The GBT Diffuse Ionized Gas Survey (GDIGS)

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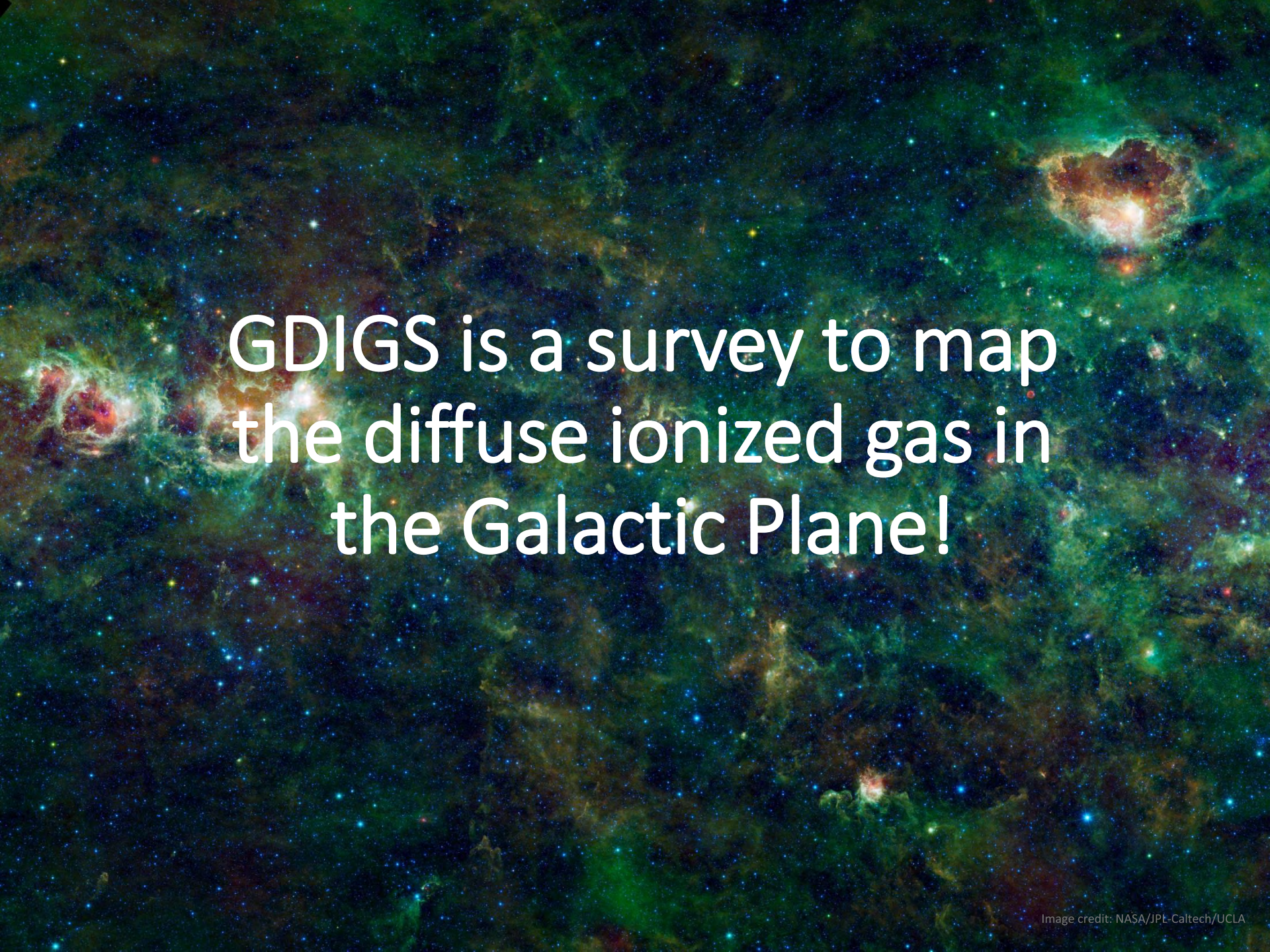
GBT Surveys Workshop

The Green Bank Telescope
Image courtesy of NRAO/AUI

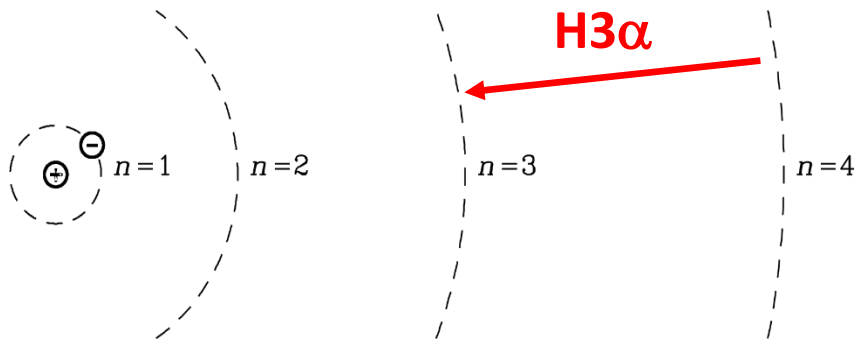

GDIGS is a survey to map the diffuse ionized gas in the Galactic Plane!
Image credit: NASA/JPL-Caltech/UCLA

Motivation

- Diffuse ionized gas (DIG), also known as Warm Ionized Medium (WIM) is major component of the interstellar medium
- It is believed that the DIG maintains its ionization due to leaking radiation from HII regions
- However, distribution & kinematics of the DIG in our Galaxy is still not fully understood
- DIG has never been studied at high spatial and spectral resolution
- Thus, the connection between DIG and high-mass star formation is still unclear

GDIGS

- VEGAS: can simultaneously observe 64 spectral windows at C-band
  - 22 Hnα recombination lines
  - 25 Hnβ recombination lines
  - 8 Hnγ recombination lines
  - 9 molecular lines



- Can average together all Hnα lines to increase sensitivity!
  - rms sensitivity ~3 mJy/beam at velocity resolution of 0.5 km/s
  - Nyquist sampled on 1 arcmin spatial grid
- Measure continuum temperature at ~60 frequencies

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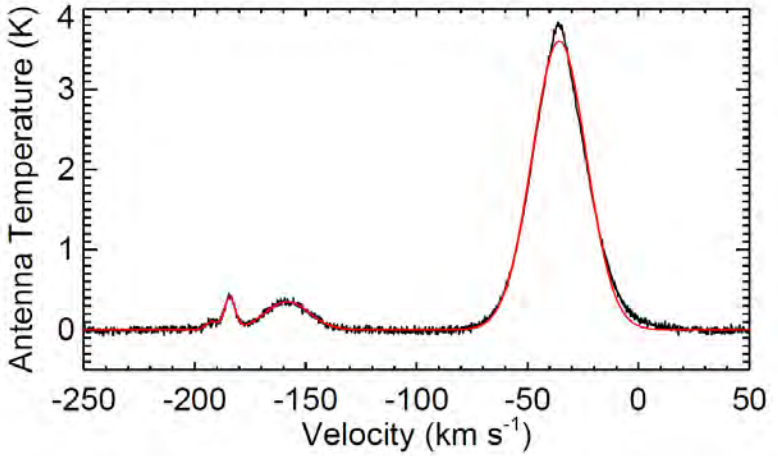

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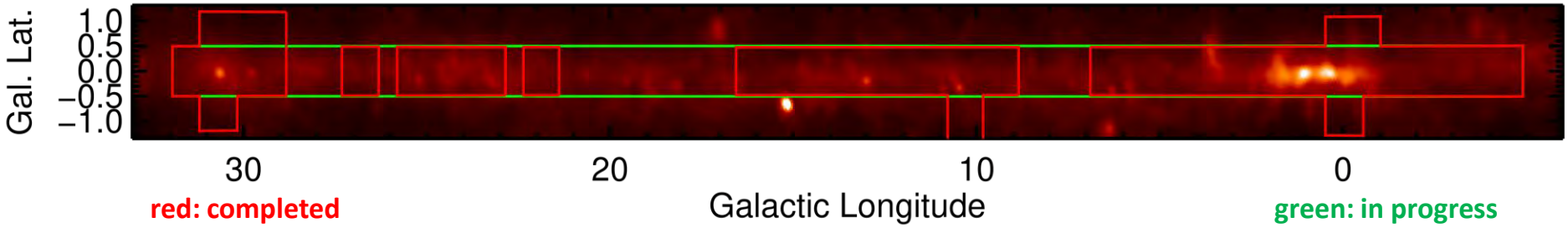


- Mapping the range 32° > l > -5°, |b| < 0.5°
- Filler time; mapping observations are operator-run
- Supplement data with deep pointed GBT observations of discrete HII regions
- ~70% completed, expect to finish survey mid 2019

Observing

Using C-band receiver (4-8 GHz) with VEGAS:

- Observing in total-power mode
- 8 bandpasses × 8 banks = 64 spectral windows
- Bandpass width 23.44 MHz, 8192 channels

  → Velocity resolution of 0.1 to 0.2 km/s

We observe 1° x 1° OTF maps with reference position 3° off the plane

- Observe each area 4 times to minimize streaking
- Nyquist-sampled for highest frequency between rows → 89 rows
- Double-Nyquist sampled along rows (t_{int} = 0.4 s)
- Each map takes 2.5 h

Data Processing

All data processing done on Lustre filesystem using public server machines (Newton, Planck, Fourier)

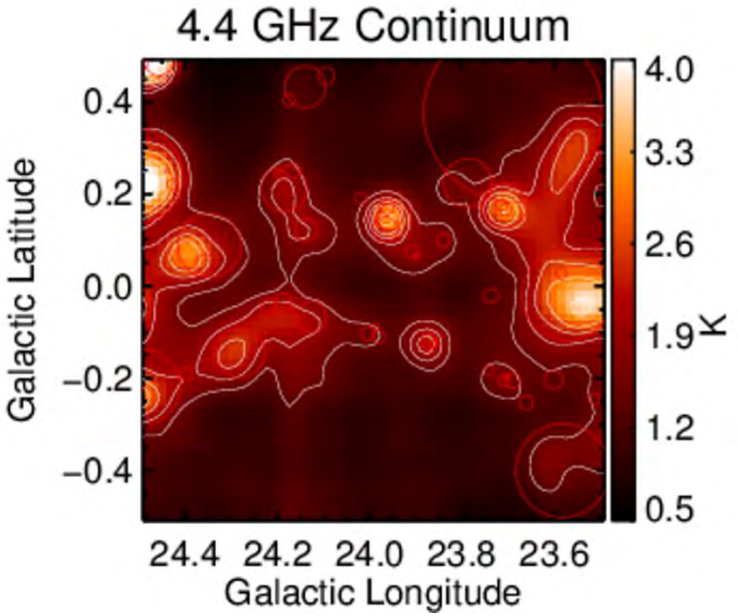
Data reduction steps:

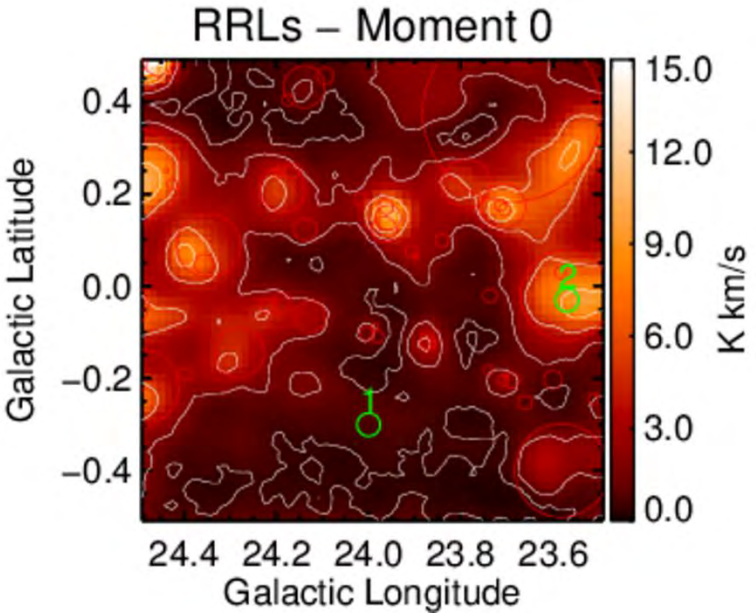
1) Filling data with sdfits

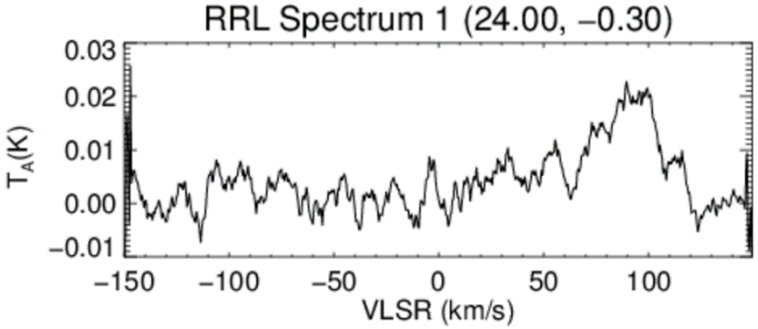
2) Generating *keep* files

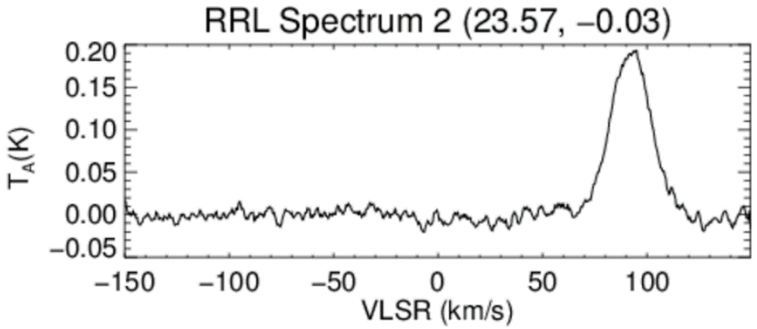
3) Gridding all spectral windows separately using gbtgridder
   - Rebinning to common velocity resolution (0.5 km/s)

4) Averaging all Hnα, Hnβ, and Hnγ spectral windows, respectively
   - Calibration, RFI removal, and baseline fitting during this stage


4.4 GHz Continuum
Galactic Latitude
0.4
0.2
0.0
−0.2
−0.4
24.4 24.2 24.0 23.8 23.6
Galactic Longitude
4.0
3.3
2.6
1.9
1.2
0.5
K


RRLs – Moment 0
Galactic Latitude
0.4
0.2
0.0
−0.2
−0.4
24.4 24.2 24.0 23.8 23.6
Galactic Longitude
15.0
12.0
9.0
6.0
3.0
0.0
K km/s
1
2

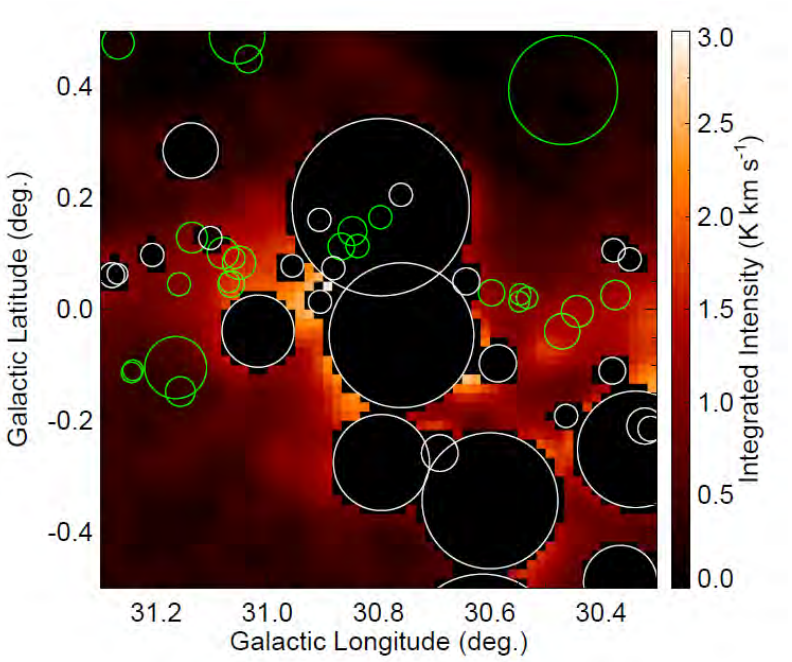

RRL Spectrum 1 (24.00, −0.30)
T_A(K)
0.03
0.02
0.01
0.00
−0.01
−150 −100 −50 0 50 100
VLSR (km/s)

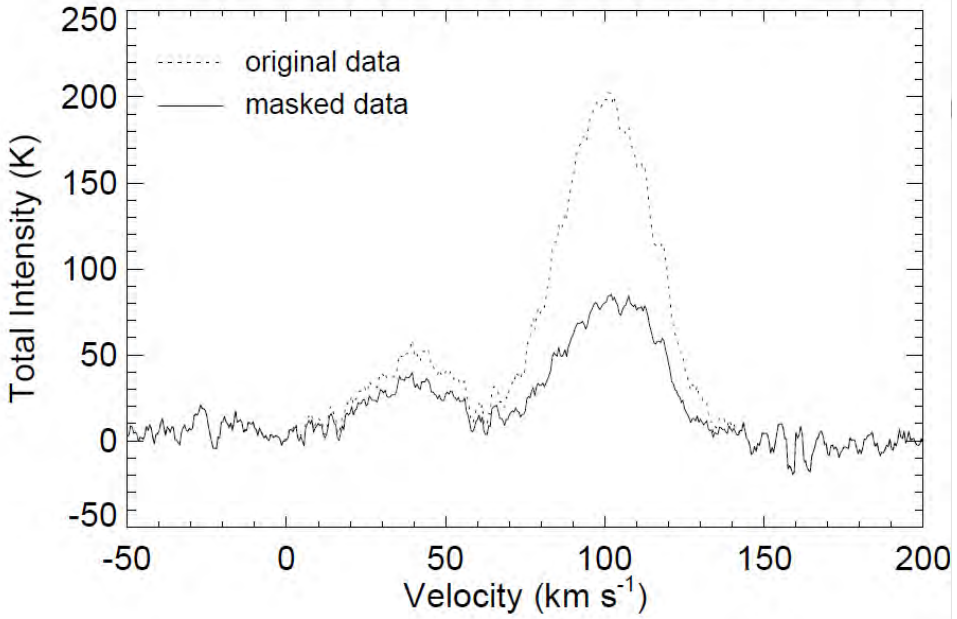

RRL Spectrum 2 (23.57, −0.03)
T_A(K)
0.20
0.15
0.10
0.05
0.00
−0.05
−150 −100 −50 0 50 100
VLSR (km/s)

Science Goals

We will study:

- Distribution of inner-Galaxy DIG

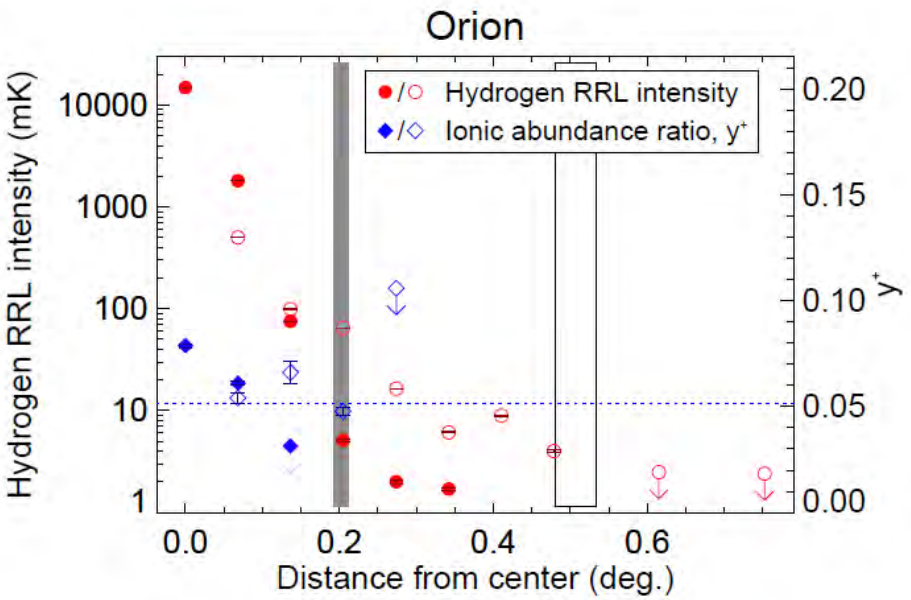


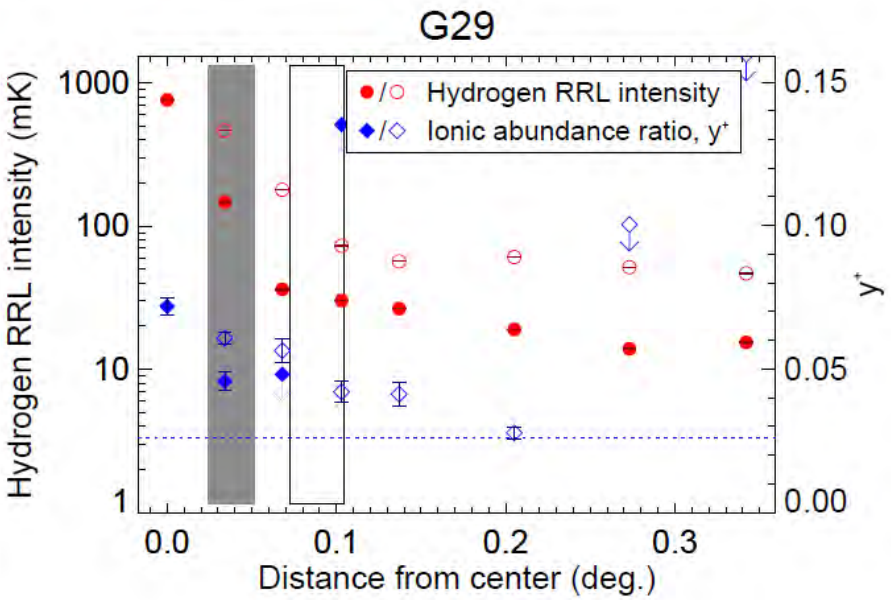


Science Goals

We will study:

- Distribution of inner-Galaxy DIG
- Ionization state of DIG

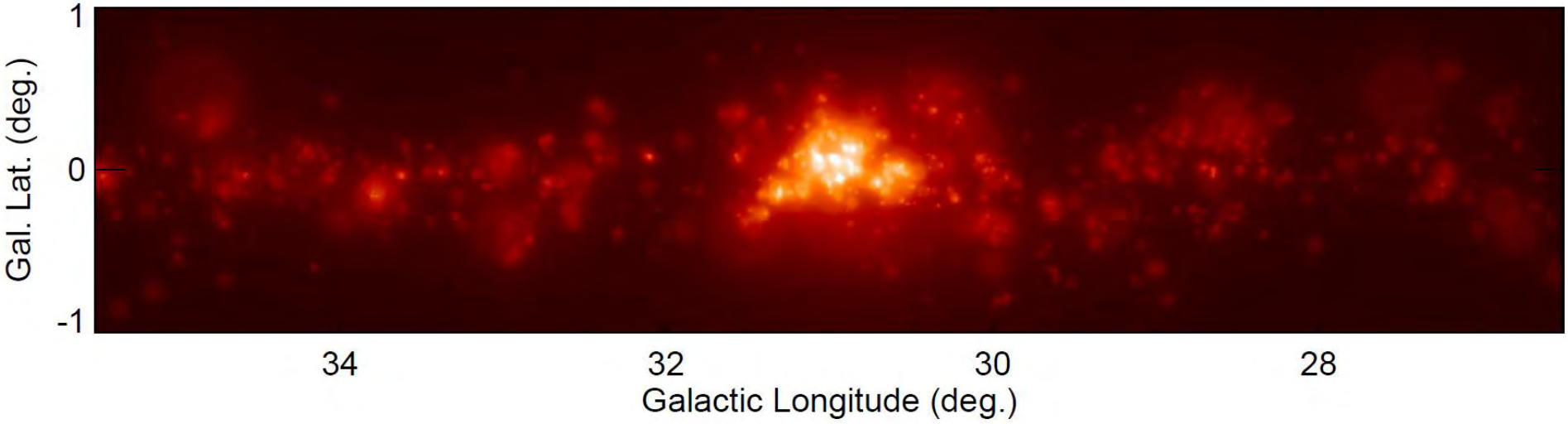




Science Goals

We will study:

- Distribution of inner-Galaxy DIG
- Ionization state of DIG
- Connection between DIG and HII regions
  - Constrain fraction of leaking photons from individual HII regions and estimate global leaking fraction



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We will study:

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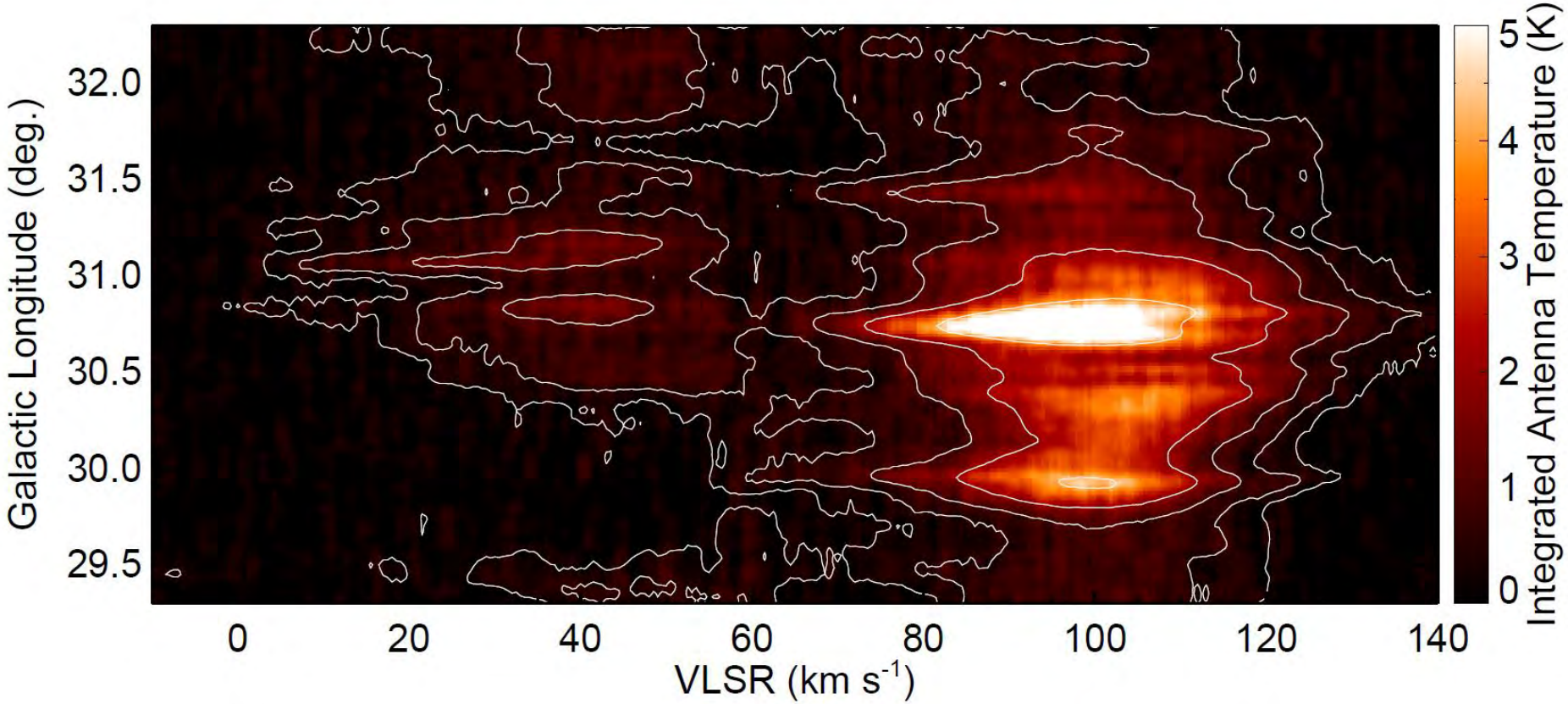
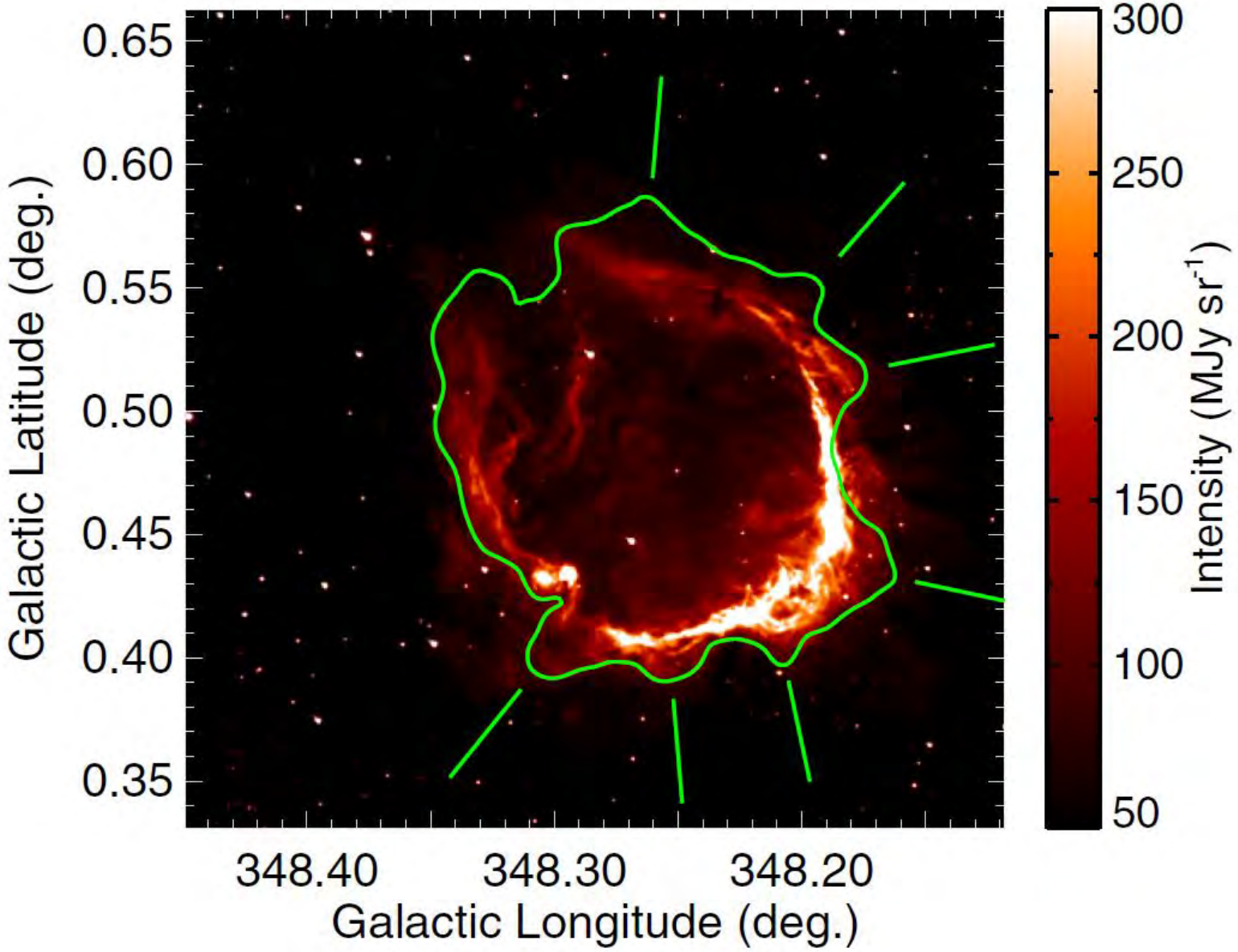
- Dynamics of the Milky Way bar


Galactic Longitude (deg.)
32.0
31.5
31.0
30.5
30.0
29.5
0
20
40
60
80
100
120
140
VLSR (km s-1)
Integrated Antenna Temperature (K)
5
4
3
2
1
0

Science Goals

We will study:

- Distribution of inner-Galaxy DIG
- Ionization state of DIG
- Connection between DIG and HII regions
  - Constrain fraction of leaking photons from individual HII regions and estimate global leaking fraction
- Dynamics of the Milky Way bar
- Impact leaking radiation has on dust emission


0.65
0.60
0.55
0.50
0.45
0.40
0.35
Galactic Latitude (deg.)
348.40
348.30
348.20
Galactic Longitude (deg.)
300
250
200
150
100
50
Intensity (MJy sr-1)

Conclusions

- GDIGS will provide first detailed look at inner-Galaxy DIG
- Observations ~70% complete and data reduction pipeline fully functional
- Data will allow us to disentangle HII region emission from DIG emission
- Expect first GDIGS publication early/mid 2019