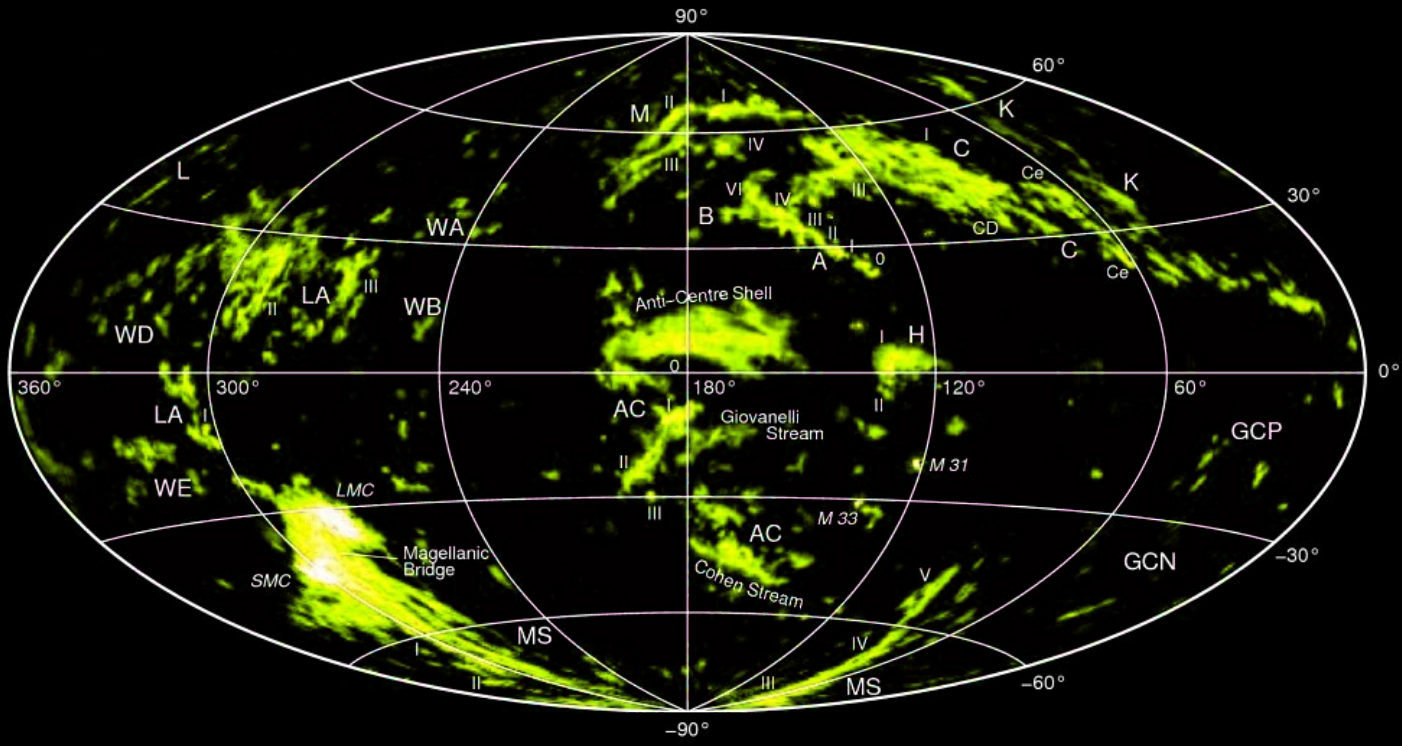
HVC Complex GCN

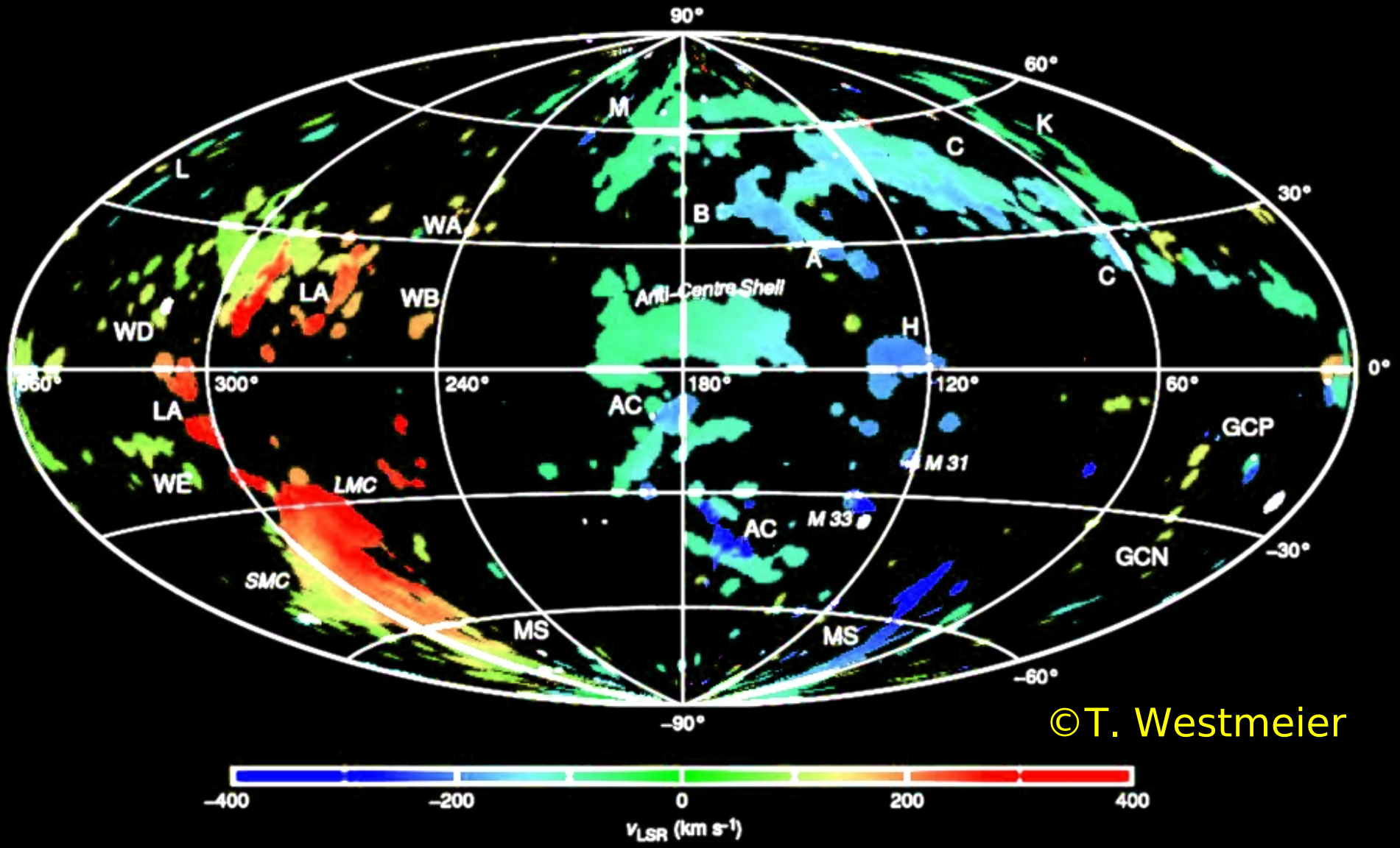
A prime example for warm accretion?

Benjamin Winkel



Max-Planck-Institut für Radioastronomie

The high-velocity sky



Overview

- The new Milky Way HI Surveys
- HVC Complex GCN
  - Data and cloud catalog
  - Statistical properties
  - Ongoing warm accretion?
- Outlook

The new Milky Way HI Surveys

Survey	Sky coverage	Angular resolution	Velocity resolution	Noise level
LAB	Full sky	30'	1.3 km/s	90 mK
GASS	$\delta < 1°$	14'	1 km/s	57 mK
GALFA-HI	$-1° < \delta < 38°$	3'	0.2 km/s	< 100 mK
EBHIS	$\delta > -5°$	9'	2 km/s	< 90 mK

Survey parameters

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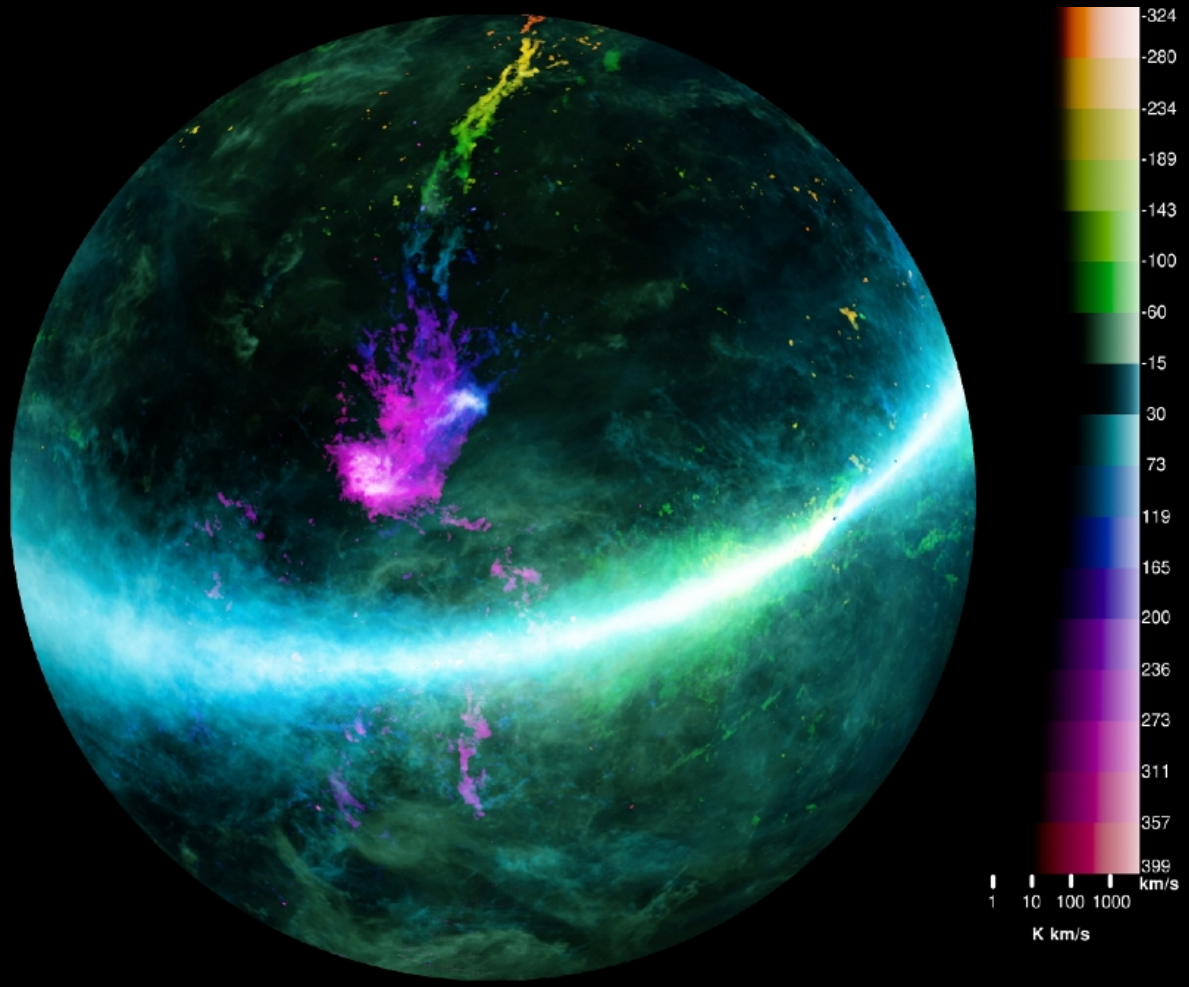
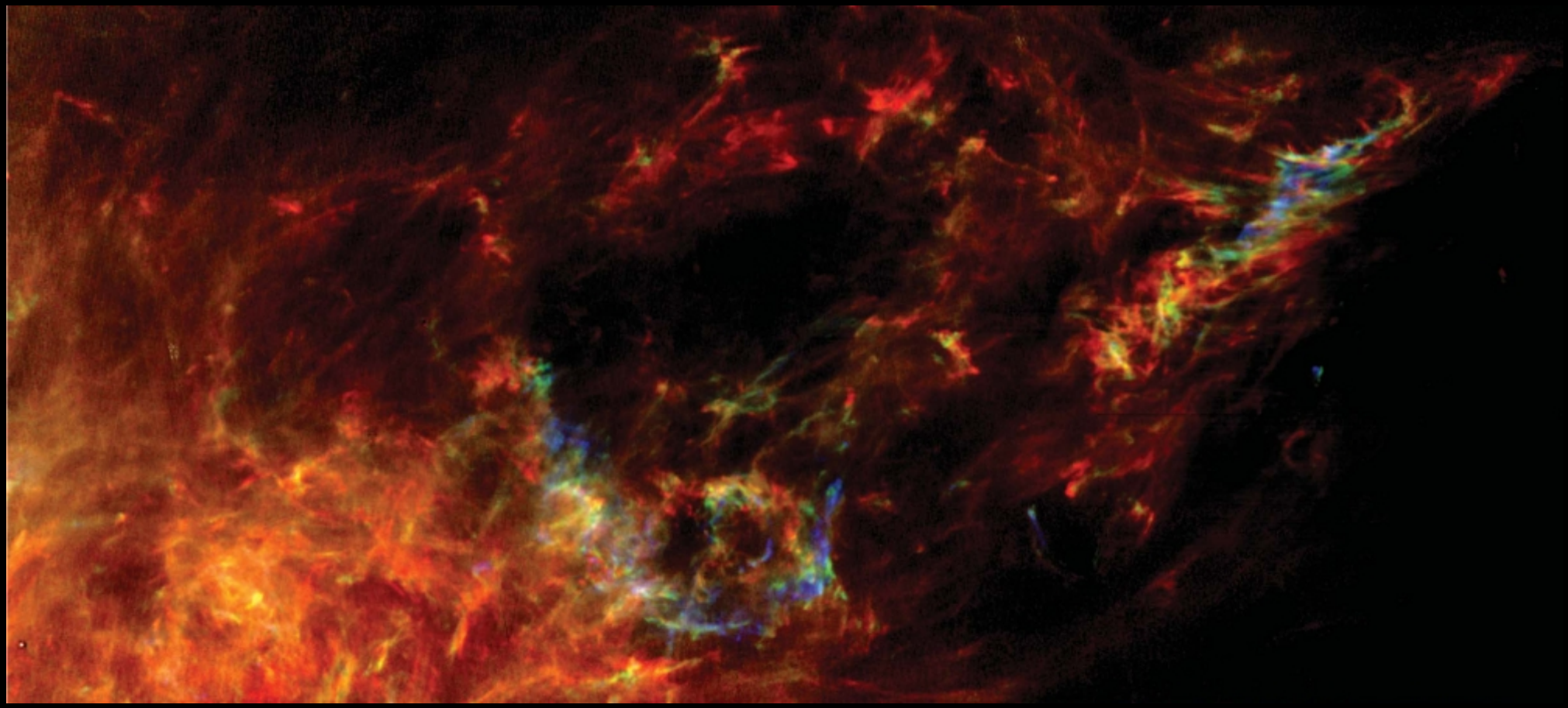
EBHIS+GASS → The ultimate successor of the LAB

The Galactic All-Sky Survey (GASS)



McClure-Griffiths et al. 2009
Kalberla et al. 2010

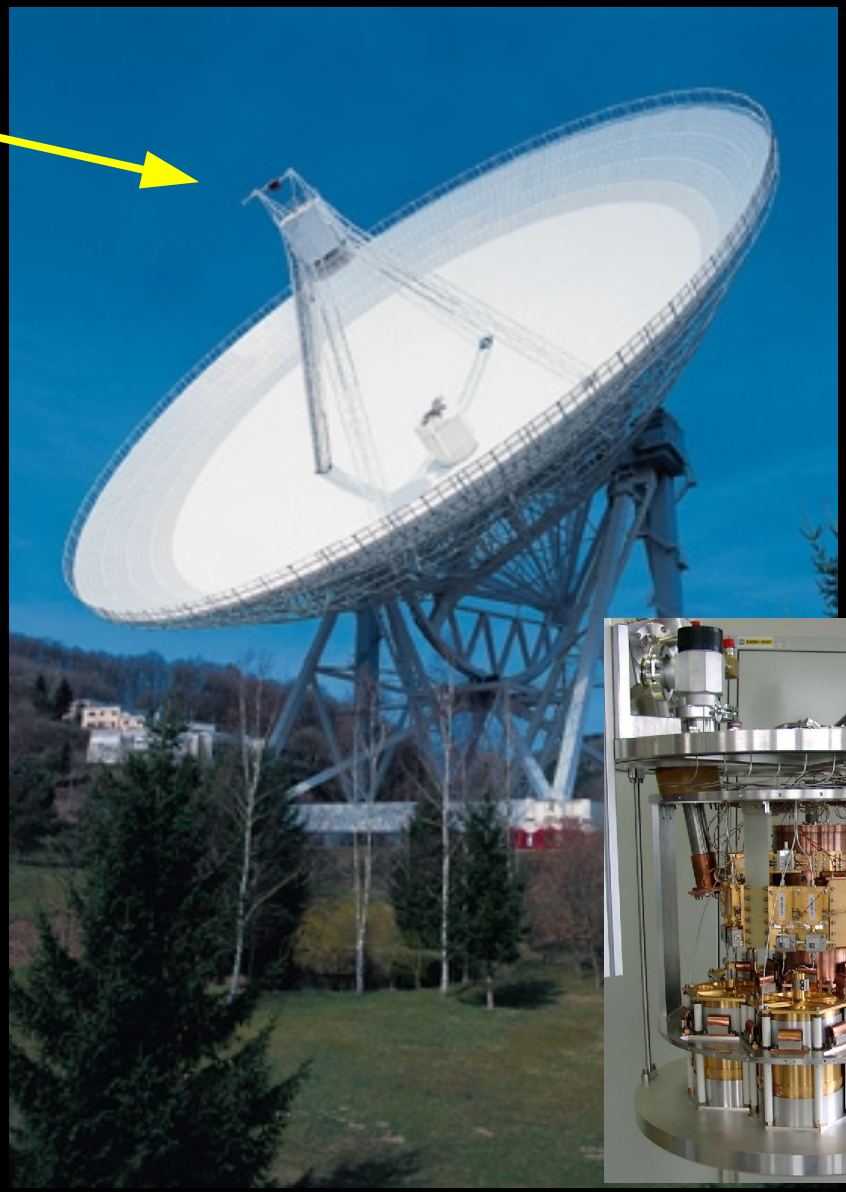
GALFA-HI



Goldsmith & GALFA consortium 2003
Peek et al. 2011

The Effelsberg-Bonn HI Survey (EBHIS)

7-Beam L Band Receiver (21-cm)



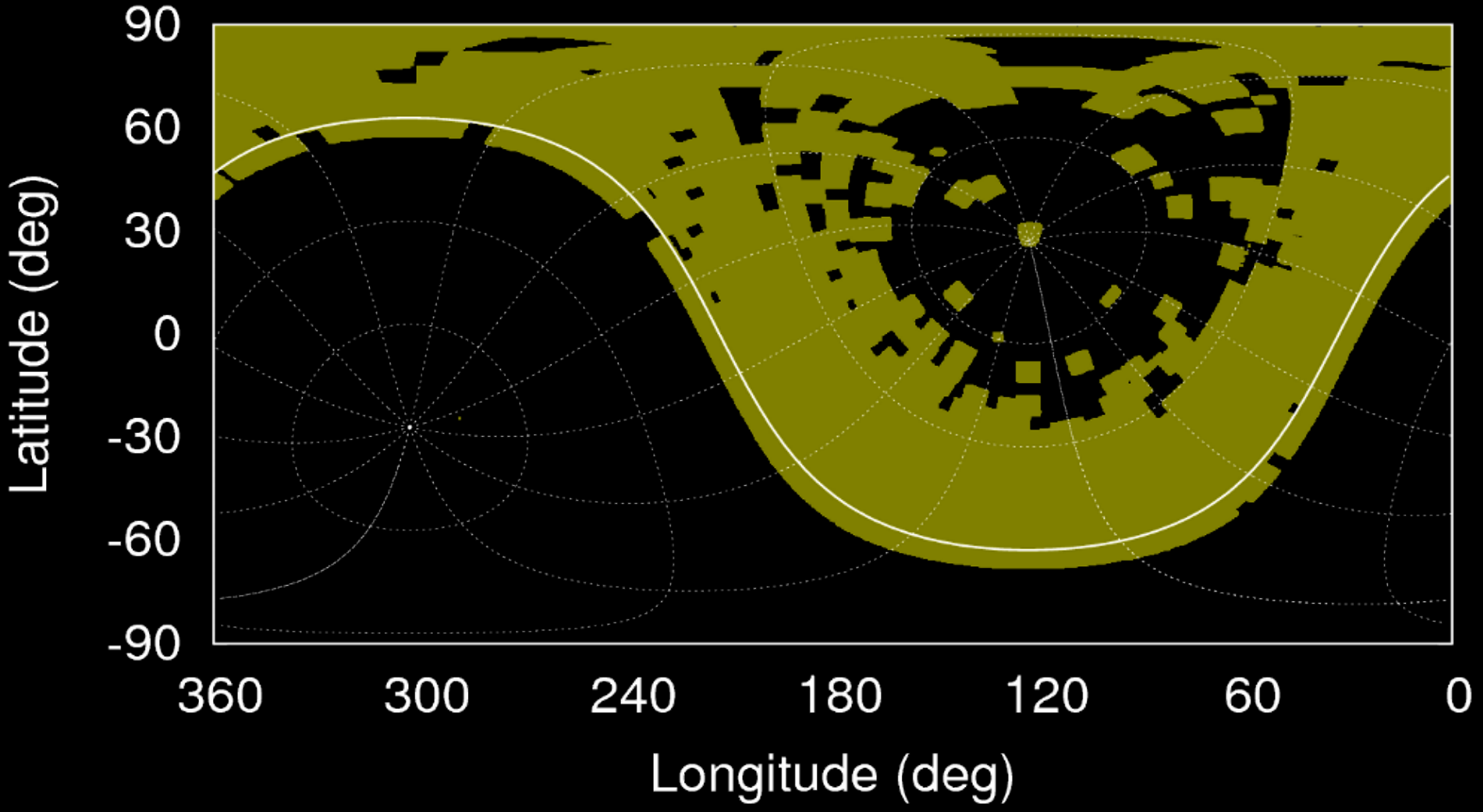
Team:

J. Kerp (PI), B. Winkel, P. Kalberla, M. Kramer, L. Flöer, N. Ben Bekhti, V. Darmstädter, D. Lenz

Collaborators:

F. Bigiel, R. Braun, W. van Driel, G. Hensler, B. Koribalski, T. Oosterloo, J. Peek, P. Richter, F. Walter, Planck collaboration

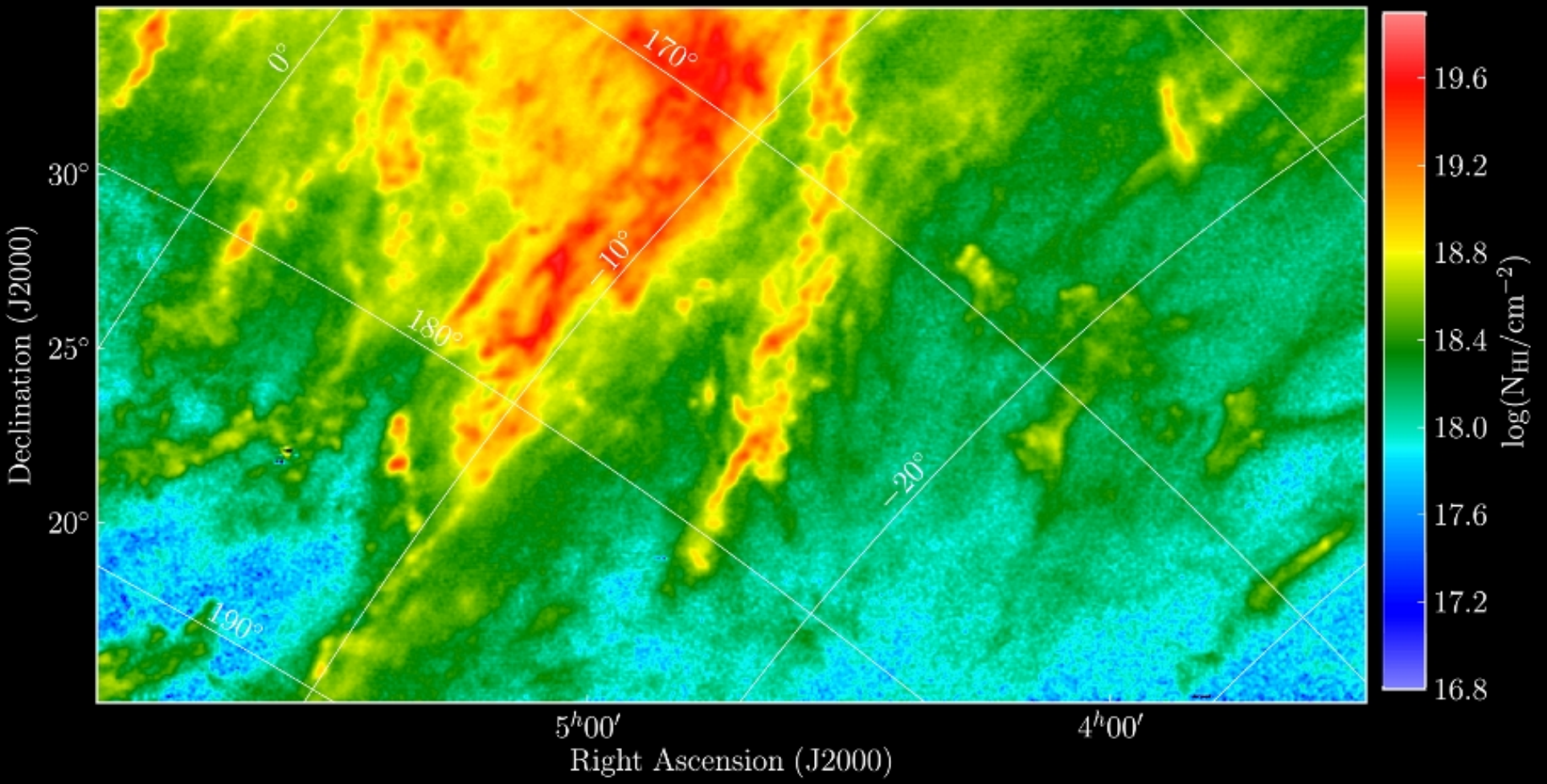
Current EBHIS sky coverage



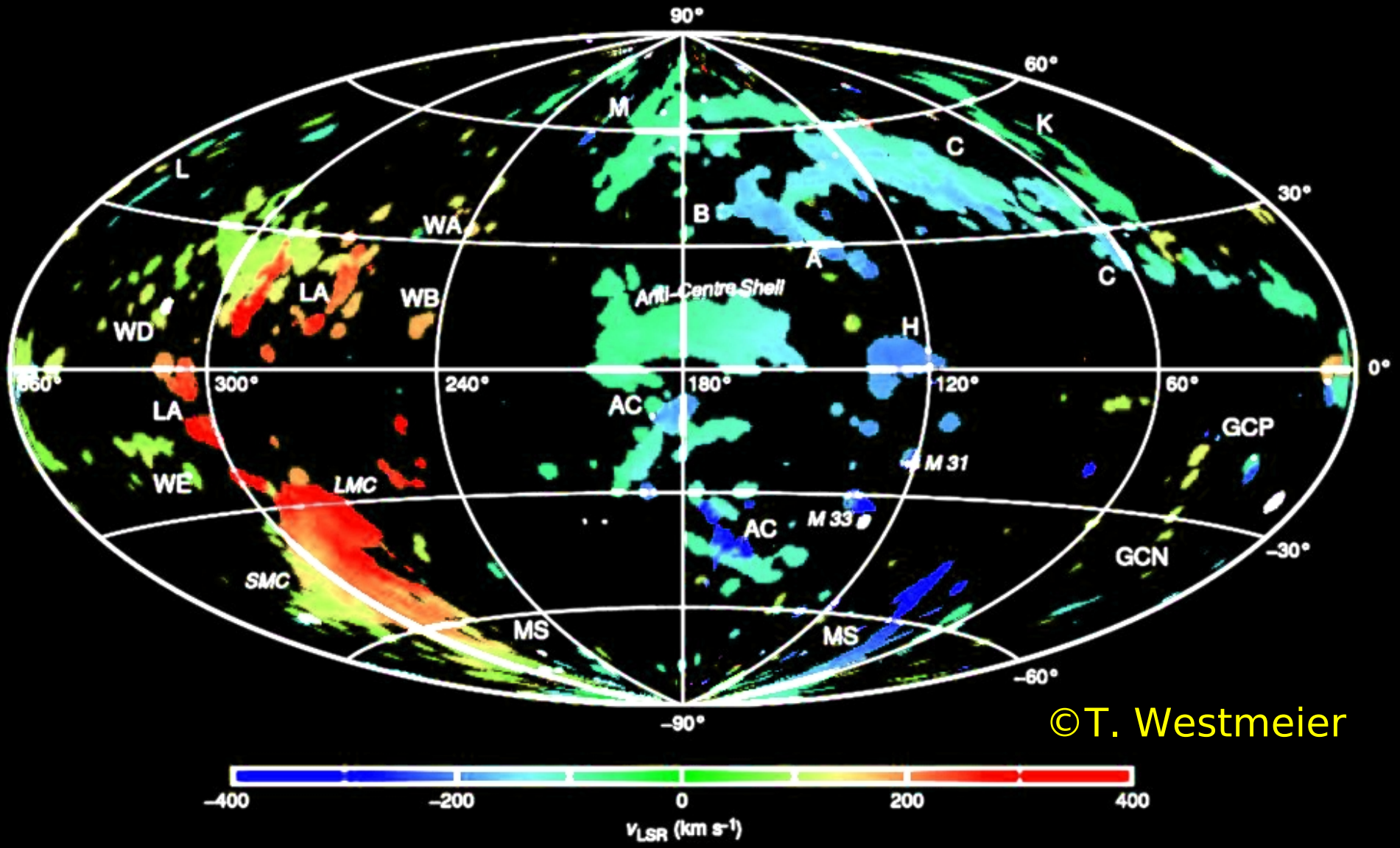
The Effelsberg-Bonn HI Survey (EBHIS)

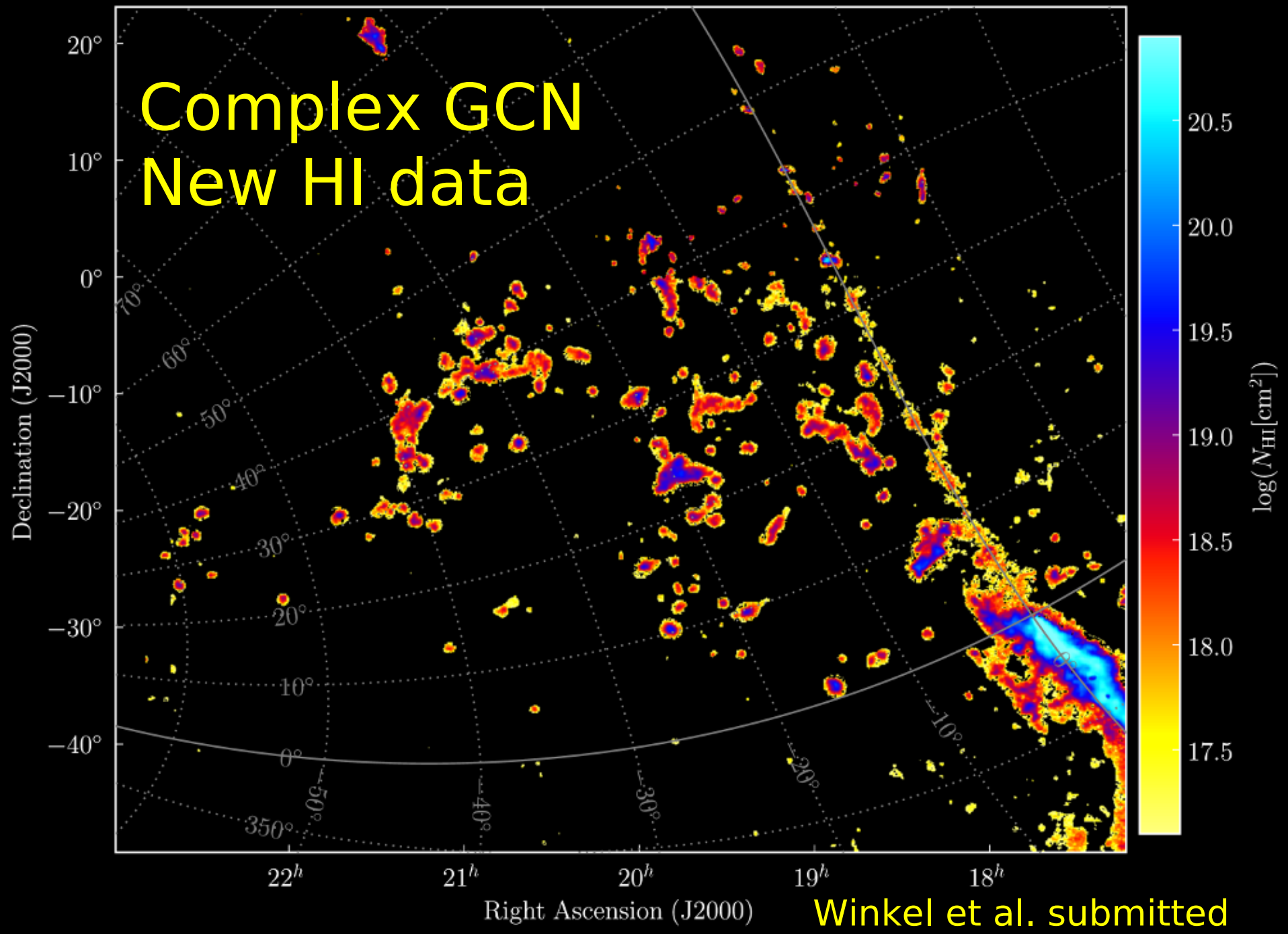
$V_{LSR} = -40$ km/s

Kerp et al. 2011
Winkel et al. 2010

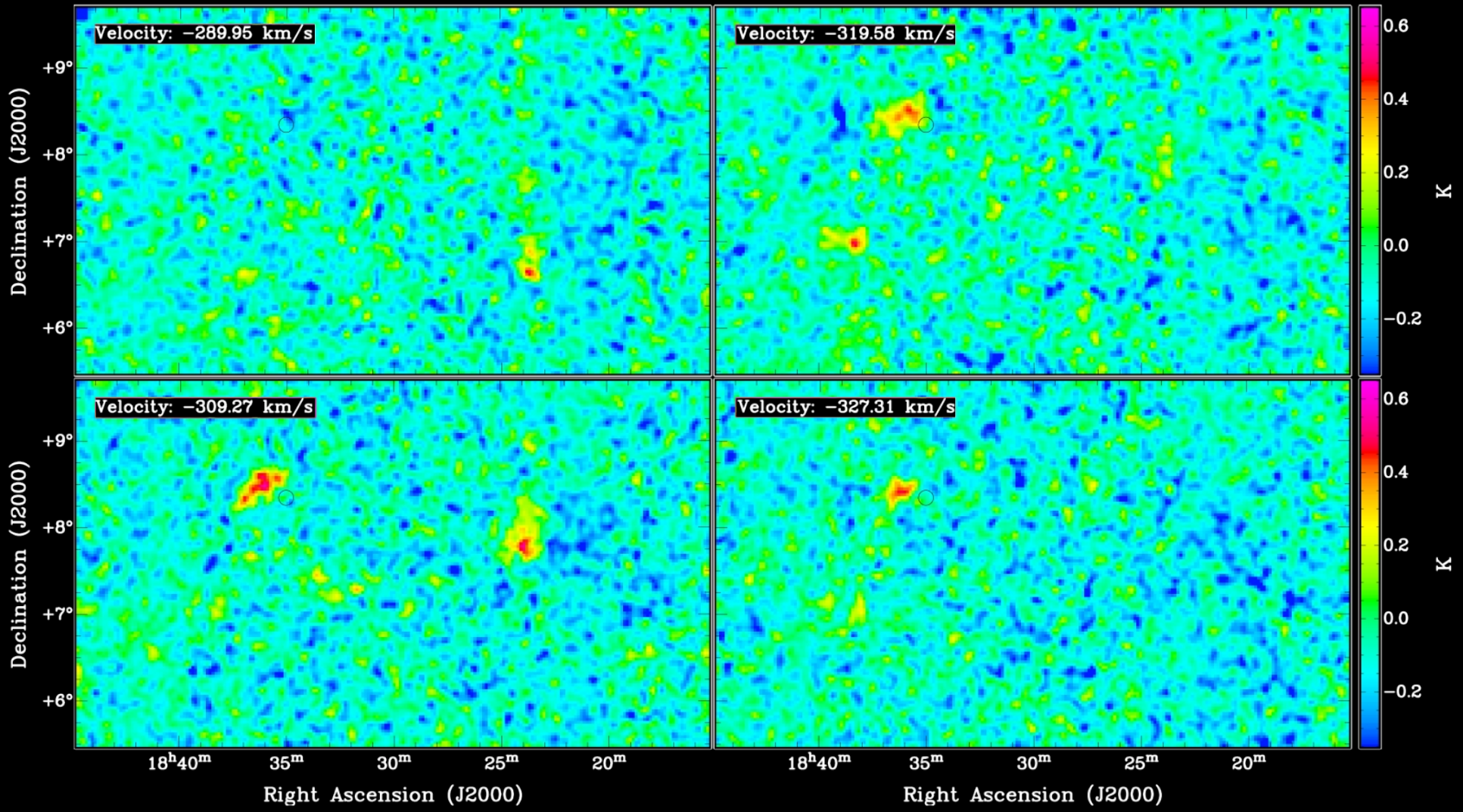


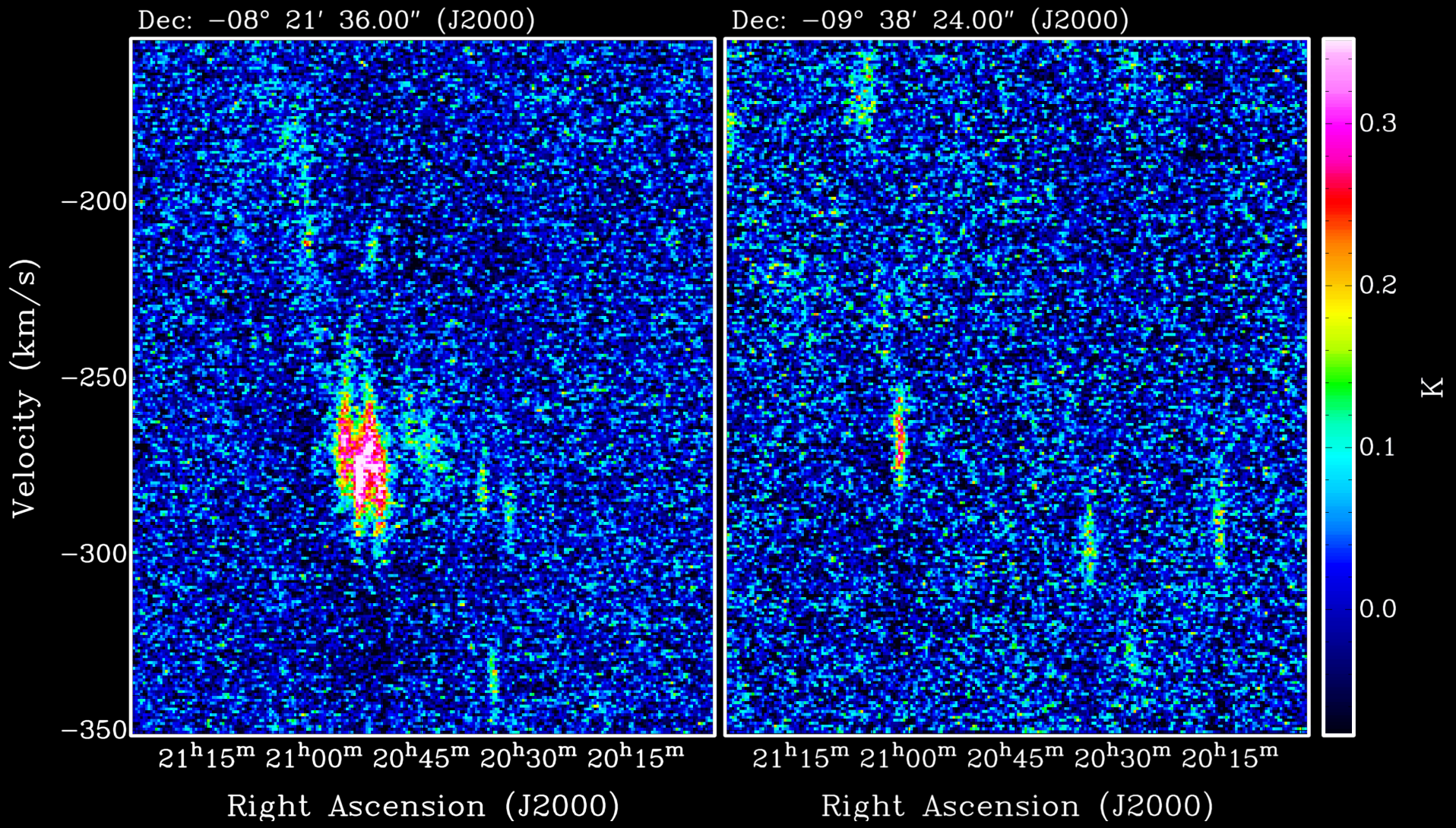
The high-velocity sky

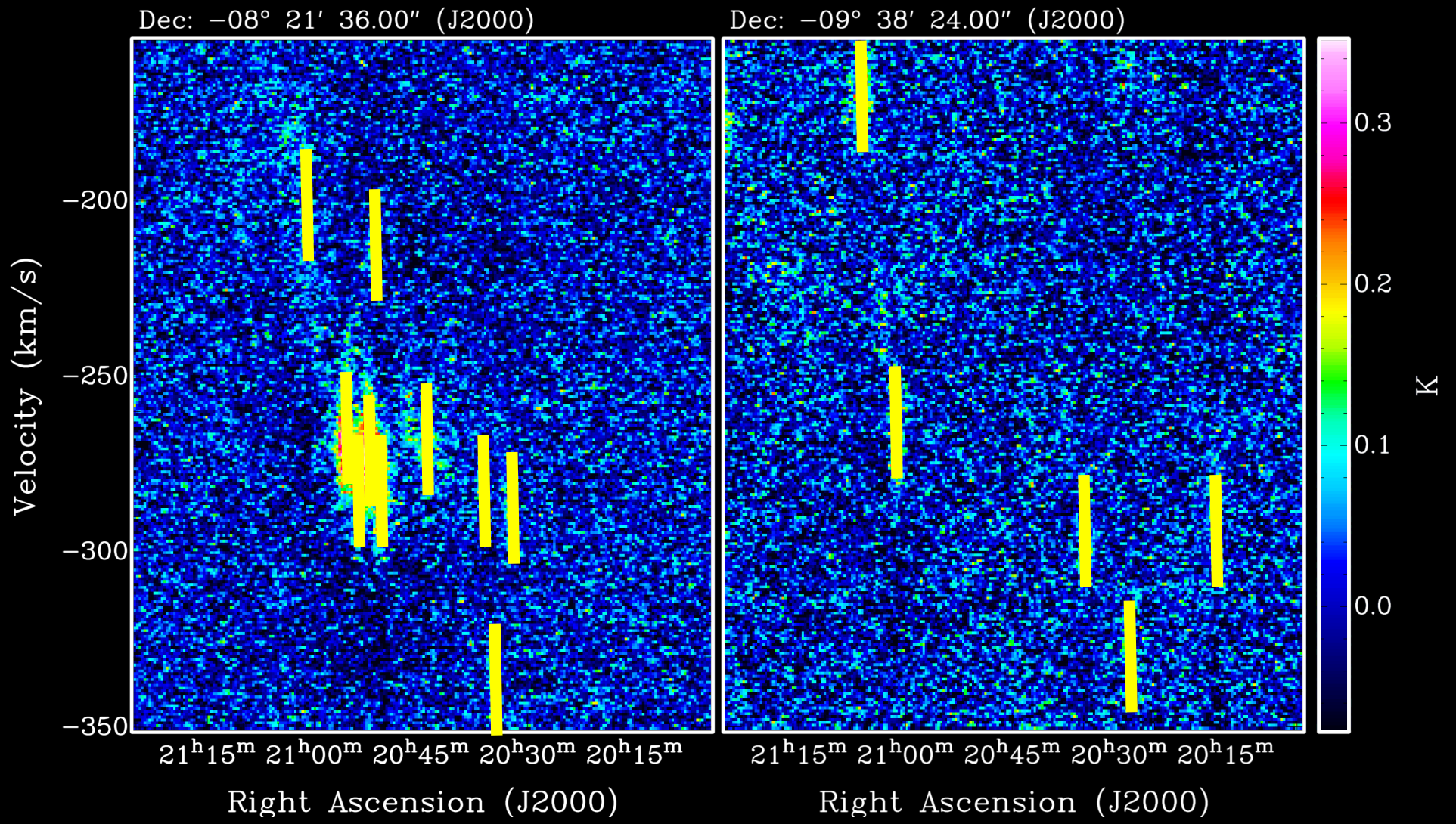



Complex GCN
New HI data
Declination (J2000)
Right Ascension (J2000)
20°
10°
0°
−10°
−20°
−30°
−40°
22h
21h
20h
19h
18h
log(NHI[cm2])
20.5
20.0
19.5
19.0
18.5
18.0
17.5
Winkel et al. submitted

Cloud properties and catalog




Dec: −08° 21′ 36.00″ (J2000)
Dec: −09° 38′ 24.00″ (J2000)
Velocity (km/s)
−200
−250
−300
−350
21h15m 21h00m 20h45m 20h30m 20h15m
Right Ascension (J2000)
21h15m 21h00m 20h45m 20h30m 20h15m
Right Ascension (J2000)
0.3
0.2
0.1
0.0
K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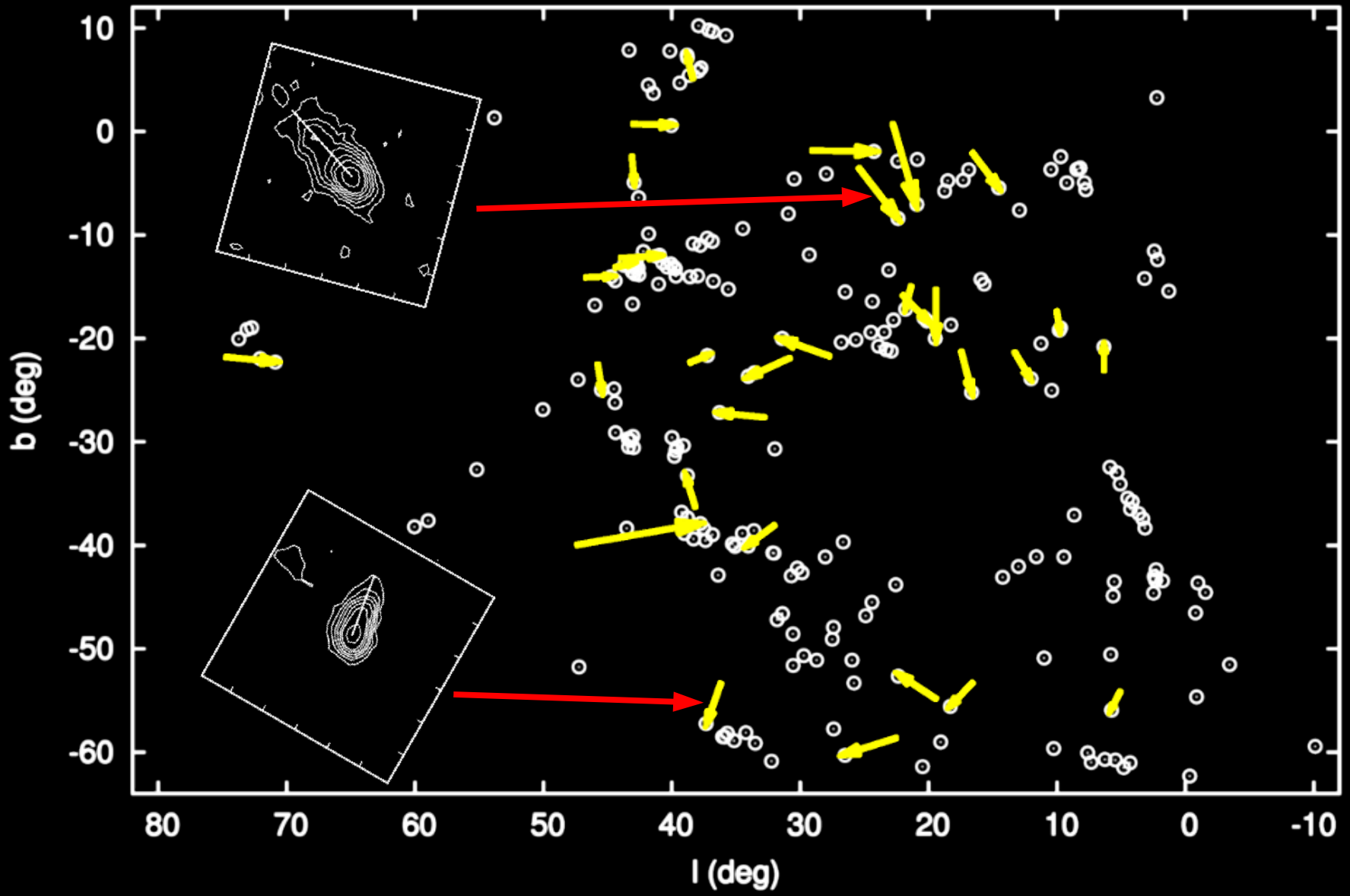
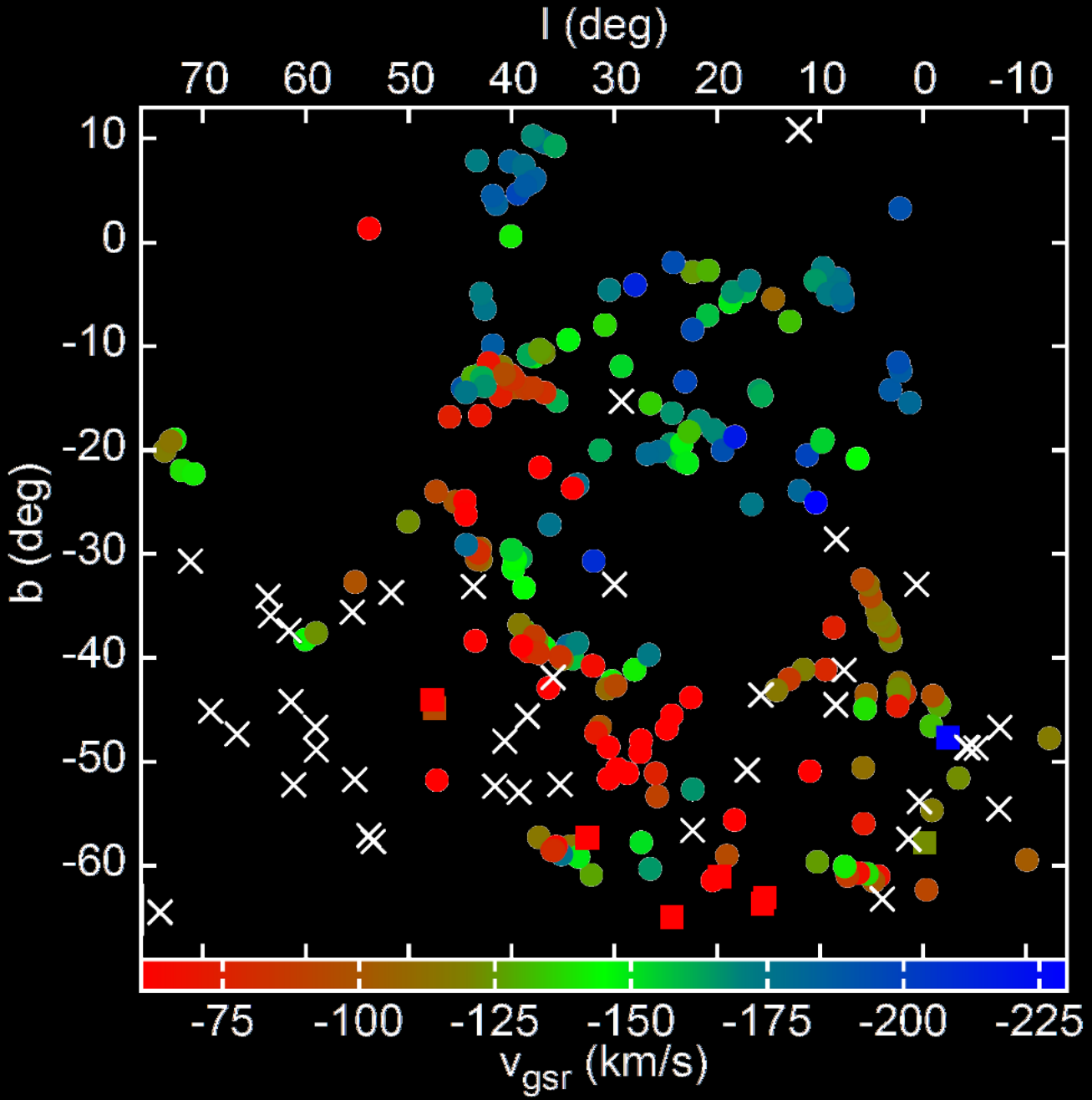
Right Ascension (J2000)
0.3
0.2
0.1
0.0
K

Cloud catalog

- Over 240 clouds/clumps were identified
- Many clumps still unresolved, often isolated
- Several head-tail structures and filaments
- Only 5% of the clumps seem to be in the cooler gas phase (< 7.5 km/s)
- No diffuse extended gas phase detected

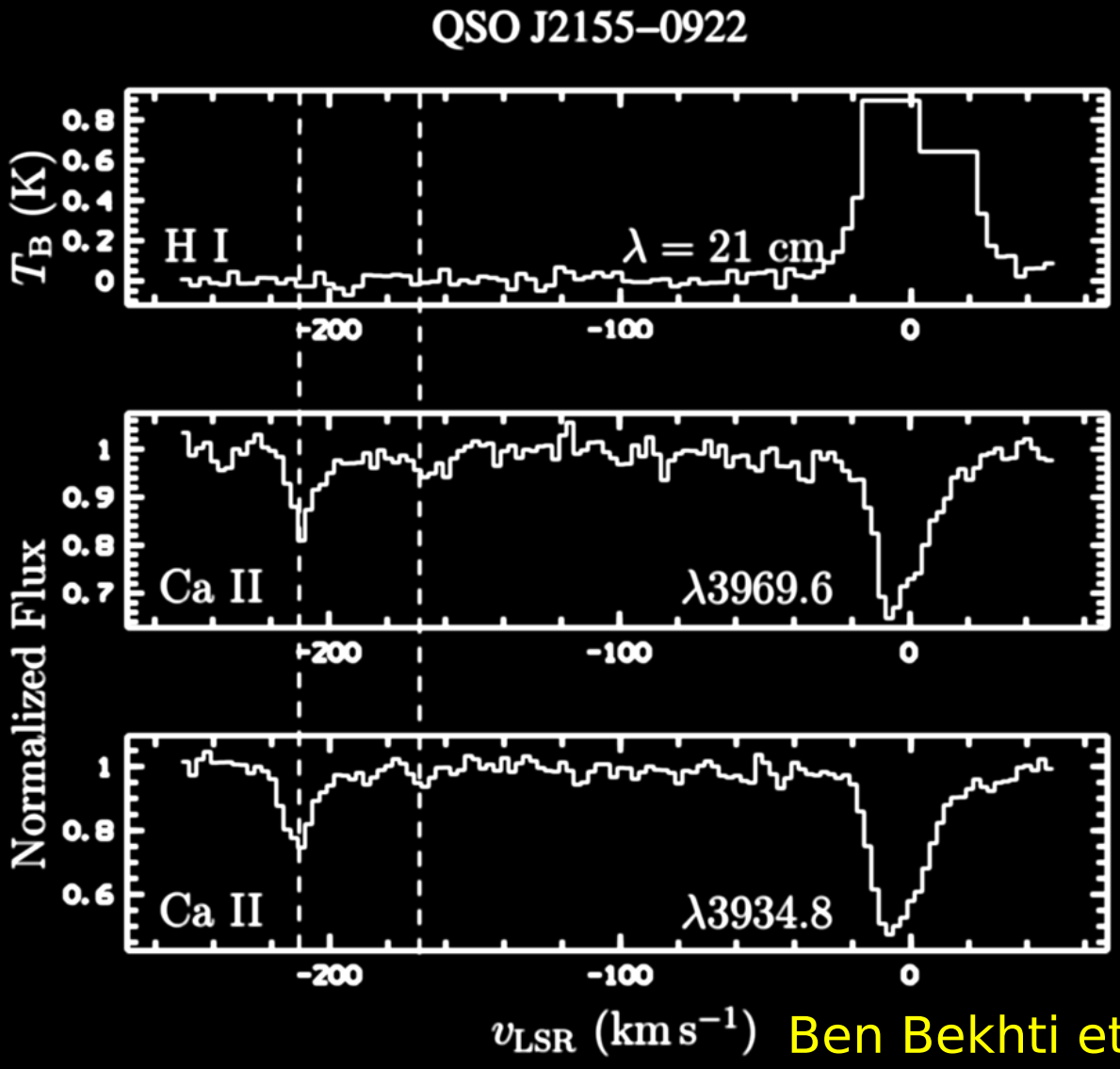
Head-tail clouds





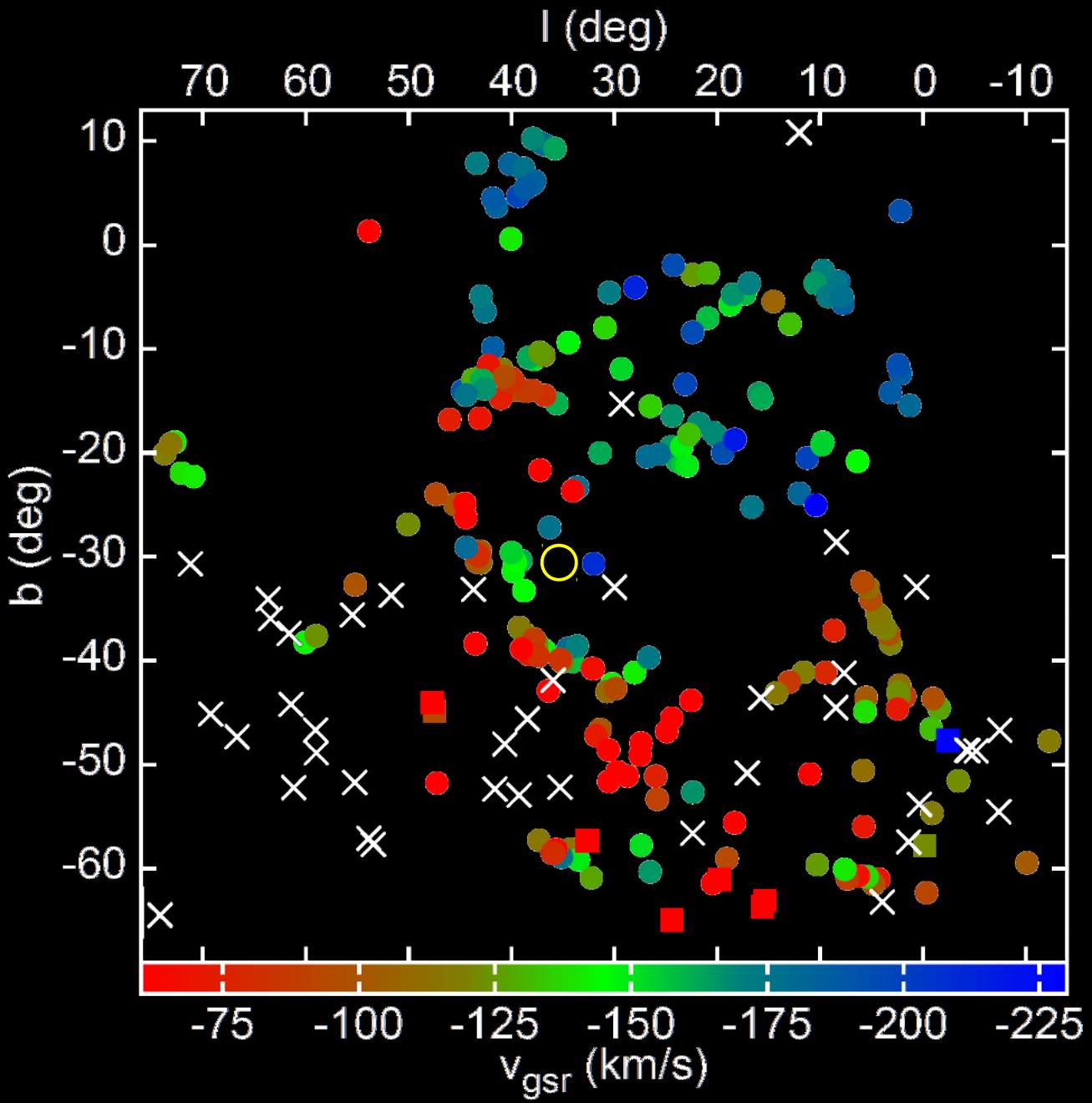
Large scatter in radial velocities

QSO absorption spectroscopy



Ben Bekhti et al. 2008

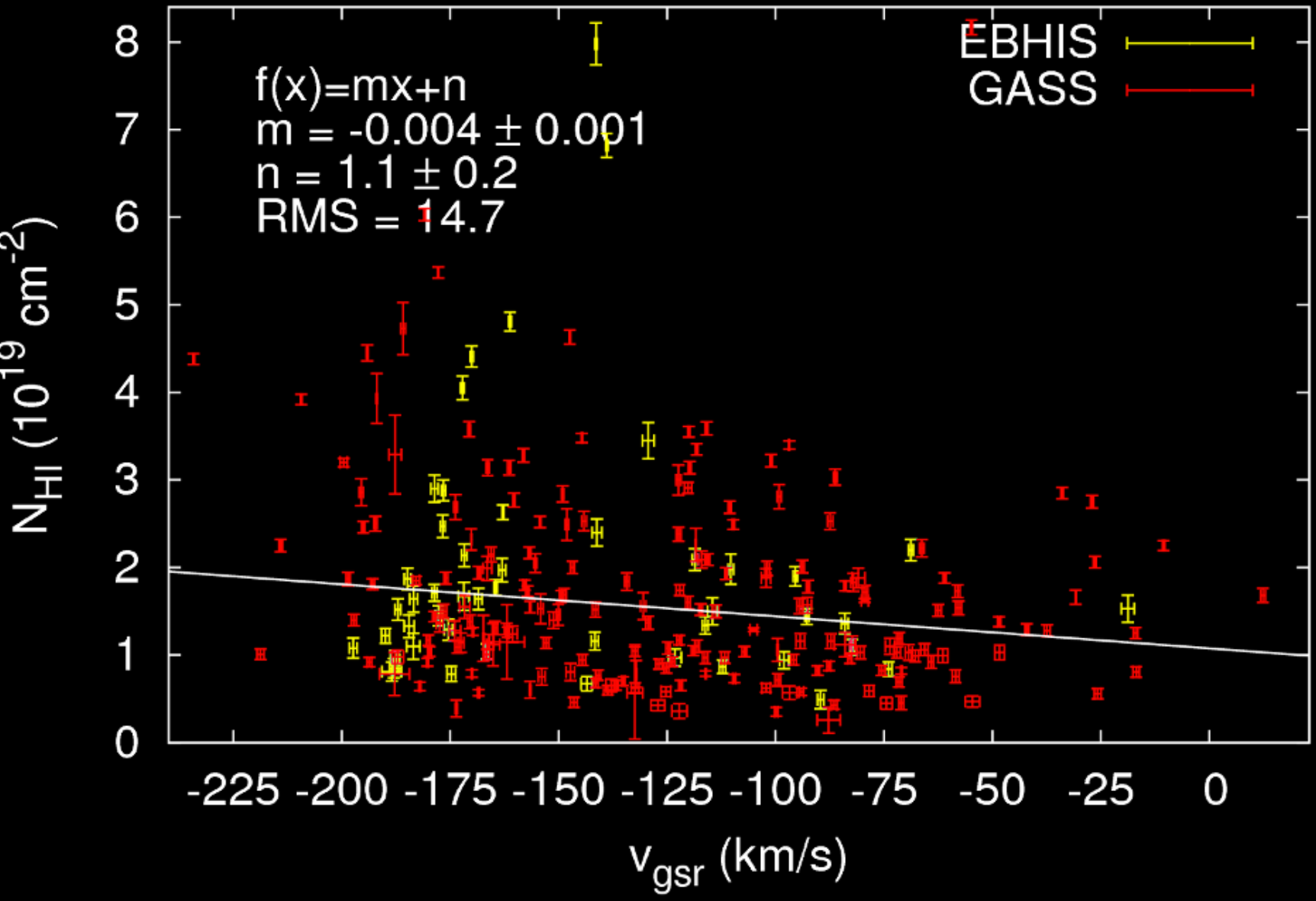
- Sample of 400 QSOs to study low-column density gas in the MW halo (using UVES/VLT)
- 57 sight lines in the GCN region

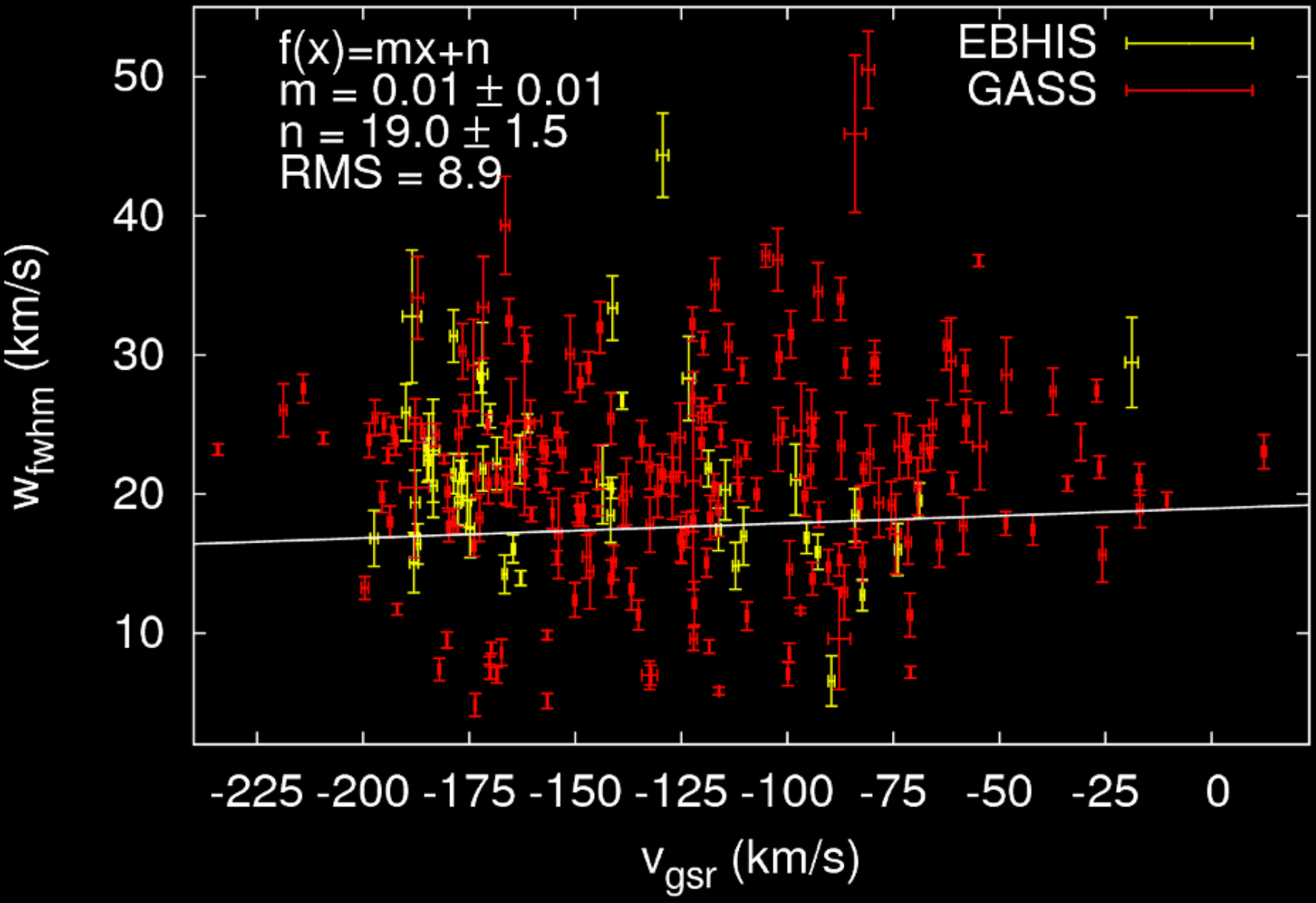


Large scatter in radial velocities

Ionized gas is around

- Several CaII detections
- No NaI detection
- Higher ions towards Mrk 509


EBHIS
GASS
f(x)=mx+n
m = -0.004 ± 0.001
n = 1.1 ± 0.2
RMS = 14.7
N_{HI} (10^{19} cm^{-2})
v_{gsr} (km/s)
0
1
2
3
4
5
6
7
8
-225
-200
-175
-150
-125
-100
-75
-50
-25
0


f(x)=mx+n
m = 0.01 ± 0.01
n = 19.0 ± 1.5
RMS = 8.9
EBHIS
GASS
50
40
30
20
10
w_{fwhm} (km/s)
-225 -200 -175 -150 -125 -100 -75 -50 -25 0
v_{gsr} (km/s)

The warm gas accretion scenario

- Observations: ram-pressure interaction is likely the most important process
- Neutral gas clouds or a stream encounter the MW halo, get decelerated and dissolve
- Under certain conditions only slow cooling takes place (Heitsch & Putman 2009; wind tunnel)
- Ablated material becomes ionized and is accreted onto the MW
- What is the fraction of ionized or low-column density neutral gas?

Outlook

- Interferometric observations to study substructure and head-tail features in more detail
- Association with the Leading Arm?
  (→ Diaz & Bekki 2011)
- Study subpopulations

Thank you!

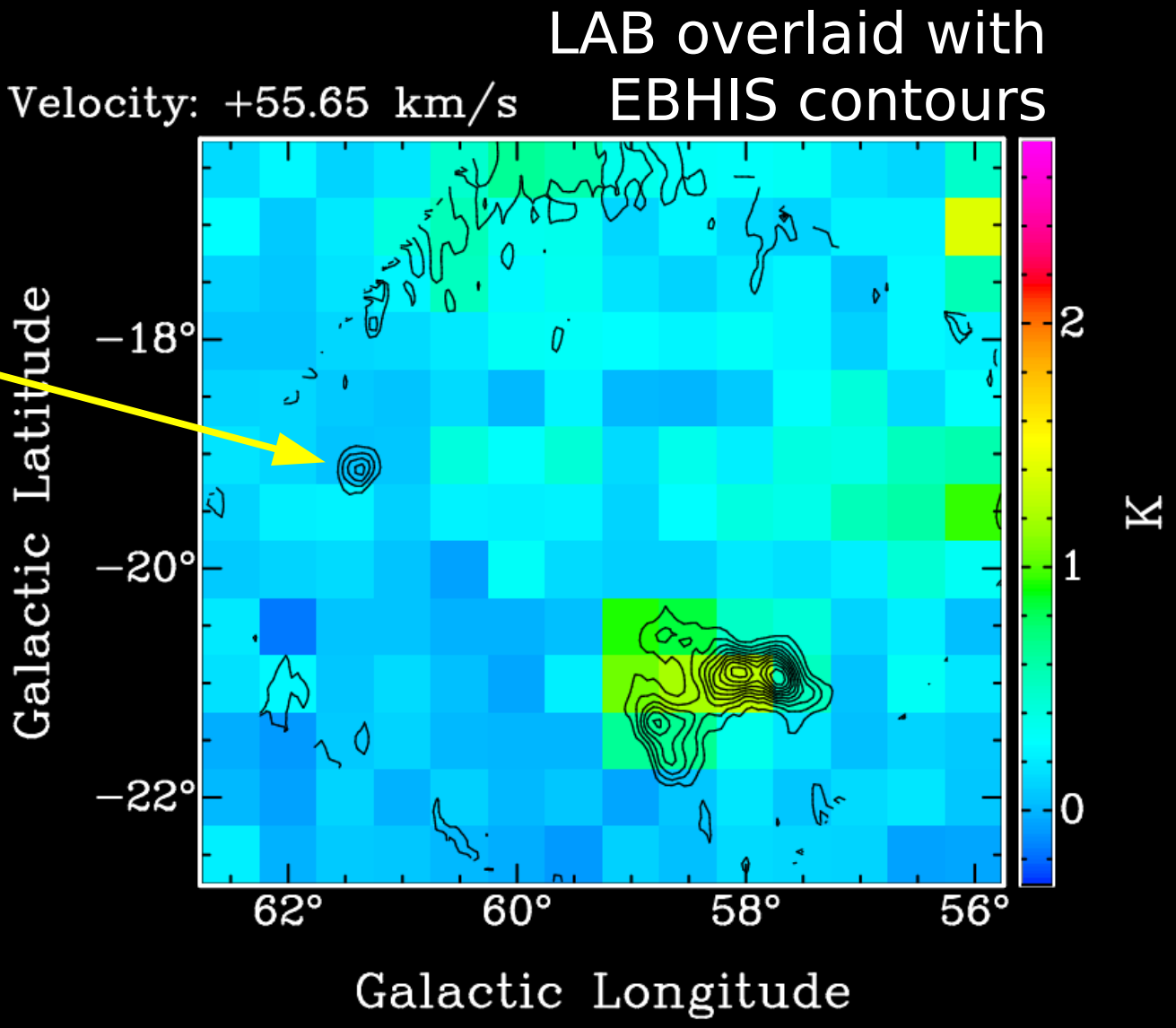
The full-sampling issue

Nondetection in LAB survey!

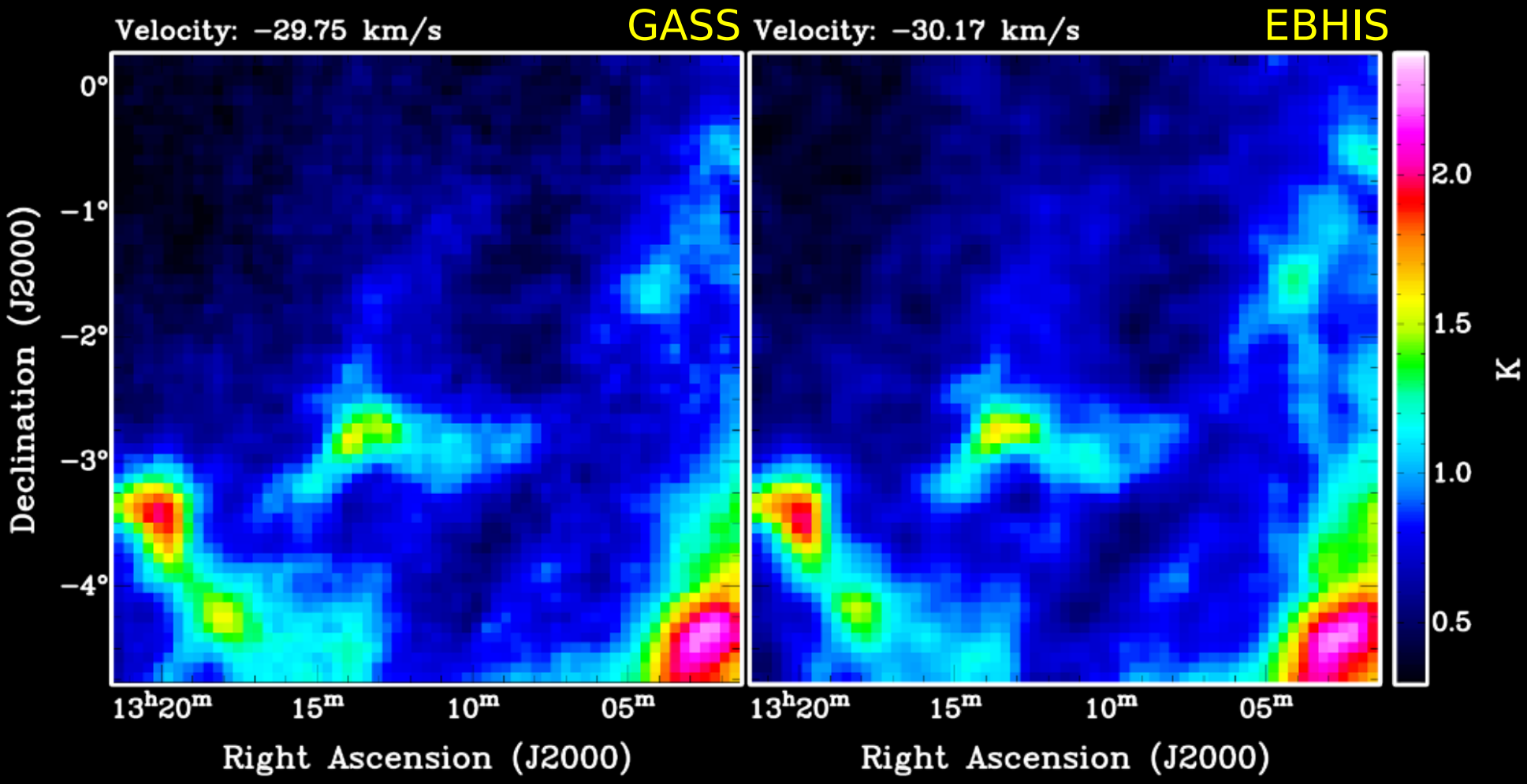
$\Delta v \sim 4$ km/s

$\varphi \sim 14'$

$T_B \sim 1.3$ K



The ultimate successor of the LAB survey



Both have similar column density detection limits

$N_{HI} \sim 3 \times 10^{19}$ cm^{-2}

$\Delta v(FWHM) \sim 20$ kms^{-1}

$\varphi \sim 16'$