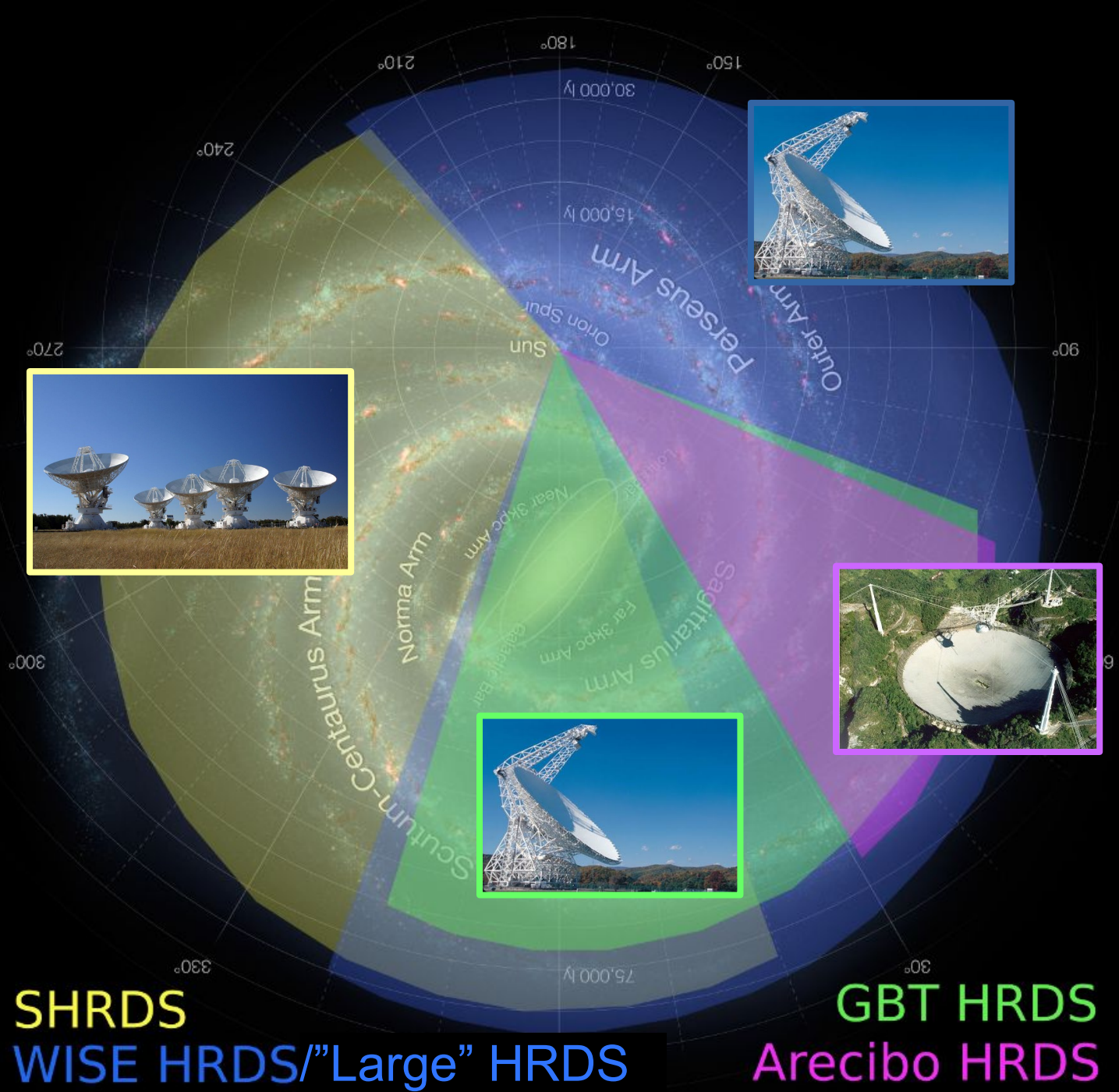
Example Data

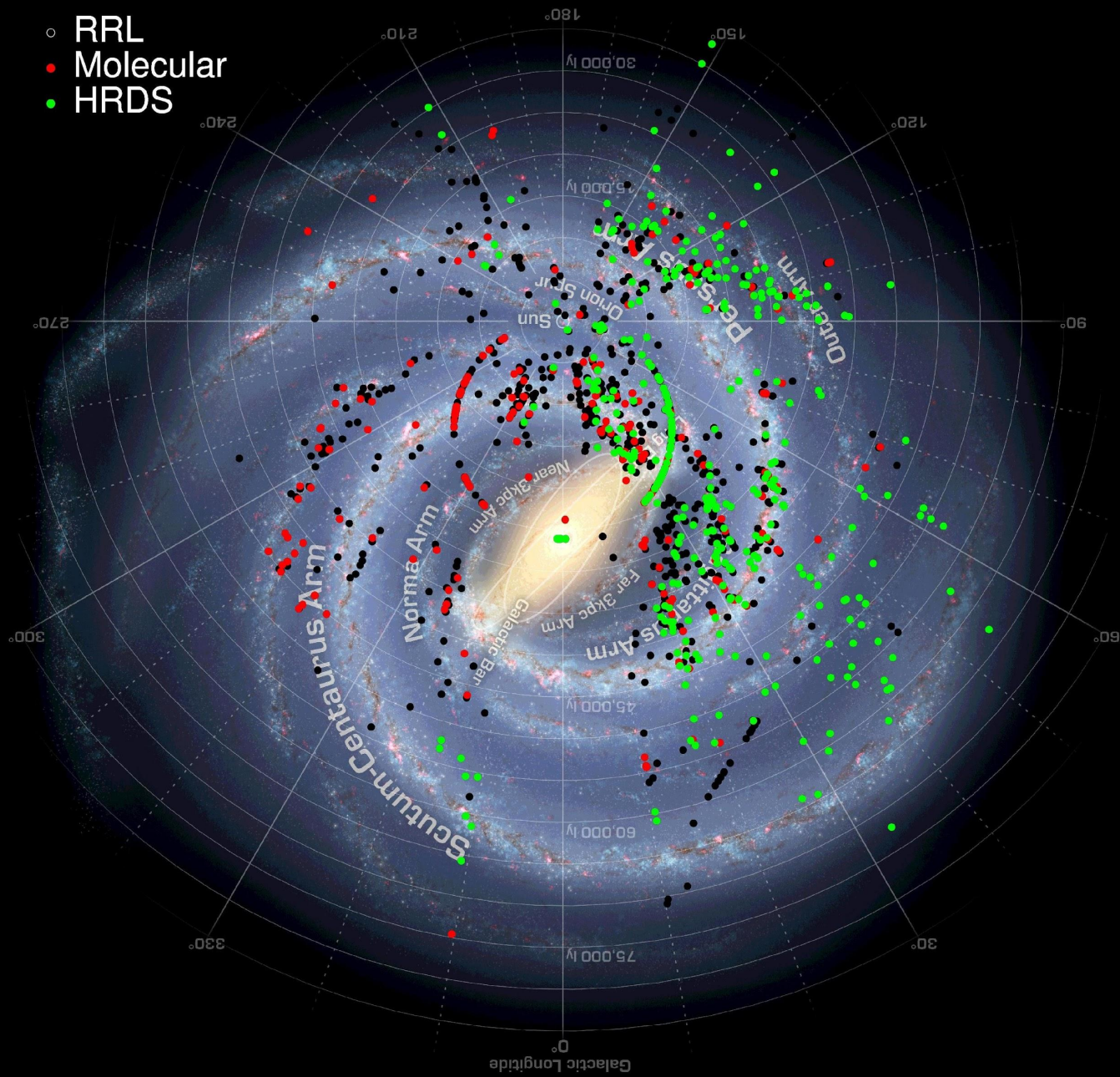


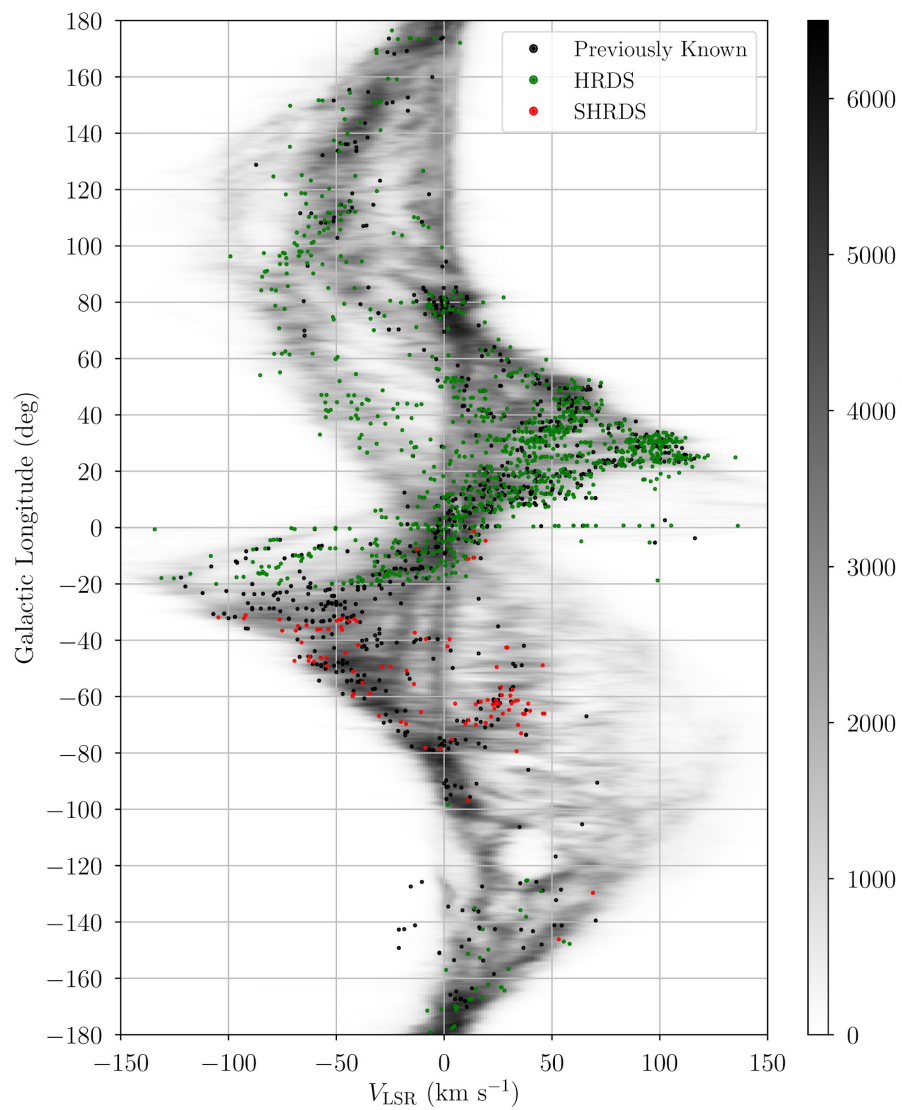
Distance = 24 kpc

$R_{\text{Gal}} = 17 \text{ kpc}$

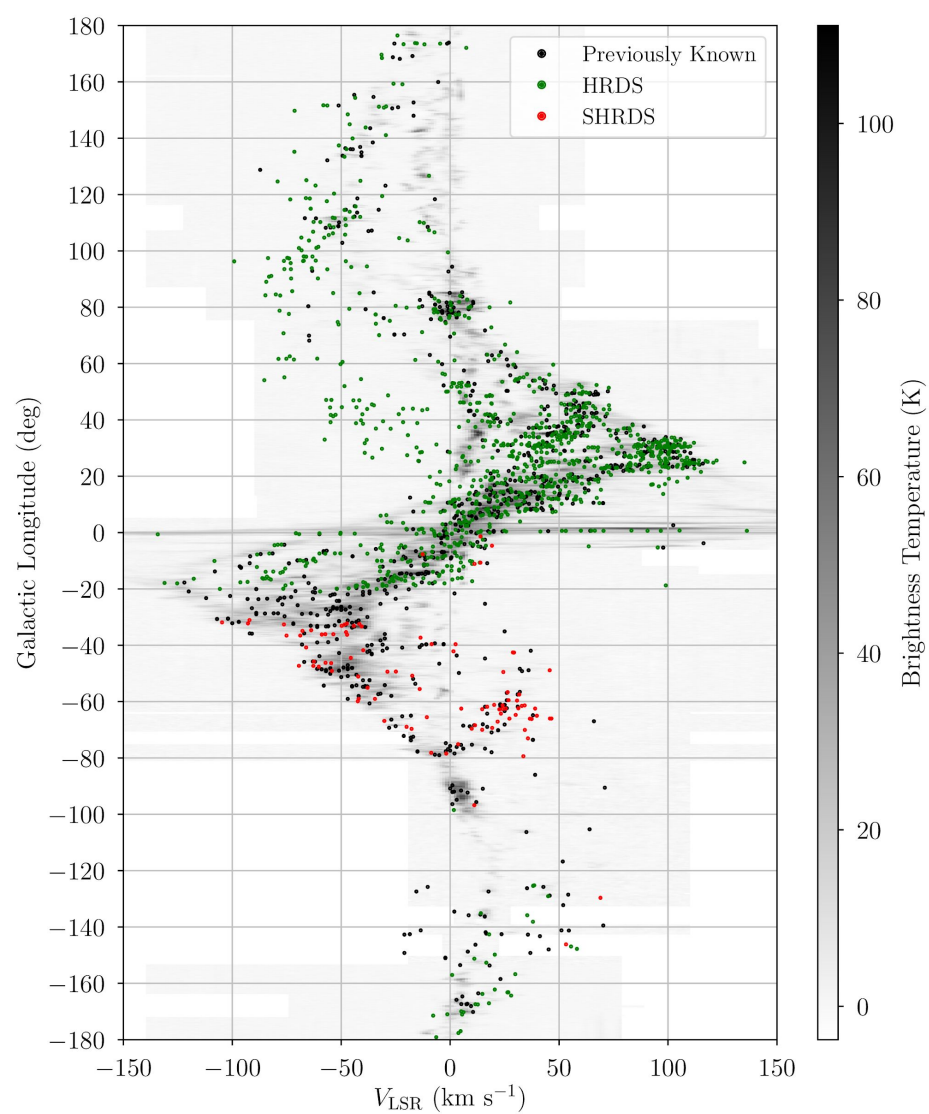








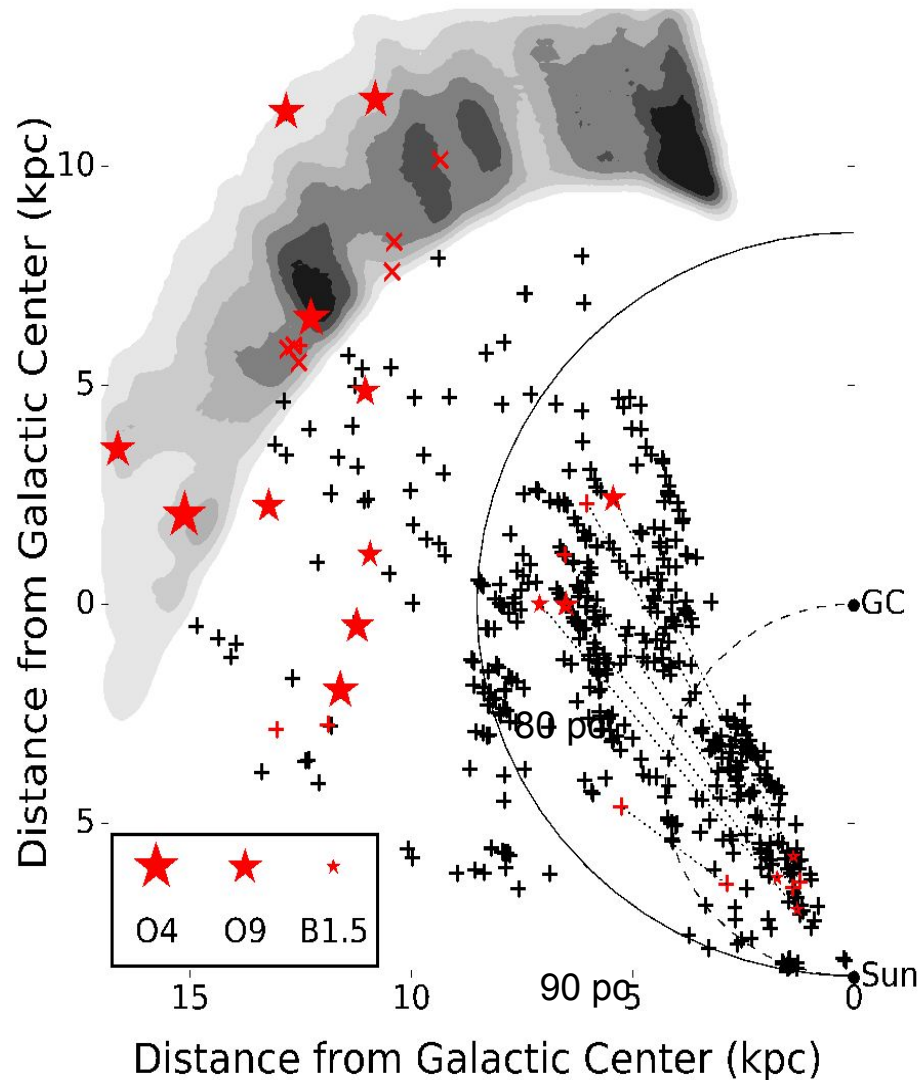
HI (HI4PI)



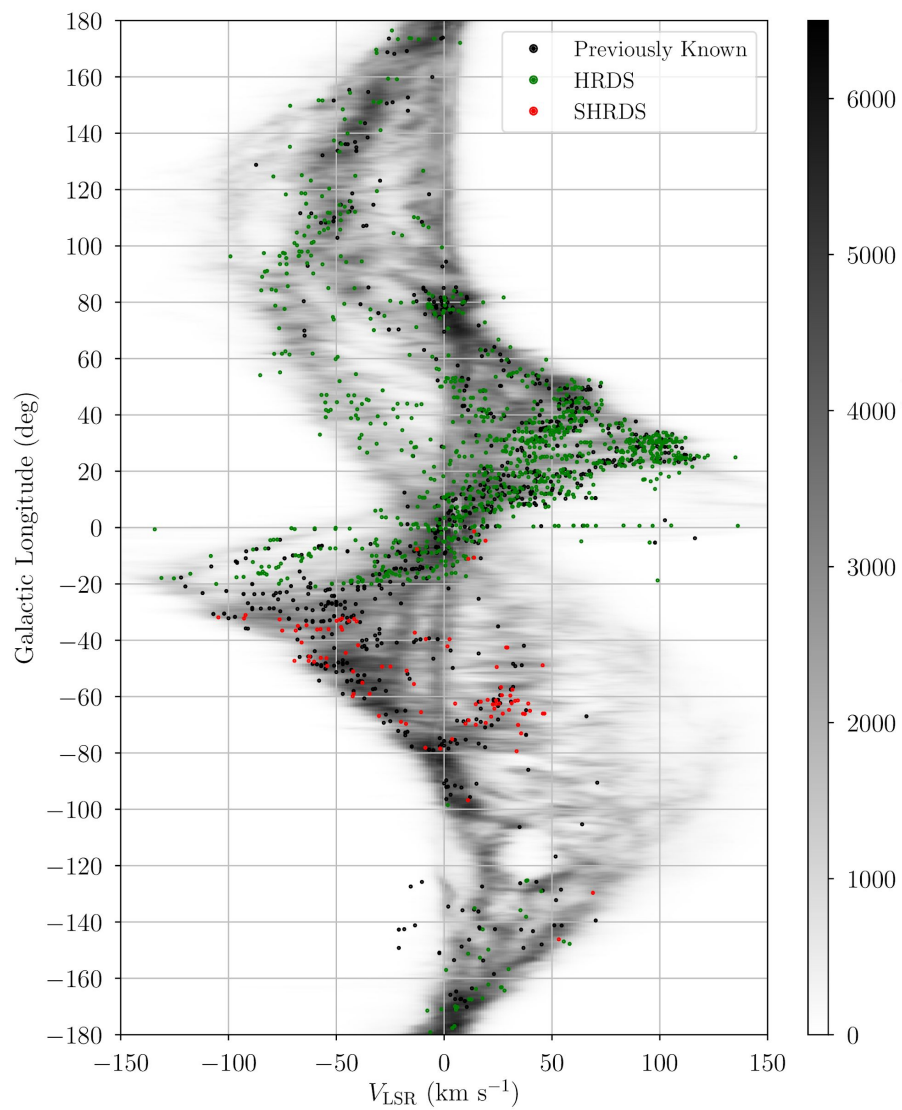
CO (Colombia/CfA)

Results

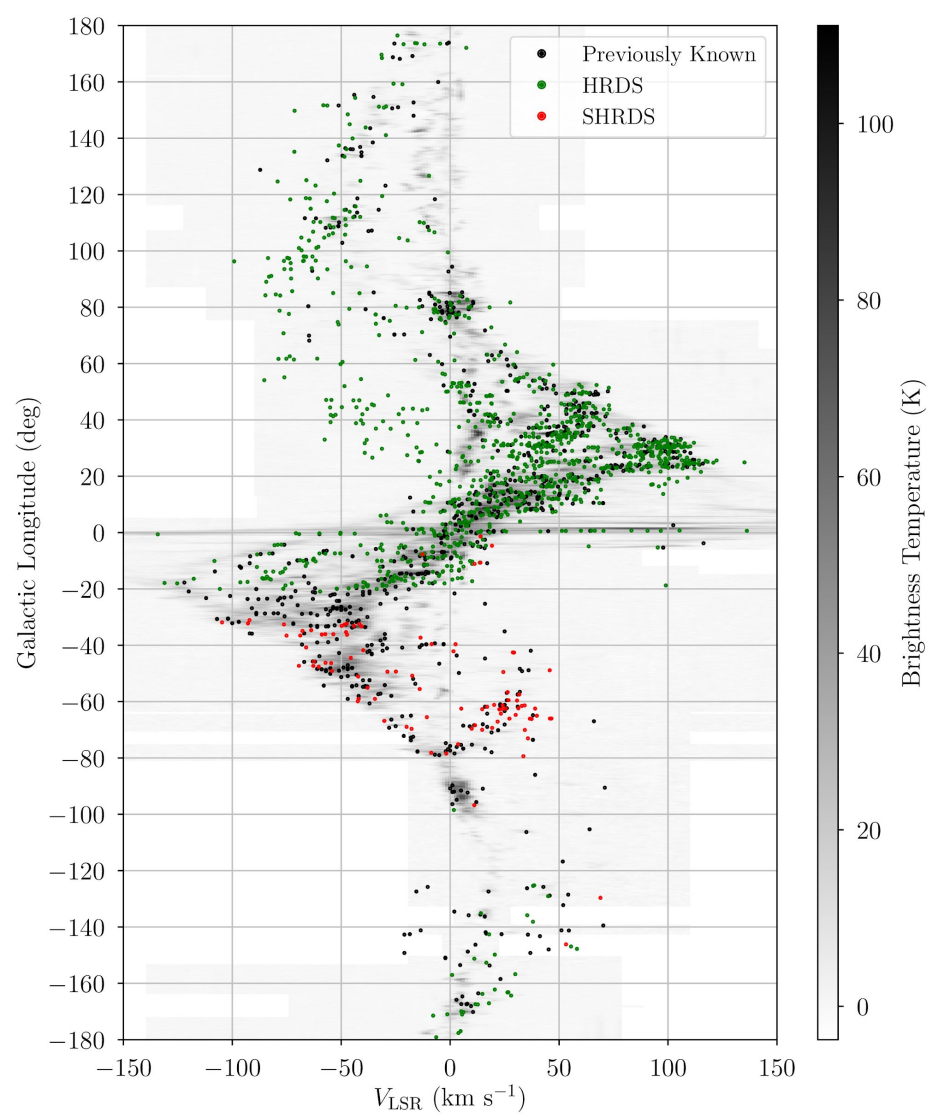
- The most distant Galactic HII regions (Anderson+, 2015, Armentrout+, 2017; Wenger+, 2017; see W. Armentrout's poster)



Armentrout+, 2017



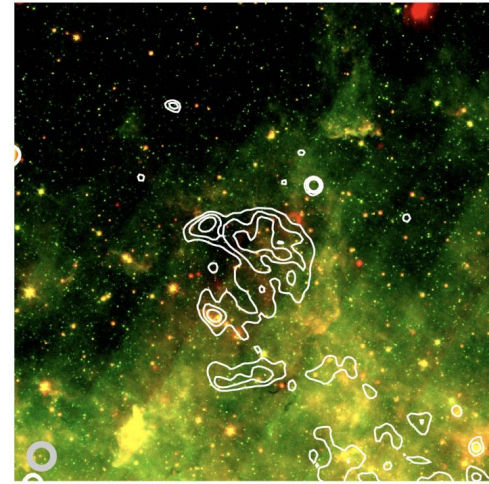
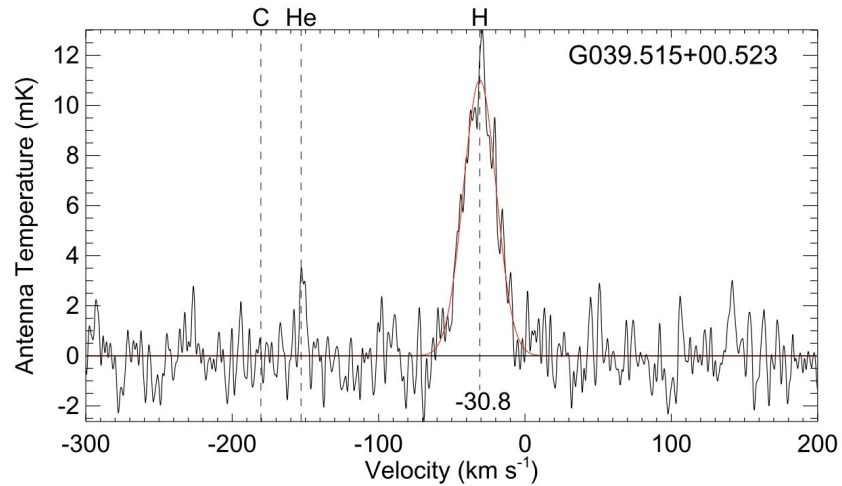
HI (HI4PI)



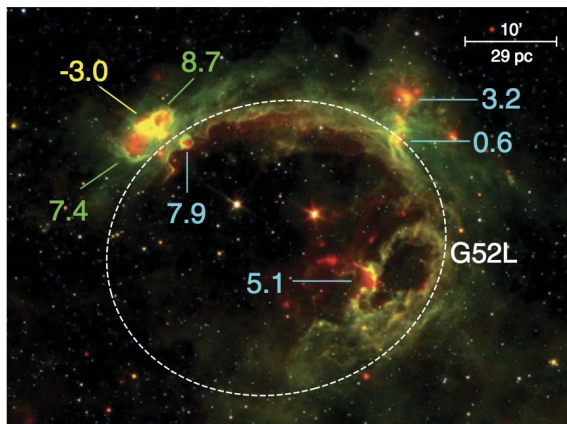
CO (Colombia/CfA)

Results

- The largest HII regions (Anderson+, 2018; Bania+, 2012)



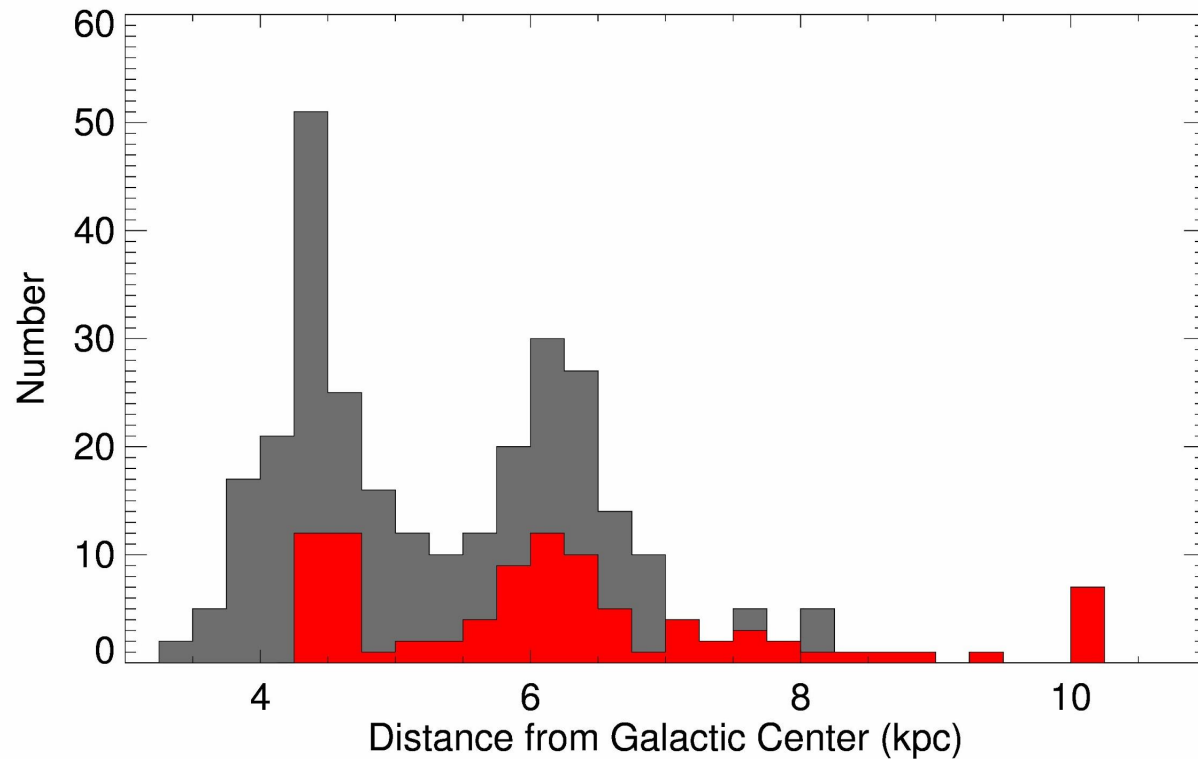
<-80 pc->



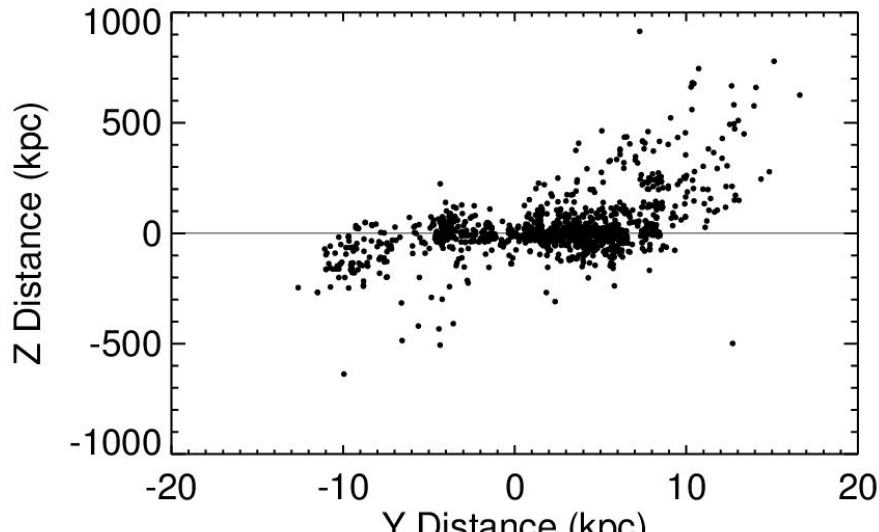
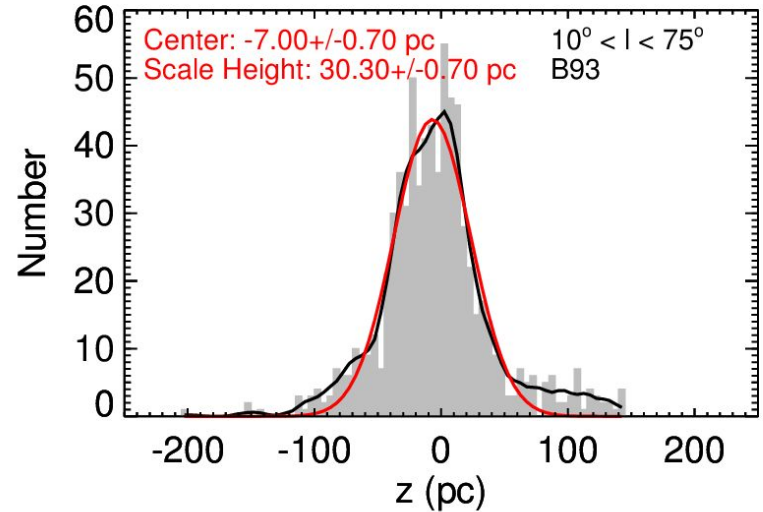
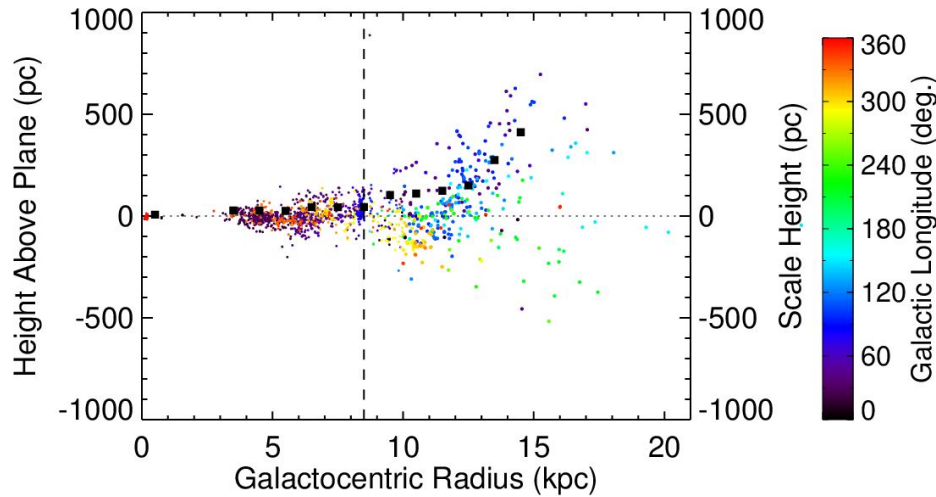
<-----90 pc----->

Results

- Peaks in the RGal distribution signifying spiral arms



The Sun's Height Above the Mid-Plane

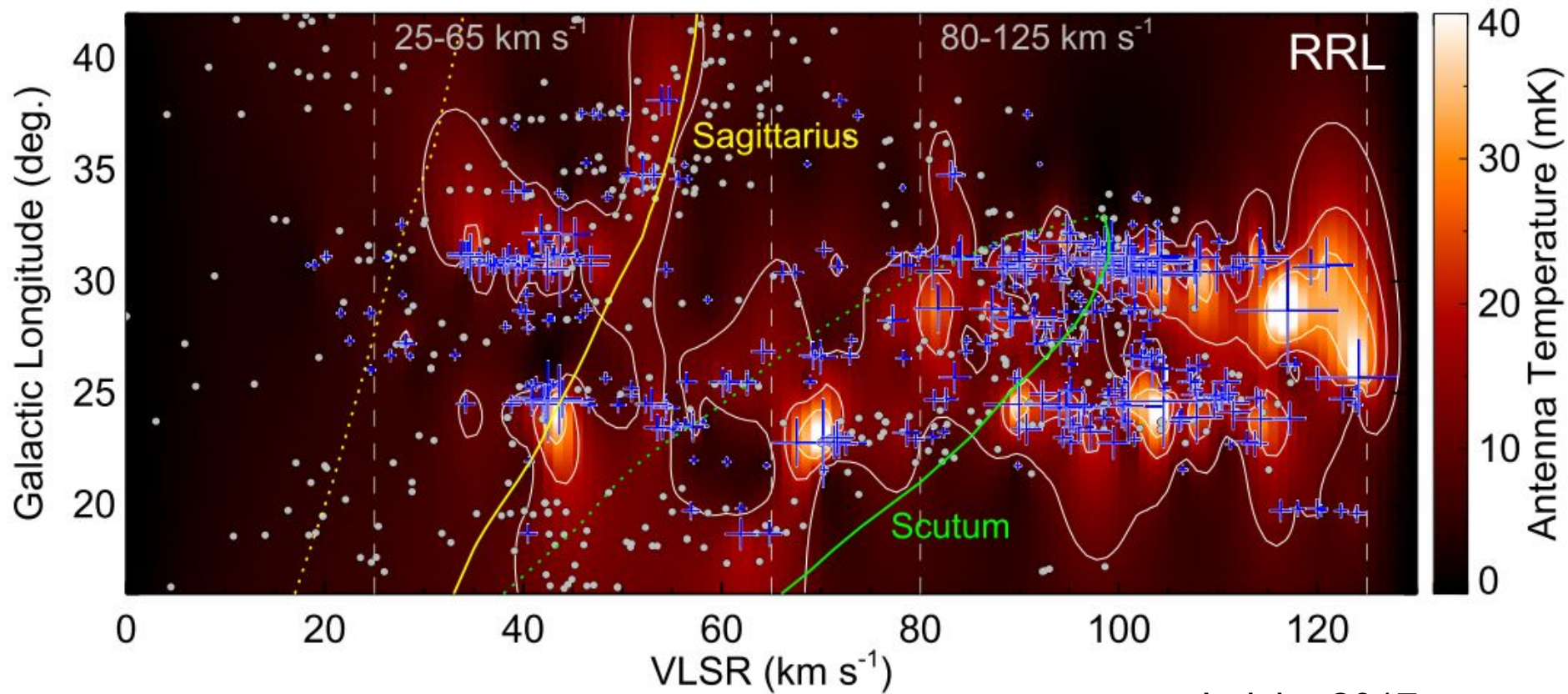


Using the HII region distribution to define the mid-plane, the Sun is only a few pc above the disk.

Does not agree with stellar results! Perhaps due to scale of different data sets.

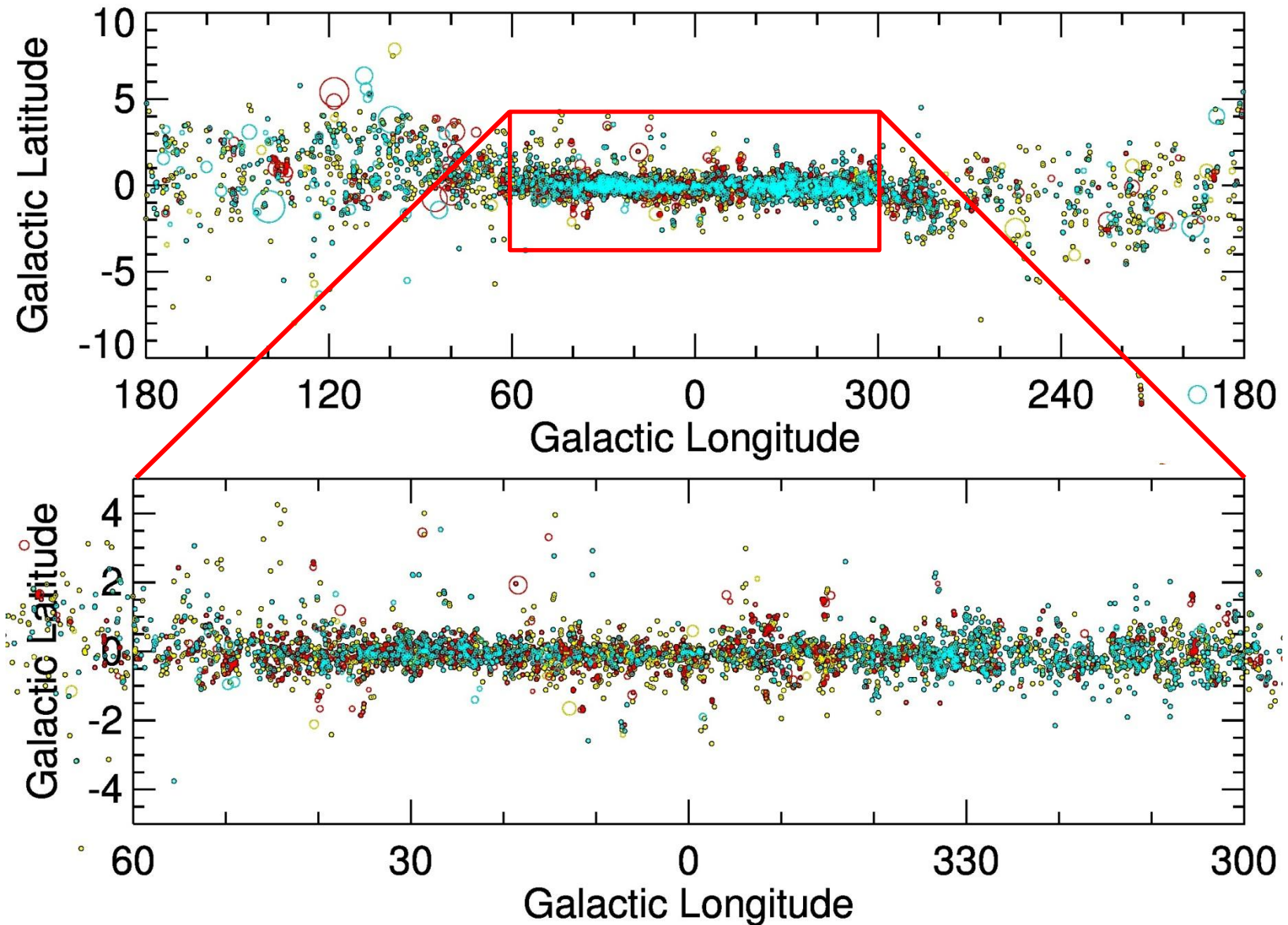
Results

- Prevalent, diffuse ionized gas in the Milky Way disk (Anderson+, 2015, Luisi+, 2017)

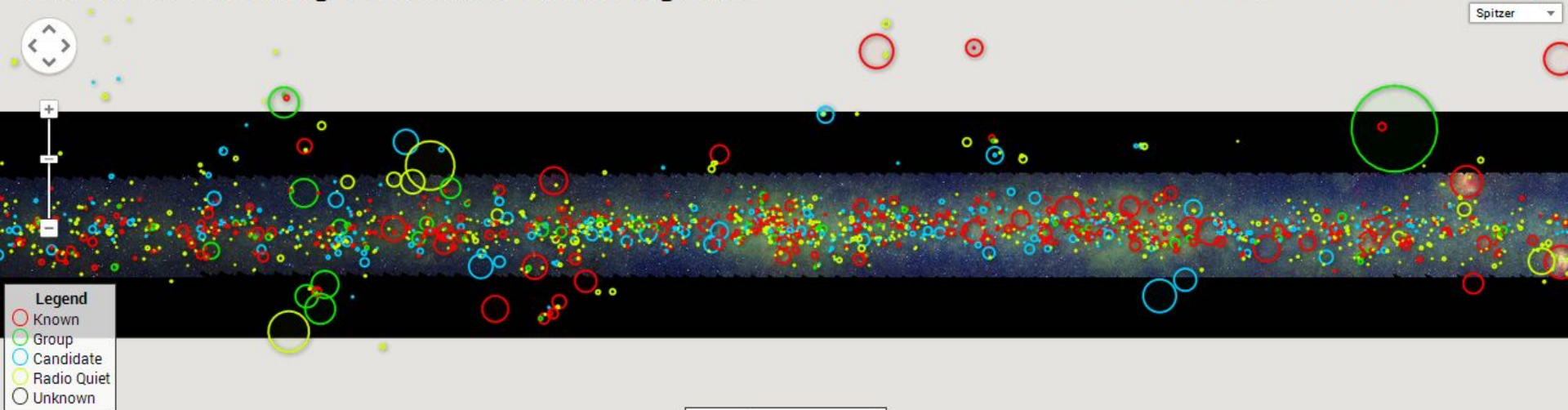


Luisi+, 2017

The WISE Catalog of Galactic HII Regions



The WISE Catalog of Galactic HII Regions



Search Column: WISE Name for text: Go to selection!

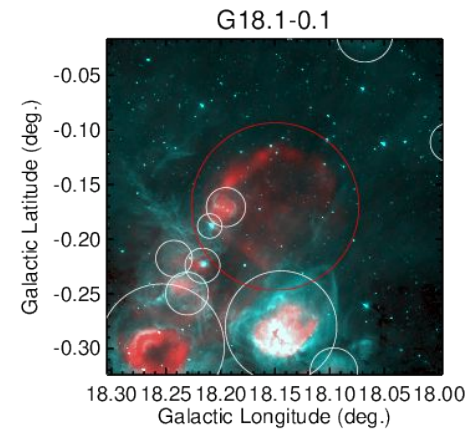
Export CSV Hide Map Hide Table Filter Options

	WISE Name	Catalog	GLong	GLat	Radius	HII Region	Membership	VLSR	VLSR (Mol.)	Molecule	KDAR	Dist.	Err Dist.	Dist. Method	RGal	z
1	G000.003+00.127	K	0.004	0.128	206	S17										
2	G000.008+00.036	Q	0.009	0.036	24											
3	G000.025-00.232	Q	0.026	-0.231	46											
4	G000.029-00.090	Q	0.03	-0.089	31											
5	G000.041+00.021	Q	0.041	0.021	20											
6	G000.043+00.013	Q	0.044	0.014	15											
7	G000.052-00.205	Q	0.053	-0.205	18											
8	G000.079-00.211	Q	0.08	-0.21	66											
9	G000.079-00.626	Q	0.08	-0.625	92											
10	G000.082-00.097	Q	0.083	-0.096	29											
11	G000.099-00.168	C	0.099	-0.168	15				16.0	CS						
12	G000.114-00.092	Q	0.115	-0.091	22											
13	G000.120-00.556	K	0.12	-0.556	360	S19		11.6								
14	G000.120-00.633	Q	0.121	-0.632	93											
15	G000.121-00.304	Q	0.122	-0.304	37											
16	G000.125-00.086	Q	0.126	-0.086	29											

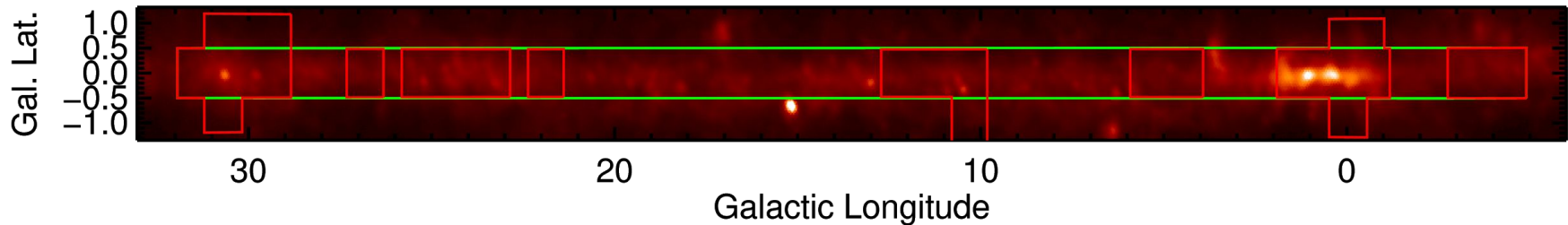
Next Directions

If we know where all the HII regions are, we can identify things that are not HII regions...

76 new SNR Candidates (Anderson+, 2017)



Diffuse Ionized Gas (GDIGS)



Next Directions

- Use the luminosities of HII regions to estimate the Milky Way luminosity (Anderson+, 2018, in prep.)
- Determine the number of Galactic HII regions (see W. Armentrout's poster; Armentrout+, 2018, in prep.)
- Investigate the shape of the HII region luminosity function (Mascoop +, 2018, in prep.)
- Publish the 4th quadrant SHRDS (Wenger+ 2018, in prep.)
- Next-gen (radio continuum, RRL) surveys?

Summary

The HRDS aims to discover all Galactic HII regions, and to date has approximately doubled the number of known regions.

We combined these observations with all previously known HII regions to create the WISE Catalog of Galactic HII regions.

astro.phys.wvu.edu/wise

This is the ideal data set to explore Galactic-scale massive star formation.