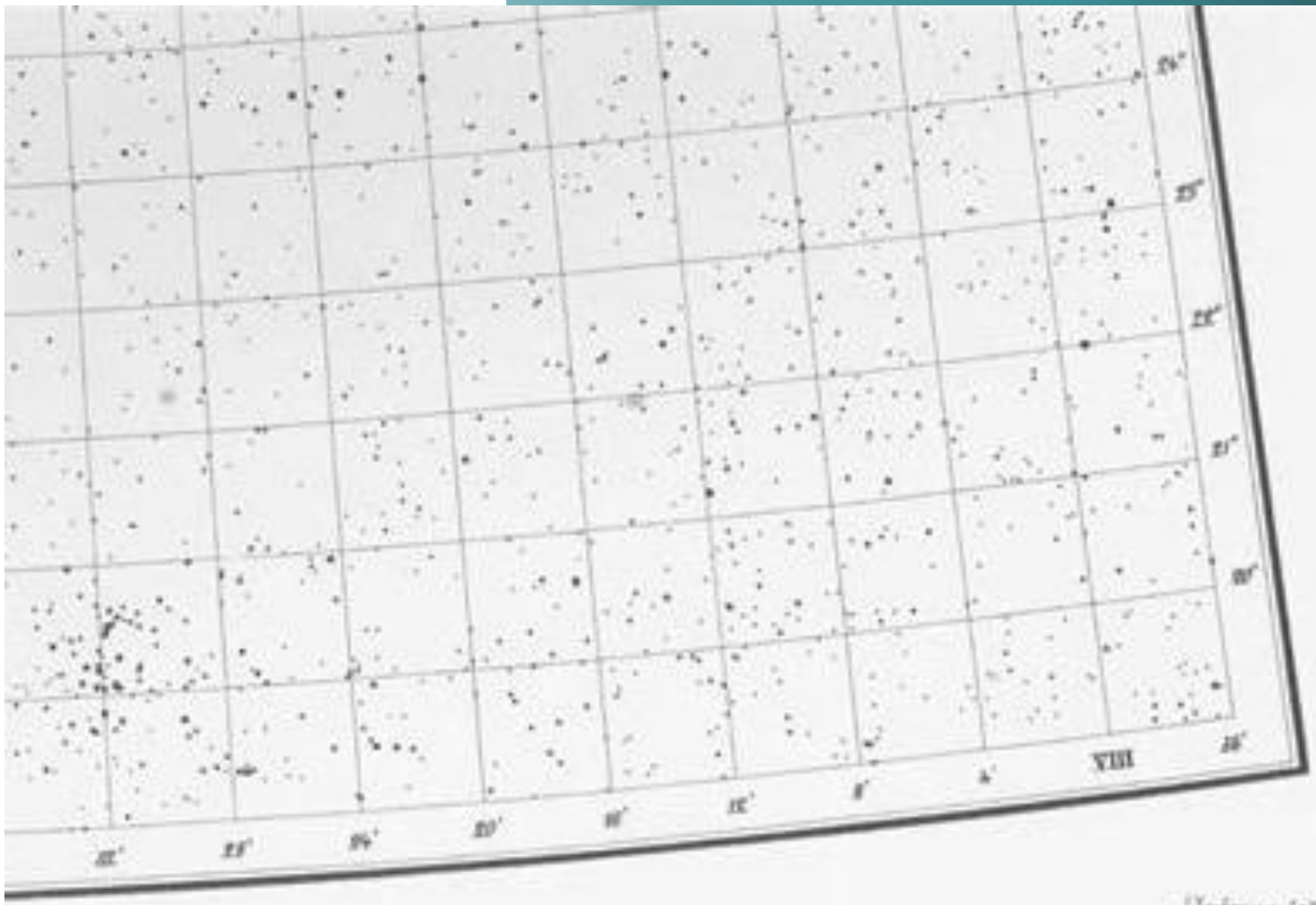
On the way to the fifth Bonner Himmelsdurchmusterung: The Effelsberg-Bonn HI Survey (EBHIS)

Dr. Jürgen Kerp
Argelander-Institut für Astronomie
Universität Bonn

Bonner Durchmusterungen

1. Bonner Durchmusterung (Argelander & Schönfeld)
2. Stockert 6-cm Survey (Mezger)
3. 408 MHz survey (Haslam)
4. Stockert 21-cm Kontinuum survey (Reich)
5. Effelsberg-Bonn HI Survey (Kerp)



Bonner Durchmusterung, nördlicher Teil

von Fr. W. Argelander.

3., berichtigte Auflage

Herausgegeben von der Universitäts-Sternwarte Bonn.

Ferd. Dümmlers Verlag, Berlin.

Aim of surveys

Shows what is present

Do an inventory

Disclose the strange

Disclose variability

Disclose changes in position

Fundament of knowledge

A homogeneous data base

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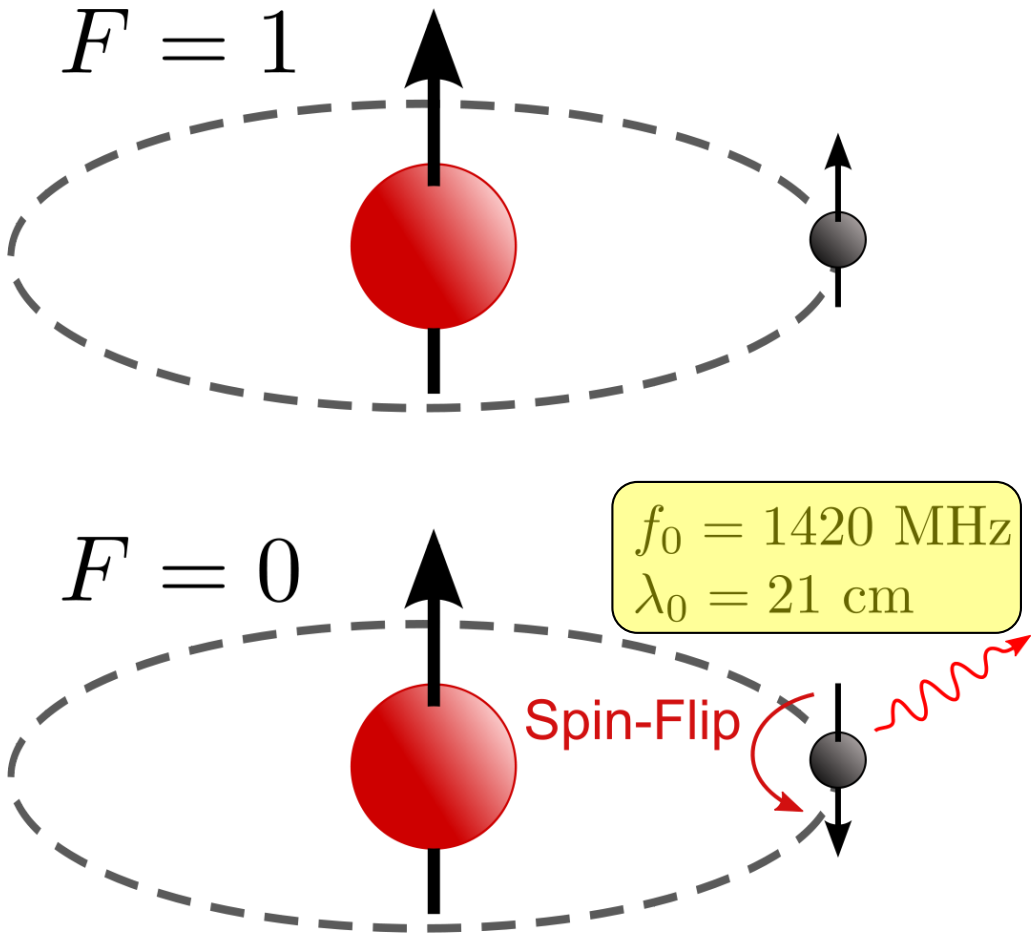
Why hydrogen with a single dish?



en.wikipedia.org/wiki/Hydrogen_line

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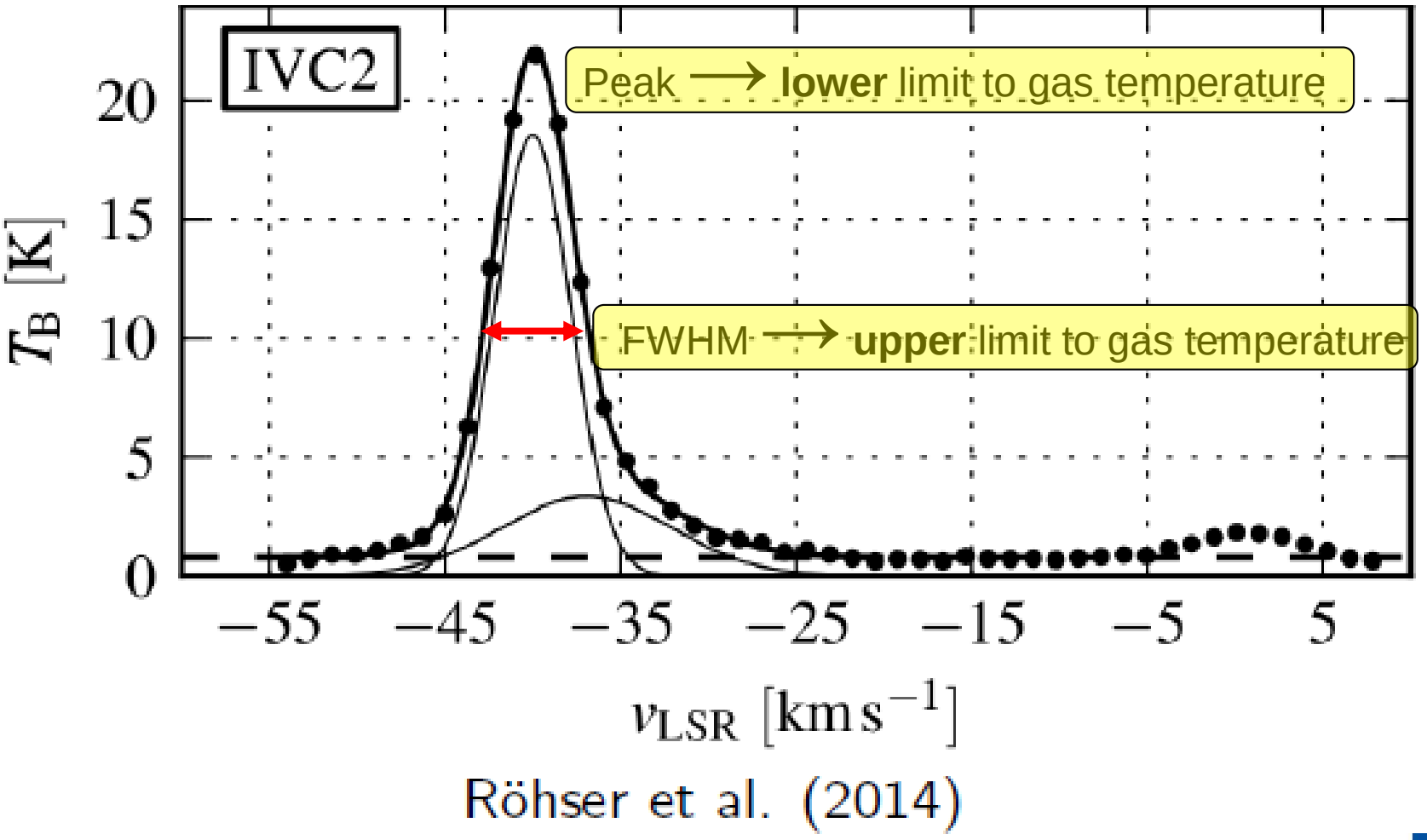
HI 21-cm line data



Röhser et al. (2014)

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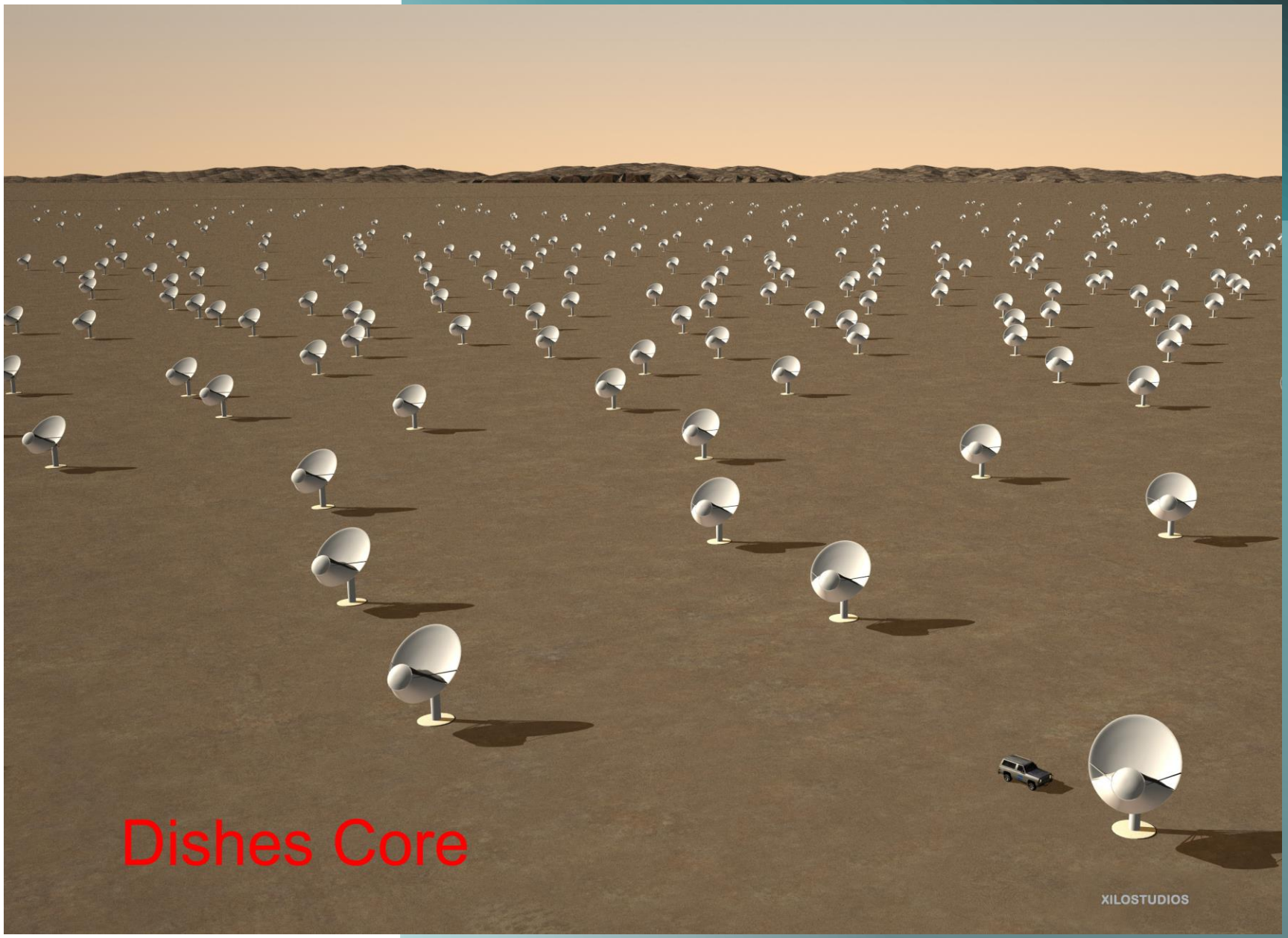
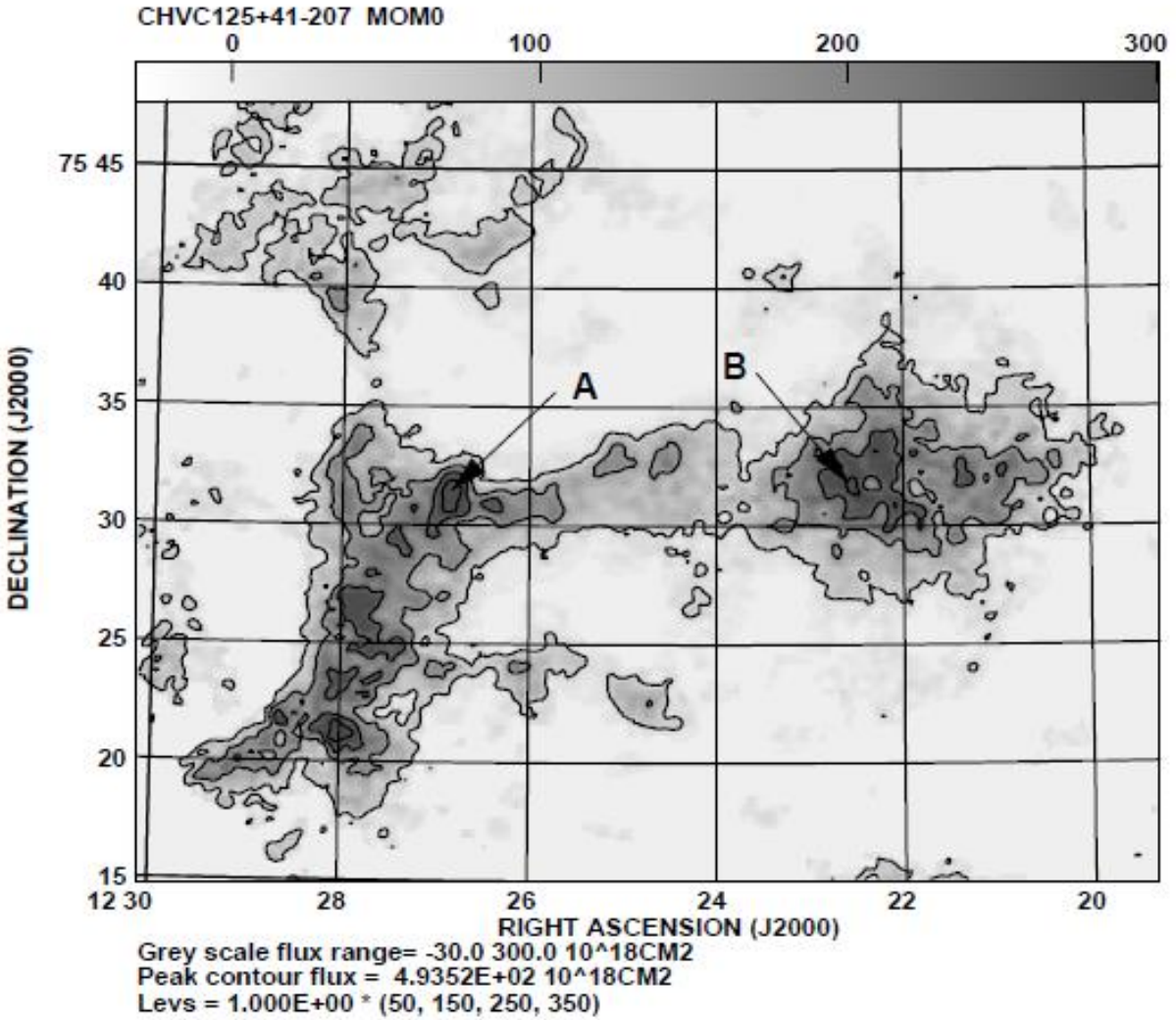

Dishes Core
XILOSTUDIOS

HVC 125+41-207: radio interferometer



Braun & Burton 2000, A&A 354, 853

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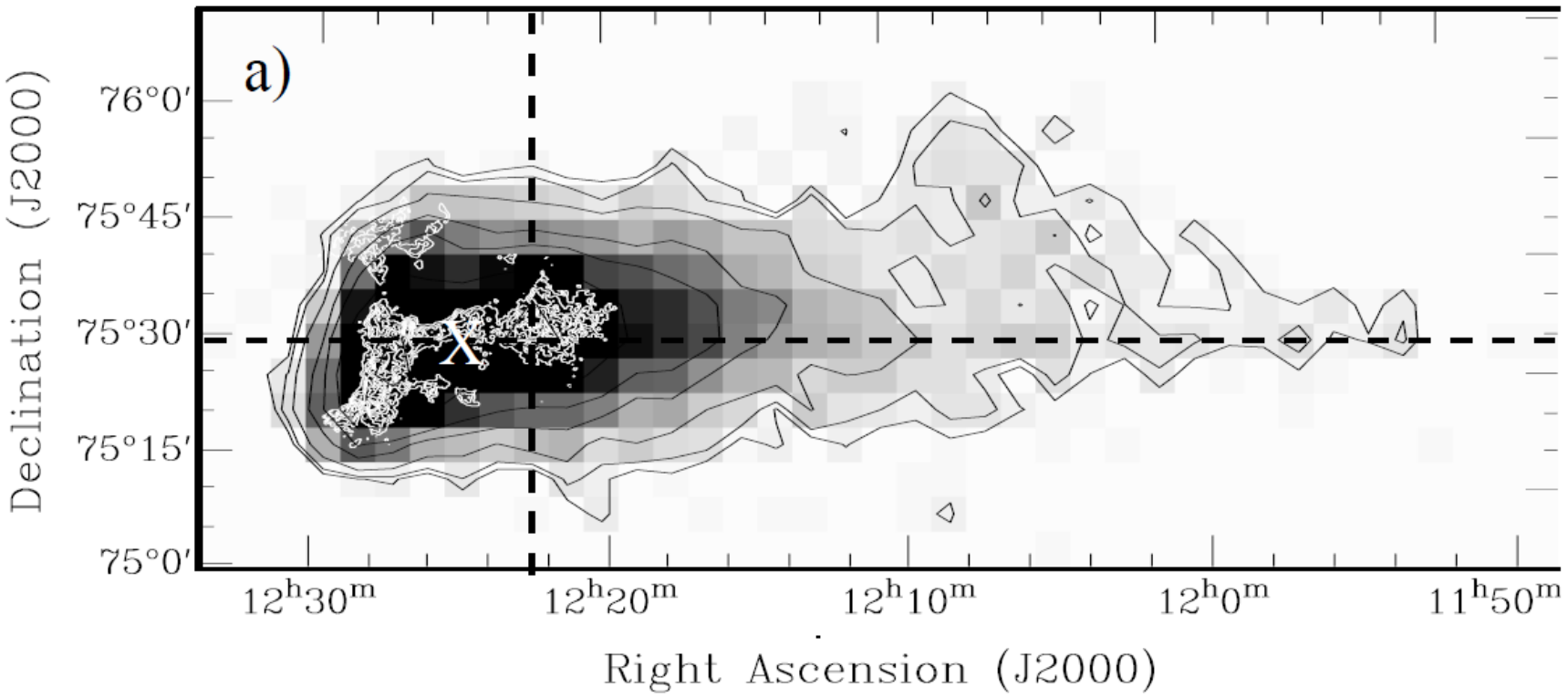
HVC 125+41-207: Effelsberg dish



Brüns, Kerp & Pagels 2001, A&A 370, L26

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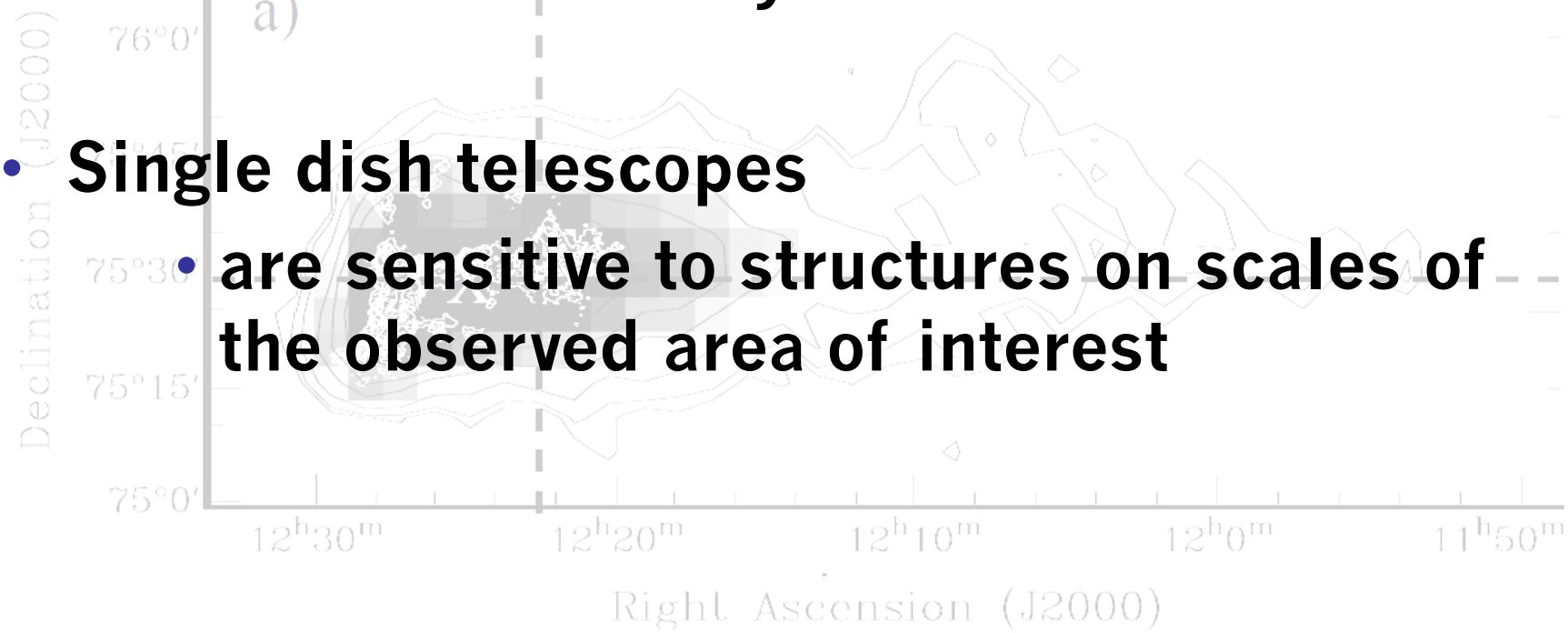
- **Radio interferometer**
  - **are sensitive only to small-scale structure**
- **Single dish telescopes**
  - **are sensitive to structures on scales of the observed area of interest**



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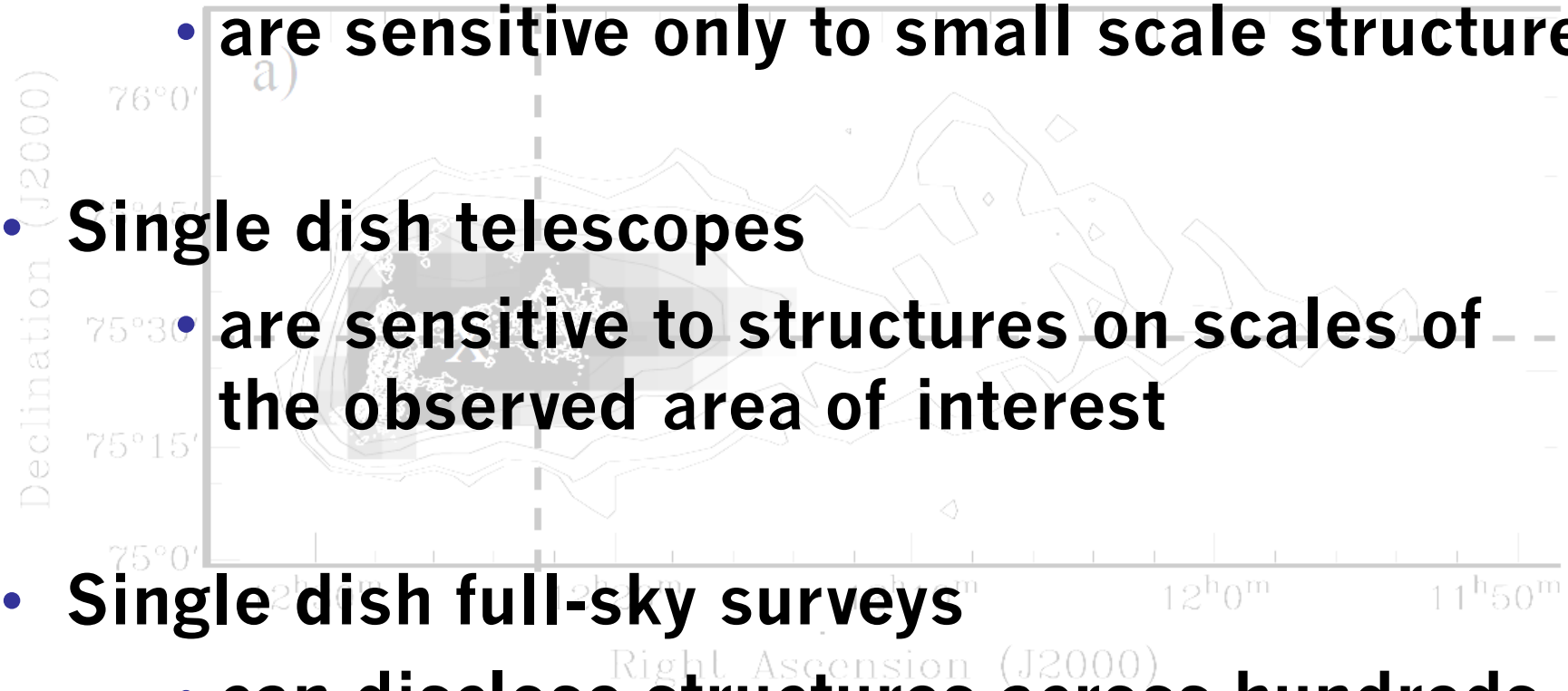
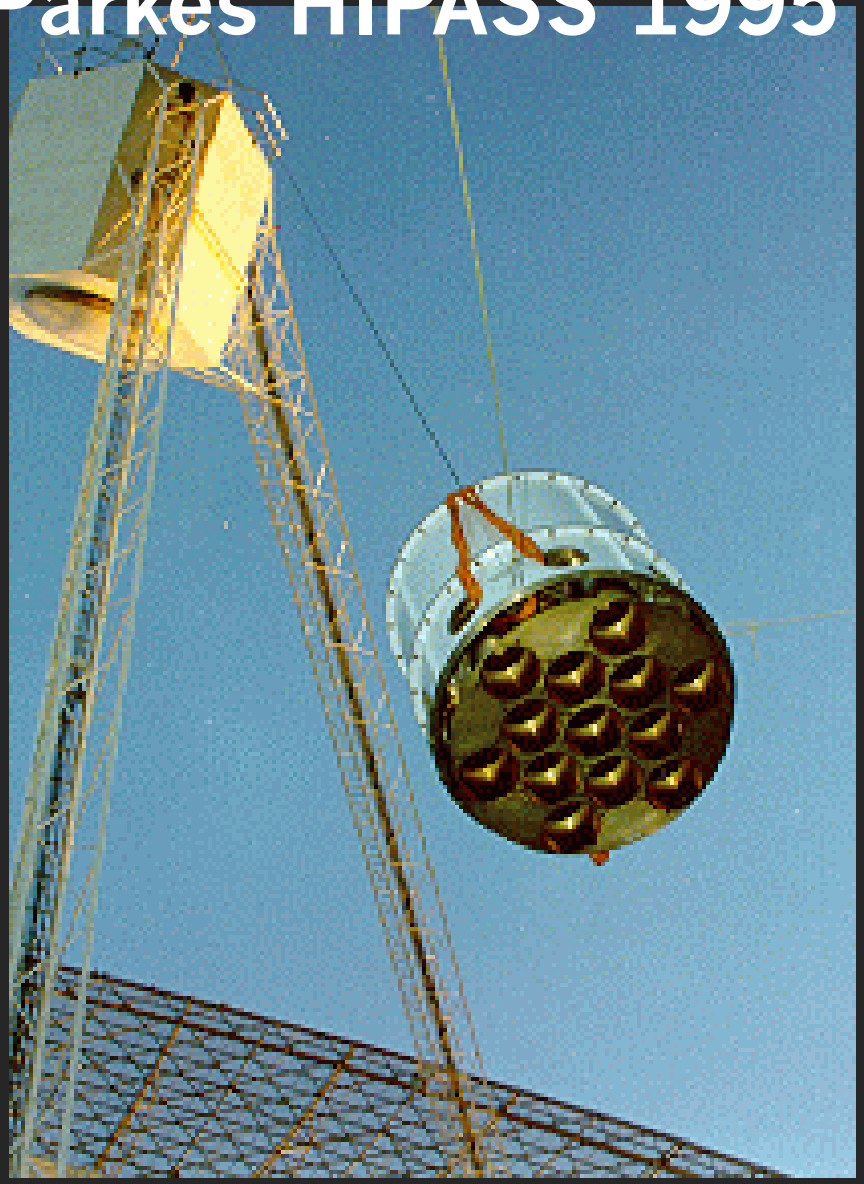
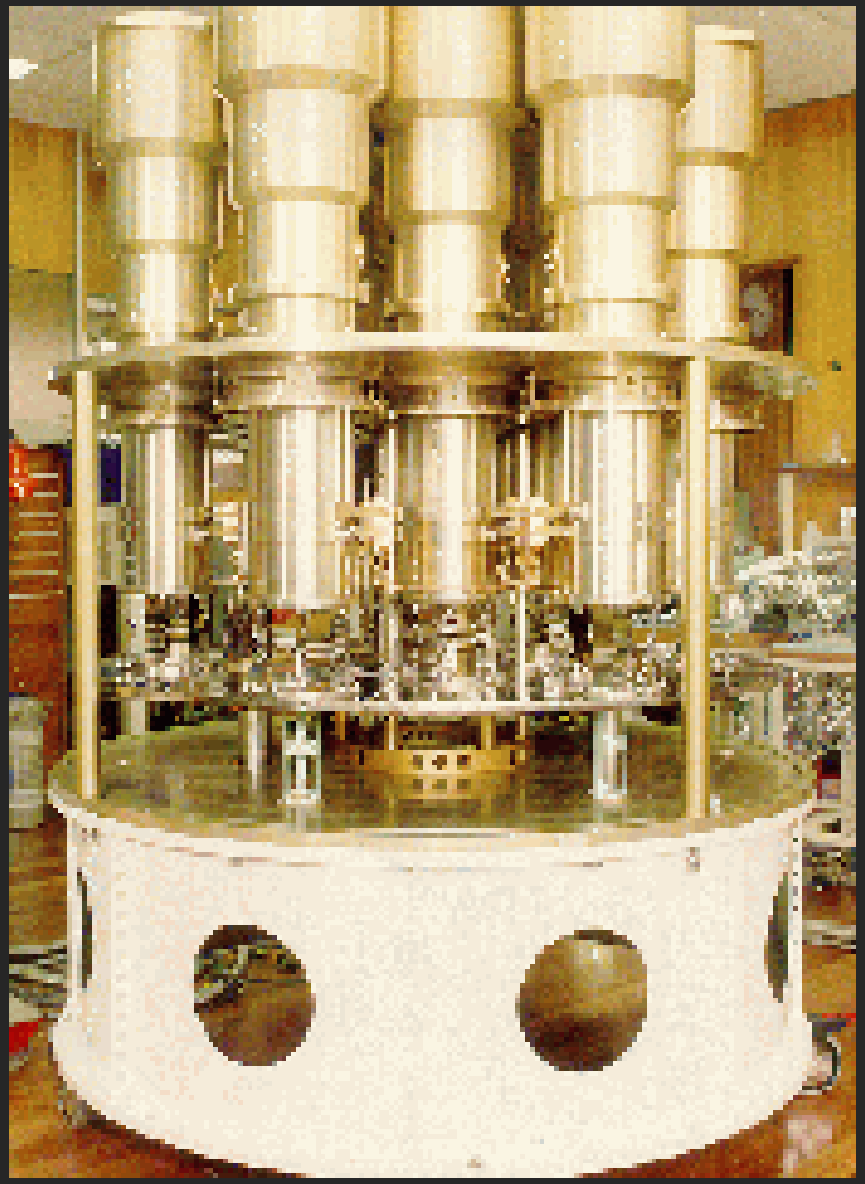
- **Radio interferometer**
  - **are sensitive only to small scale structure**
- **Single dish telescopes**
  - **are sensitive to structures on scales of the observed area of interest**
- **Single dish full-sky surveys**
  - **can disclose structures across hundreds of square degrees**



Status prior to EBHIS

Parkes HIPASS 1995





Survey Parameters	
Survey coverage	Declination -90 degrees to +25 degrees
Receiver Bandwidth	64 MHz
Velocity coverage	-1,200 to 12,700 km/s
Maximum Distance for galaxy detection	170 Mpc
Velocity resolution	18 km/s
Typical r.m.s.	13 mJy/beam
Gridded beamsize	15.5 arcminutes
Number of galaxies detected	~5,000

https://astronomy.swin.edu.au/cosmos/h/HIPASS

HIPASS Parkes

HIJASS 2003

HIJASS is a blind HI survey being conducted on the 76m Lovell telescope, at Jodrell Bank Observatory, Cheshire, UK. The survey aims to cover the whole of the Northern sky, north of Declination +25 degrees. The survey provides a northern extension to the southern sky HIPASS survey.

https://www.jb.man.ac.uk/research/hijass/

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GASS Parkes

- The Parkes Galactic All-Sky Survey (GASS) is a survey of Galactic atomic hydrogen (H I) emission in the Southern sky covering declinations $\delta \leqslant 1°$ using the Parkes Radio Telescope. The survey covers 2π steradians with an effective angular resolution of ~16', at a velocity resolution of 1.0 km s^{-1}, and with an rms brightness temperature noise of 57 mK. GASS is the most sensitive, highest angular resolution survey of Galactic H I emission ever made in the Southern sky. In this paper, we outline the survey goals, describe the observations and data analysis, and present the first-stage data release. The data product is a single cube at full resolution, not corrected for stray radiation. Spectra from the survey and other data products are publicly available online.

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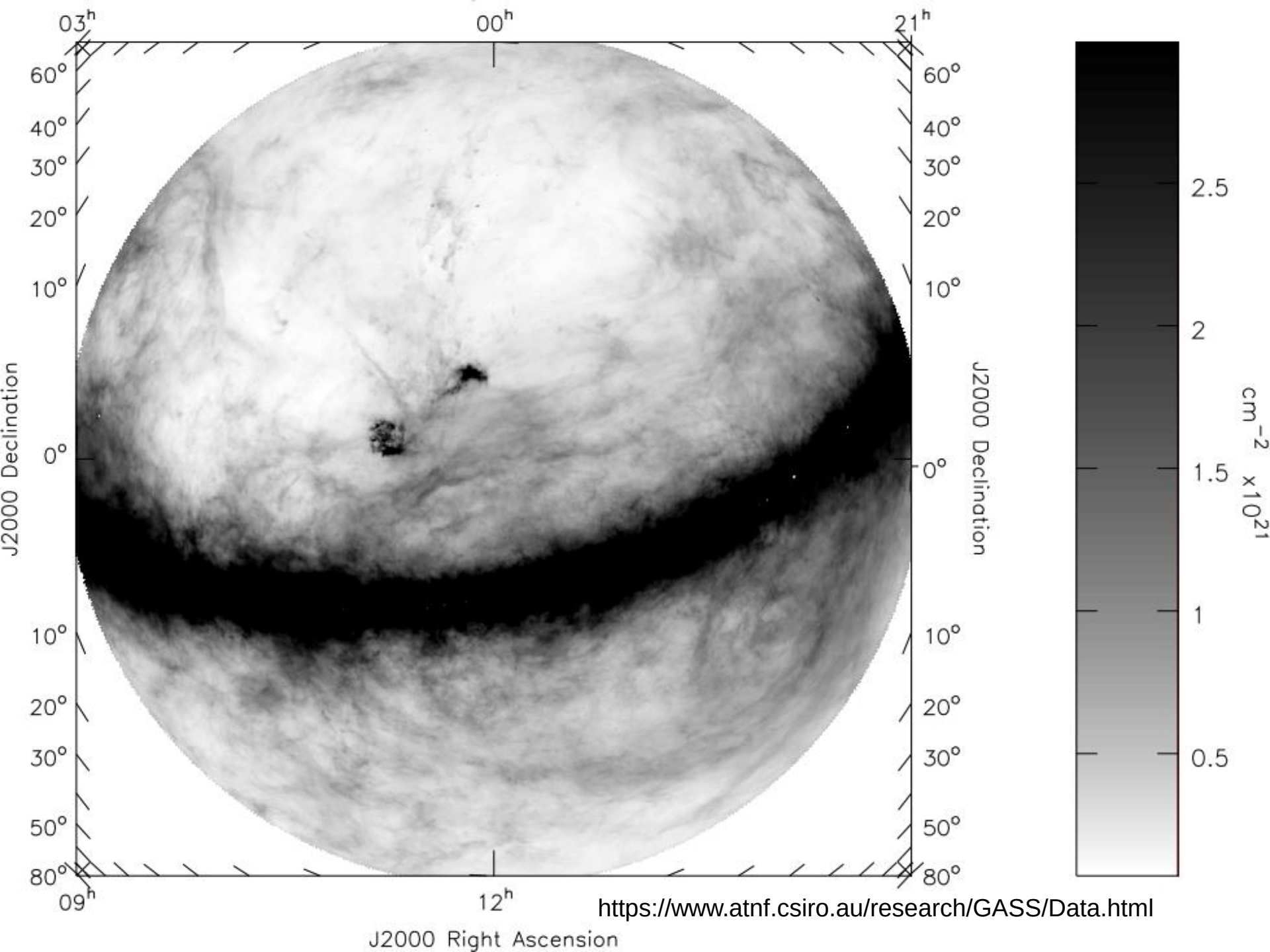

https://www.atnf.csiro.au/research/GASS/Data.html

GASS Parkes

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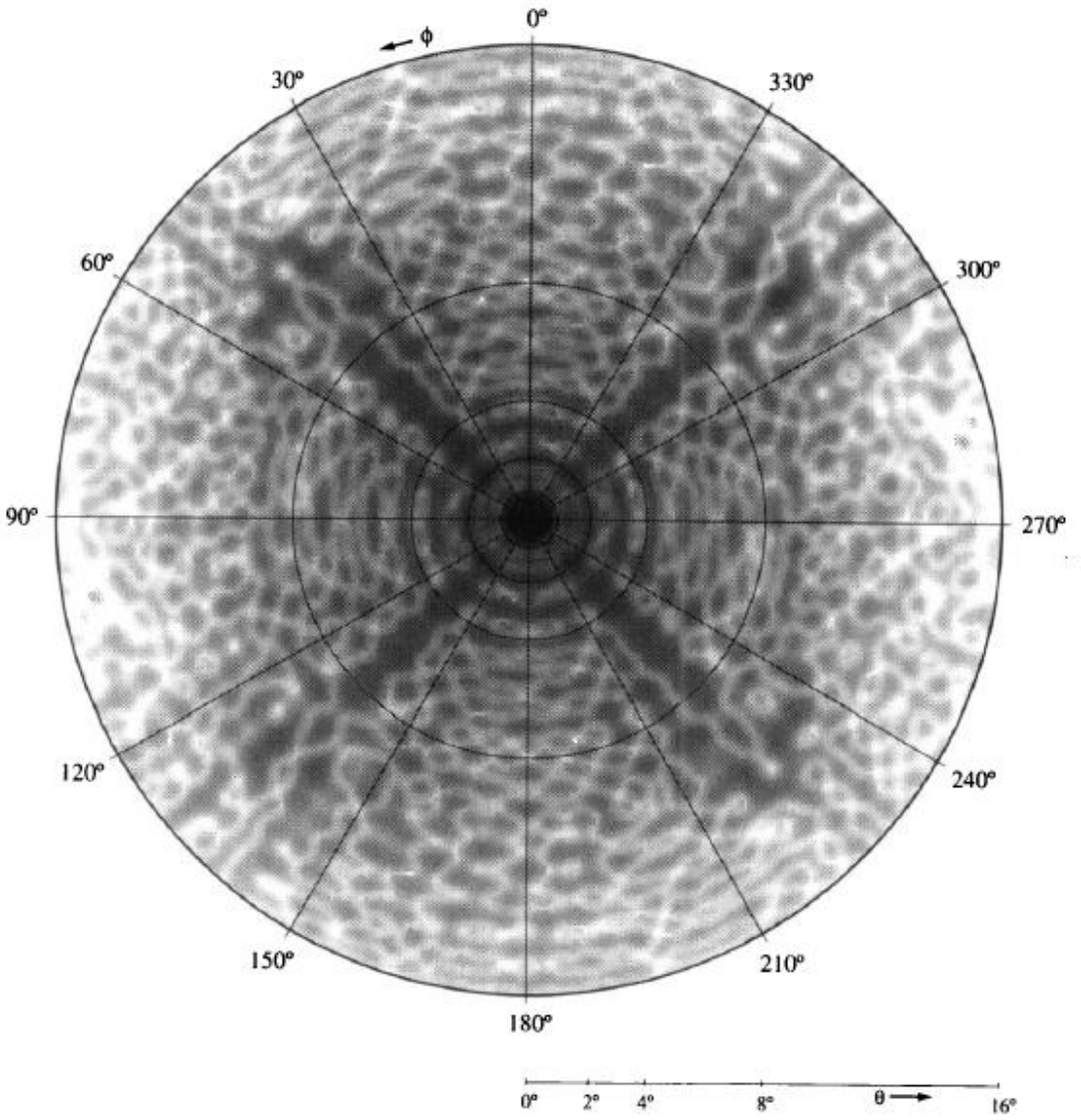
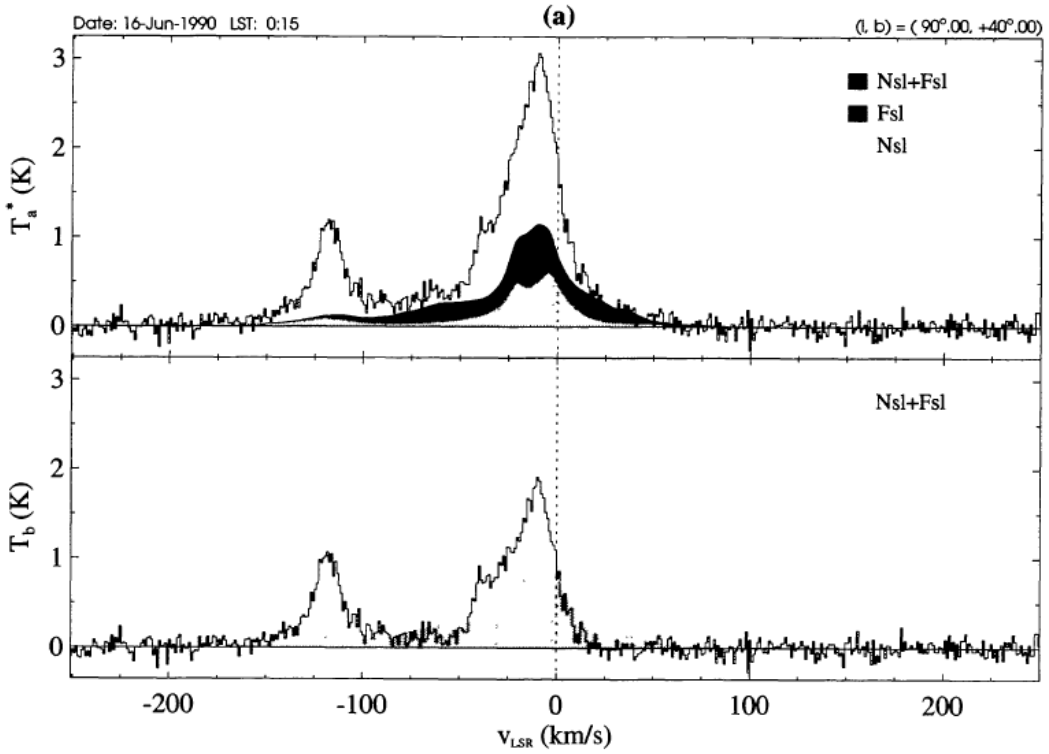
Stray radiation

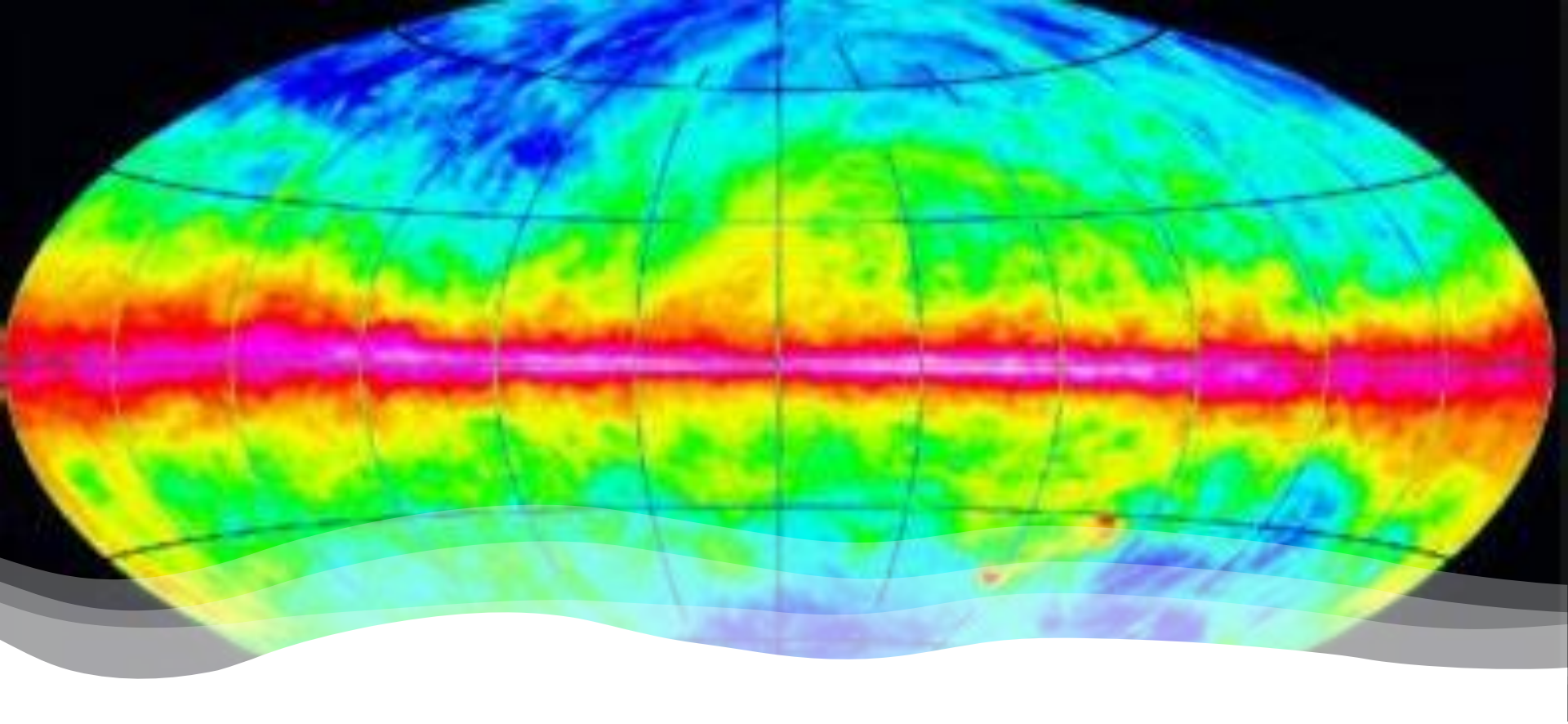


Hartmann et al. (1996) A&AS 119, 115

Stray radiation



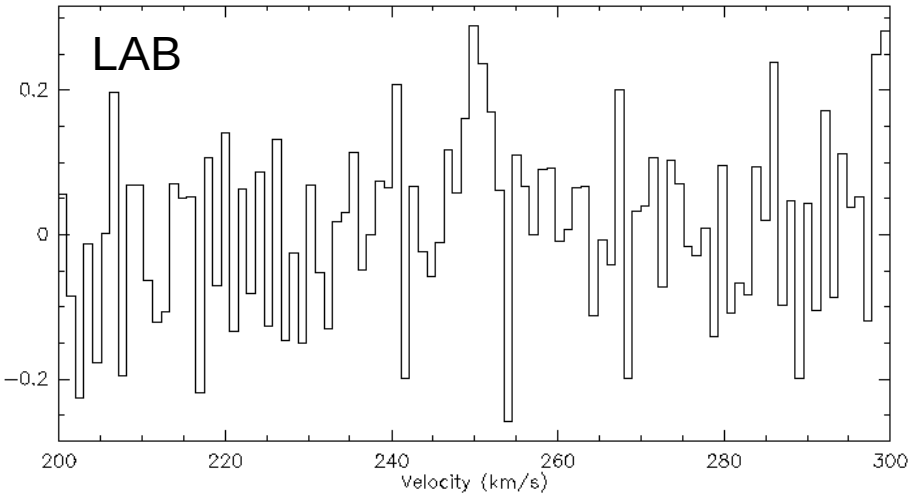
Hartmann et al. (1996) A&AS 119, 115



Leiden/Argentine/Bonn HI Survey

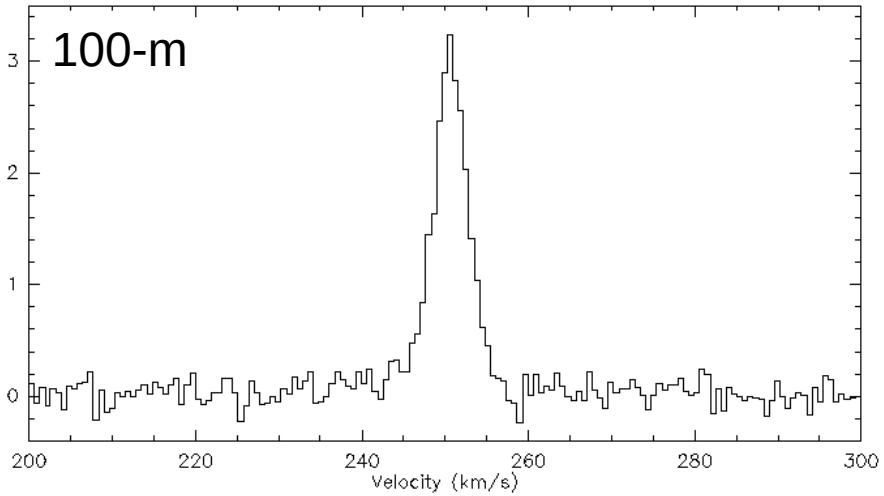
…and Effelsberg?

25-m vs. 100-m dish



HVC 289+33+251

Brüns & Westmeier 2004, A&A 426, L9



Angular resolution is of key!

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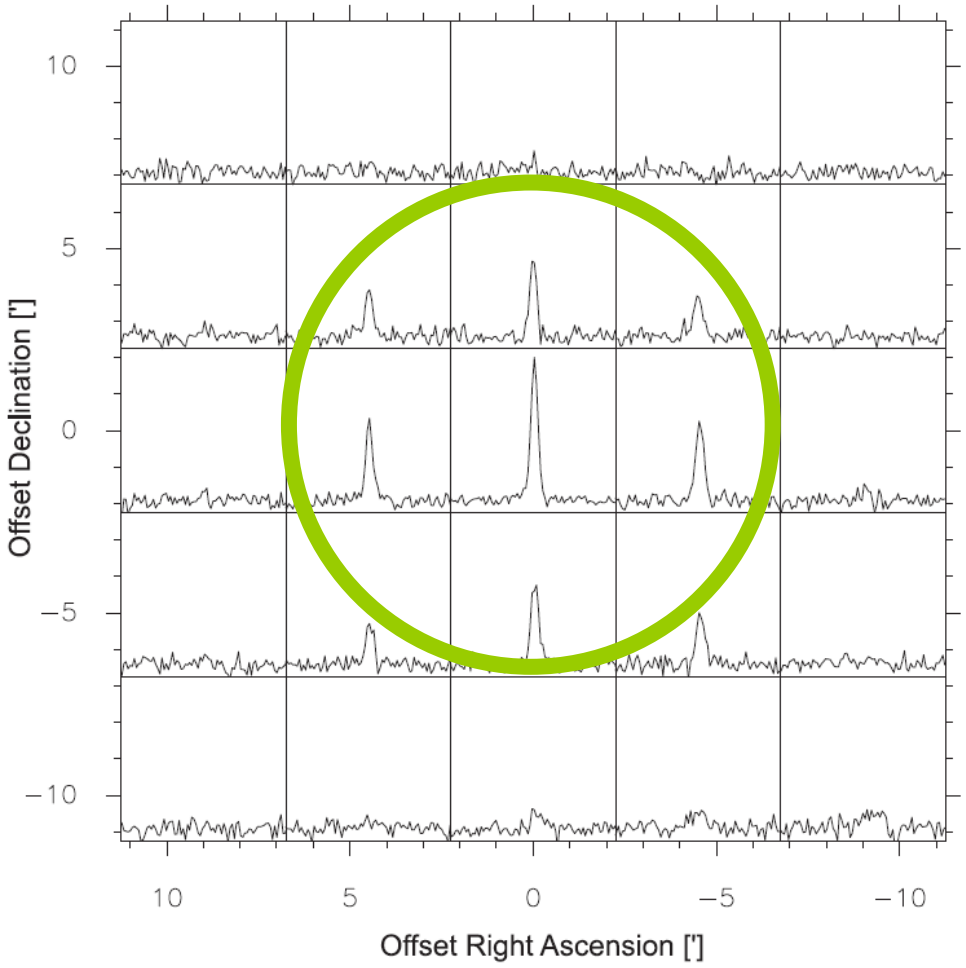
Ultra-compact high-velocity cloud



HVC 289+33+251

Brüns & Westmeier 2004, A&A 426, L9

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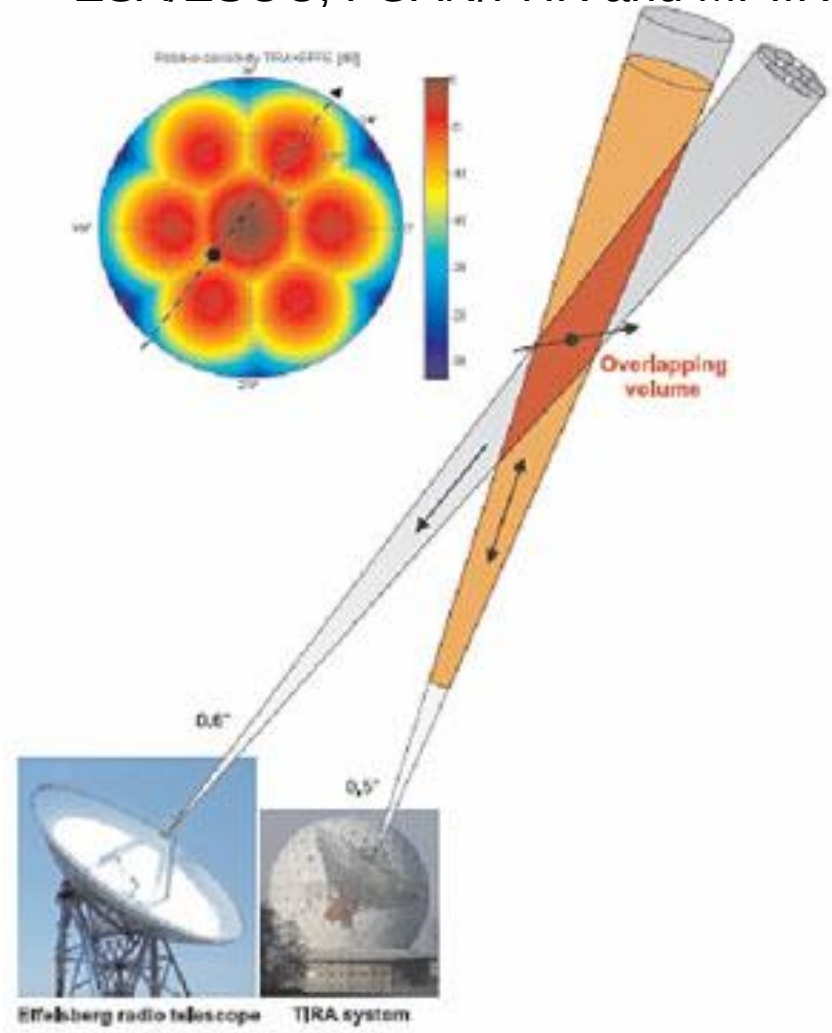
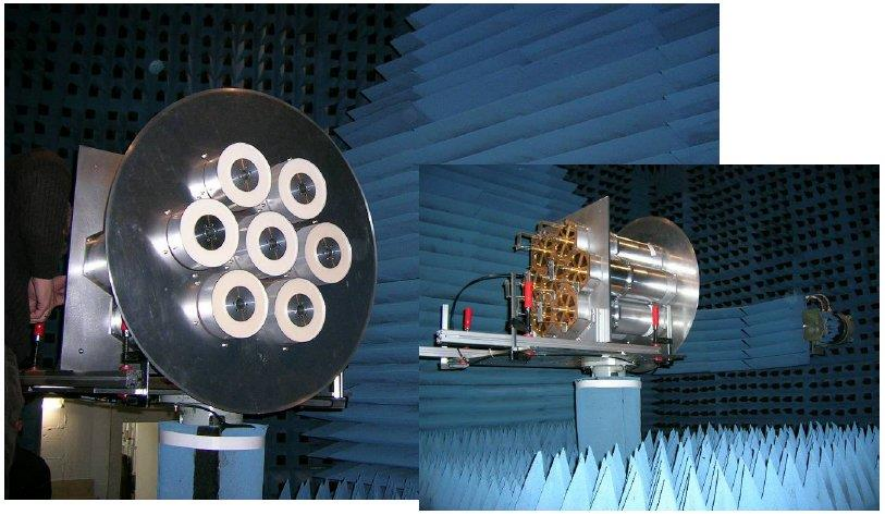
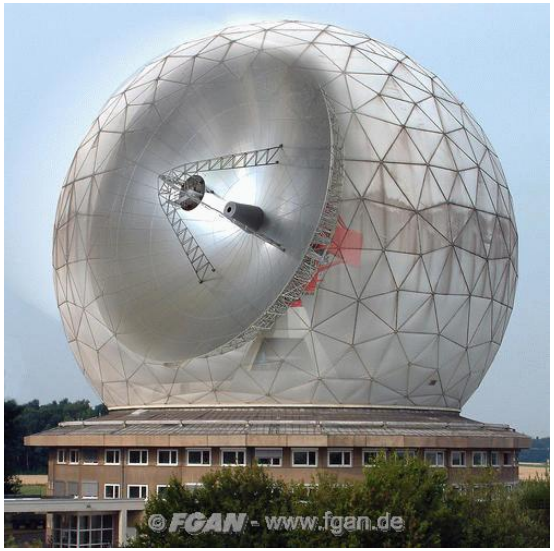
Effelsberg L-band multi-feed

ESA/ESOC, FGAN/FHR and MPIfR







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autocorrelation spectrometer

MPIfR

- Proven technology
- Long-term stability
- Variable number of channels
- Bandwidth flexibility

- Complex technology
- Channel numbers fixed
- Power supply kW range
- 1-bit/2-bit digitization ->
  Low dynamic range
- Autocorrelators are RFI sources
- special chips necessary
  (expensive and stock keeping necessary).

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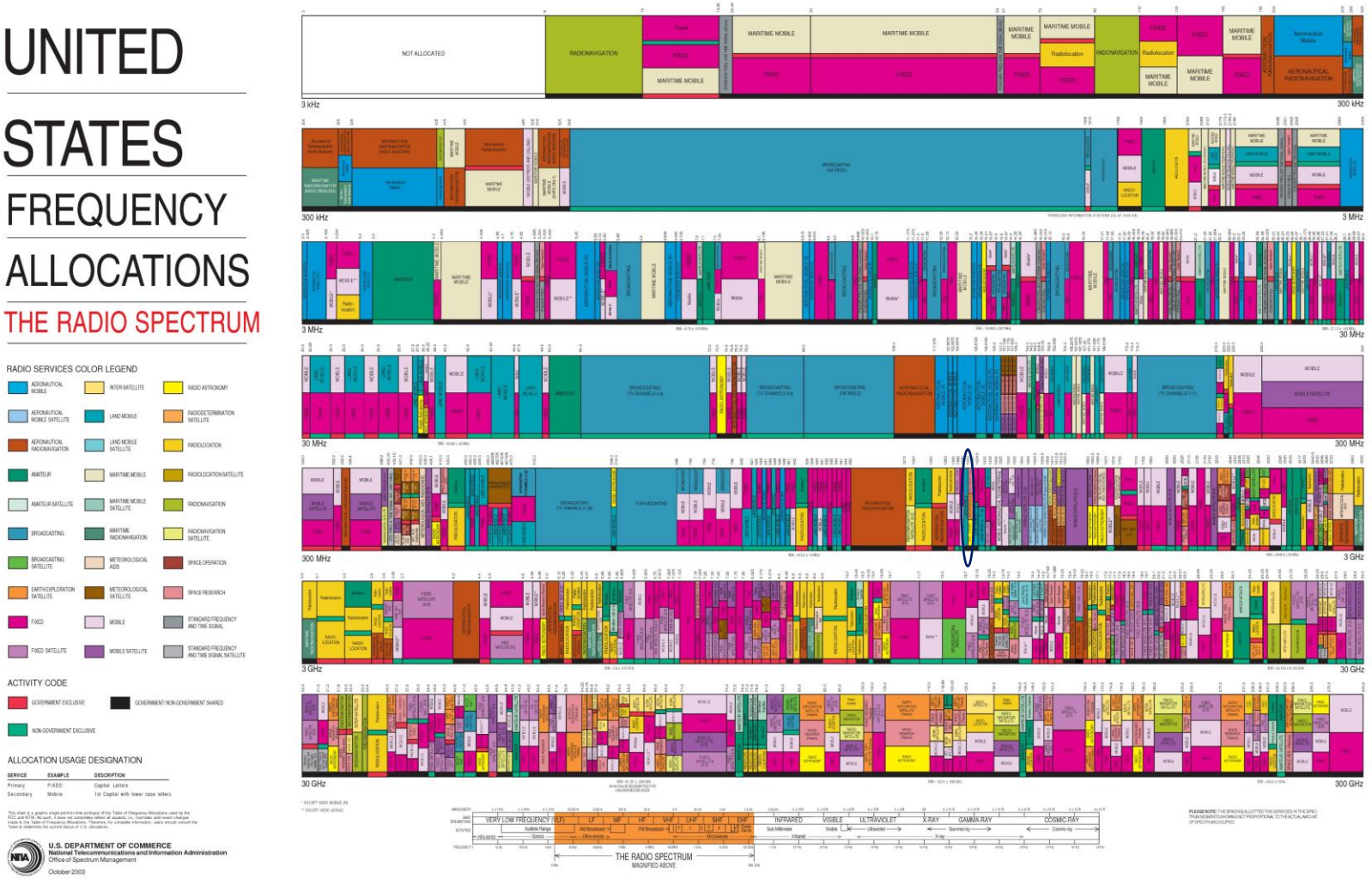
RFI



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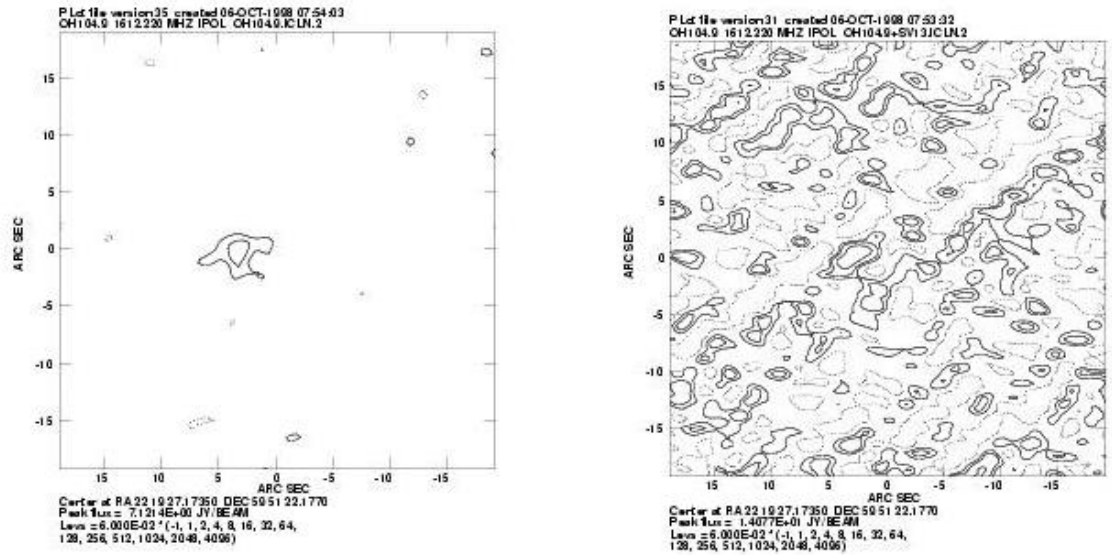
RFI

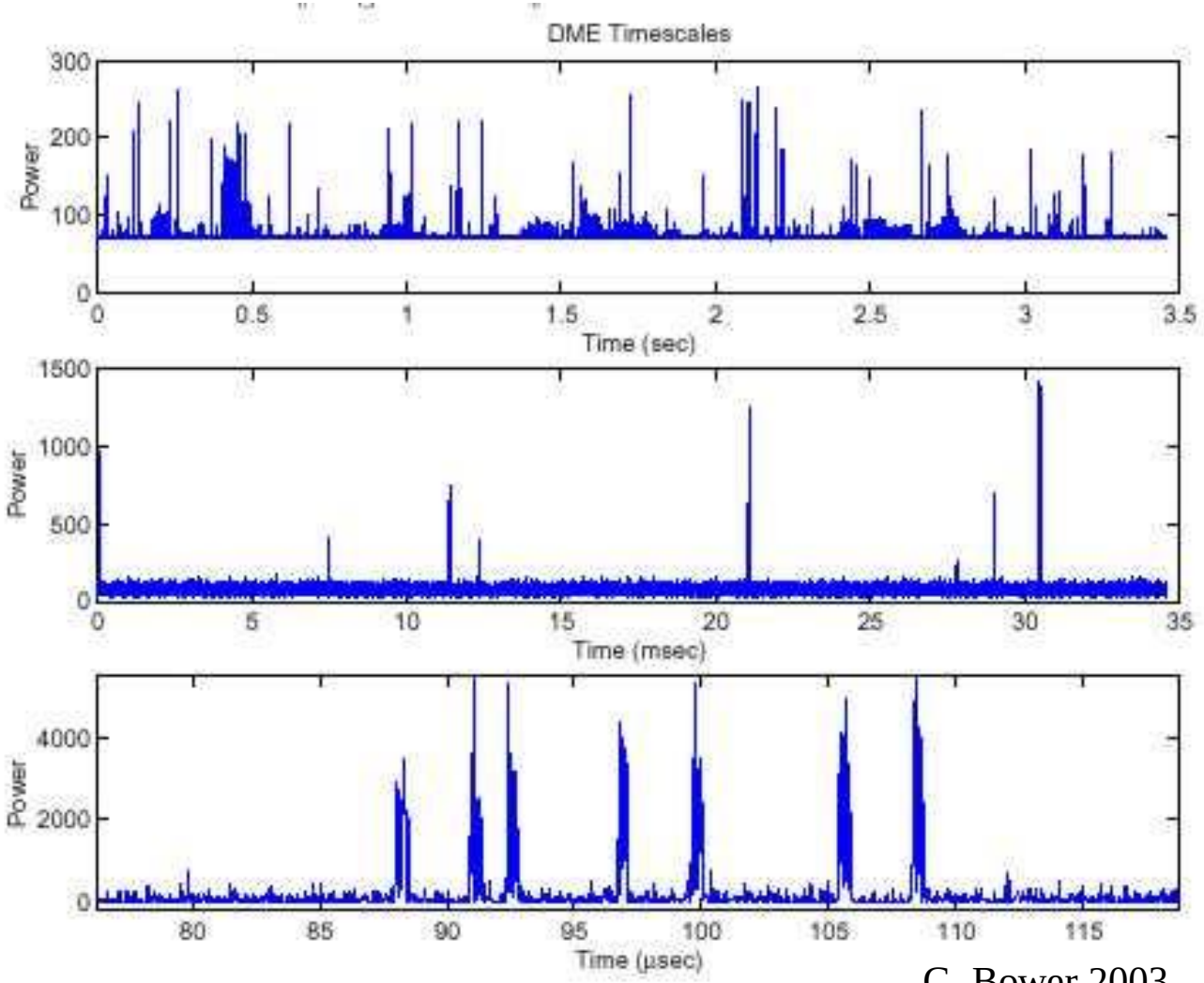
Effect of Radio Interference On Astronomical Observations



VLA Images of OH/IR Star at 1612 MHz: No satellite present (left) and satellite ~22 degrees from star (right)

(From G.B. Taylor, NRAO)

RFI



G. Bower 2003

Research Note

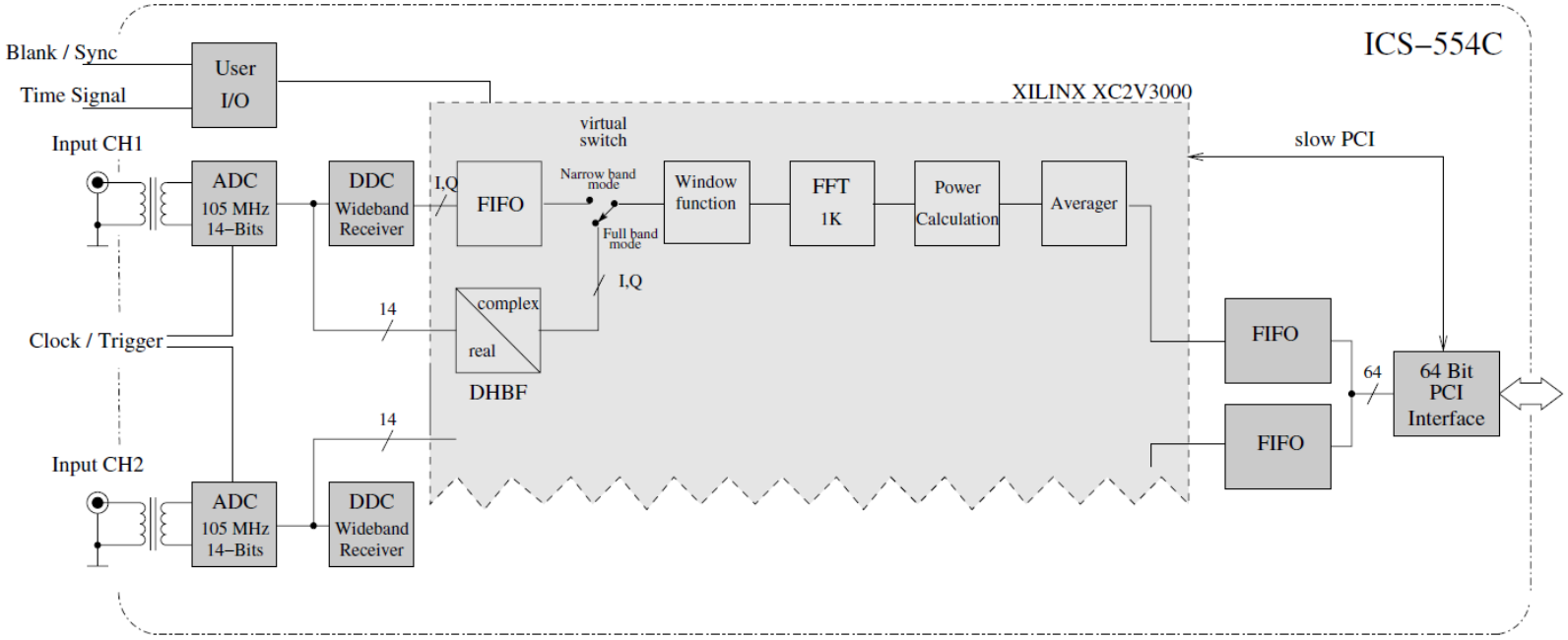
A field programmable gate array spectrometer for radio astronomy

First light at the Effelsberg 100-m telescope

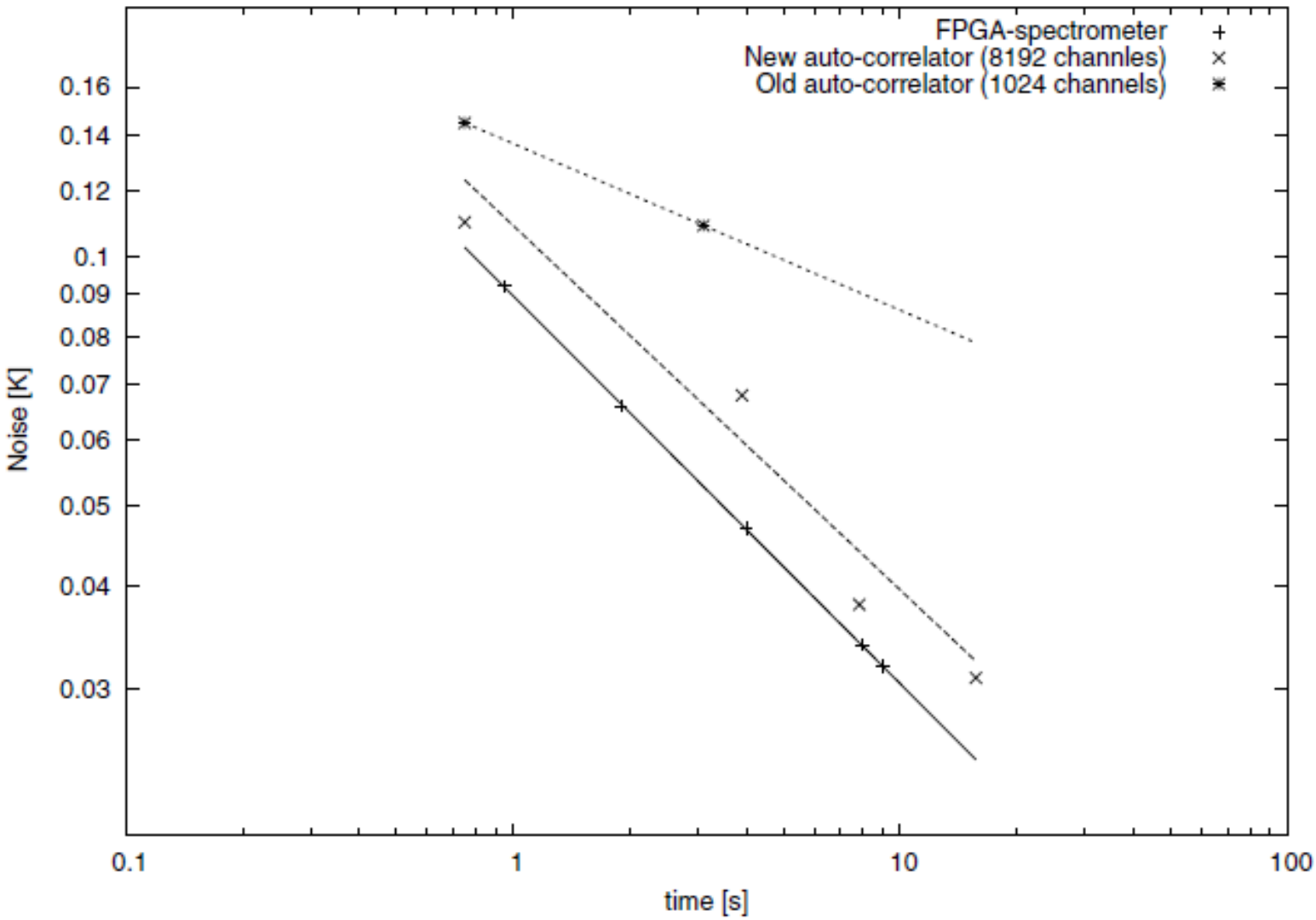
S. Stanko[1], B. Klein[2], and J. Kerp[1]

Stanko, Klein & Kerp (2005), A&A, 436, 391

FFT – Spectrometer



Stanko, Klein & Kerp (2005), A&A, 436, 391



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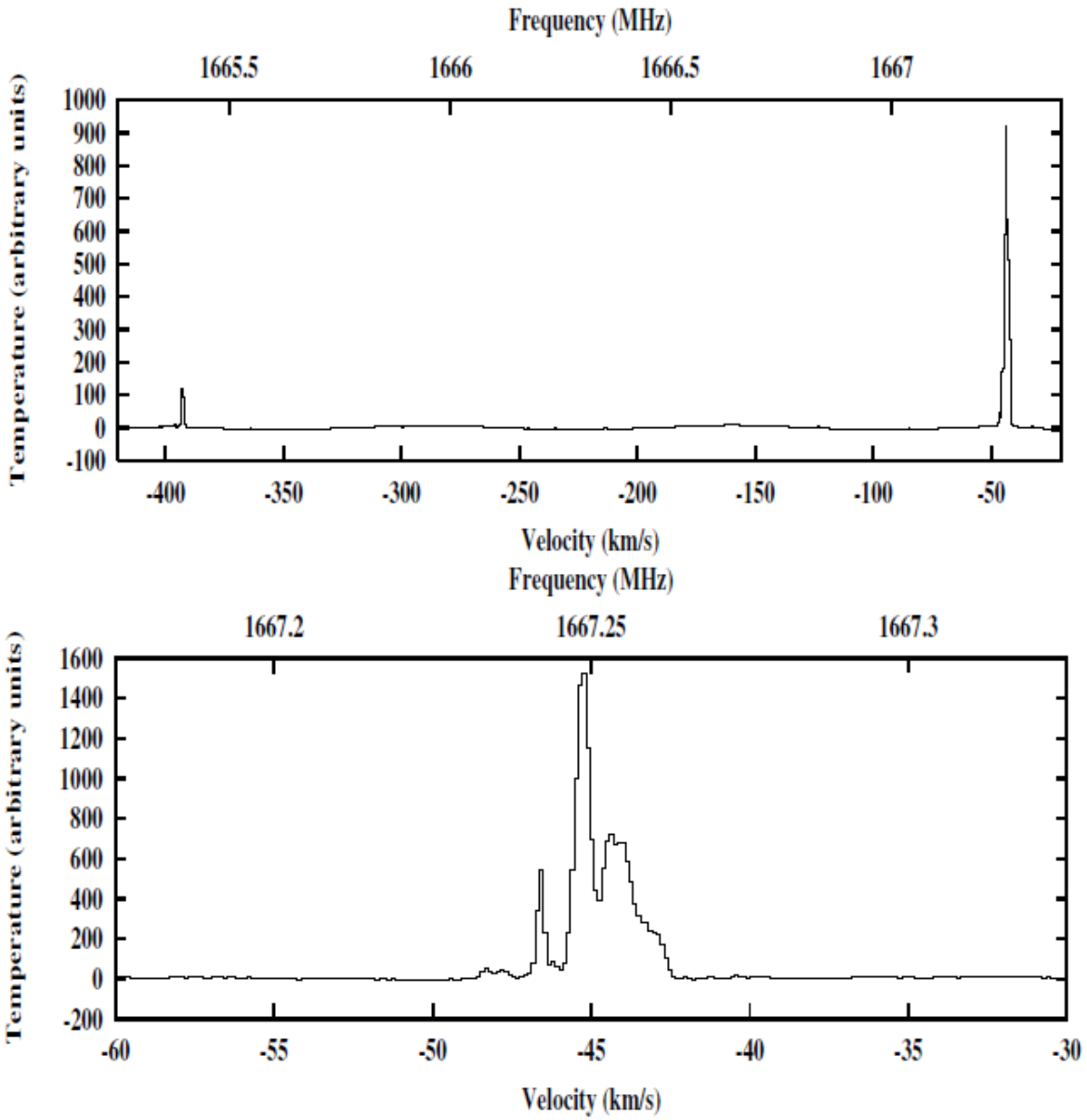
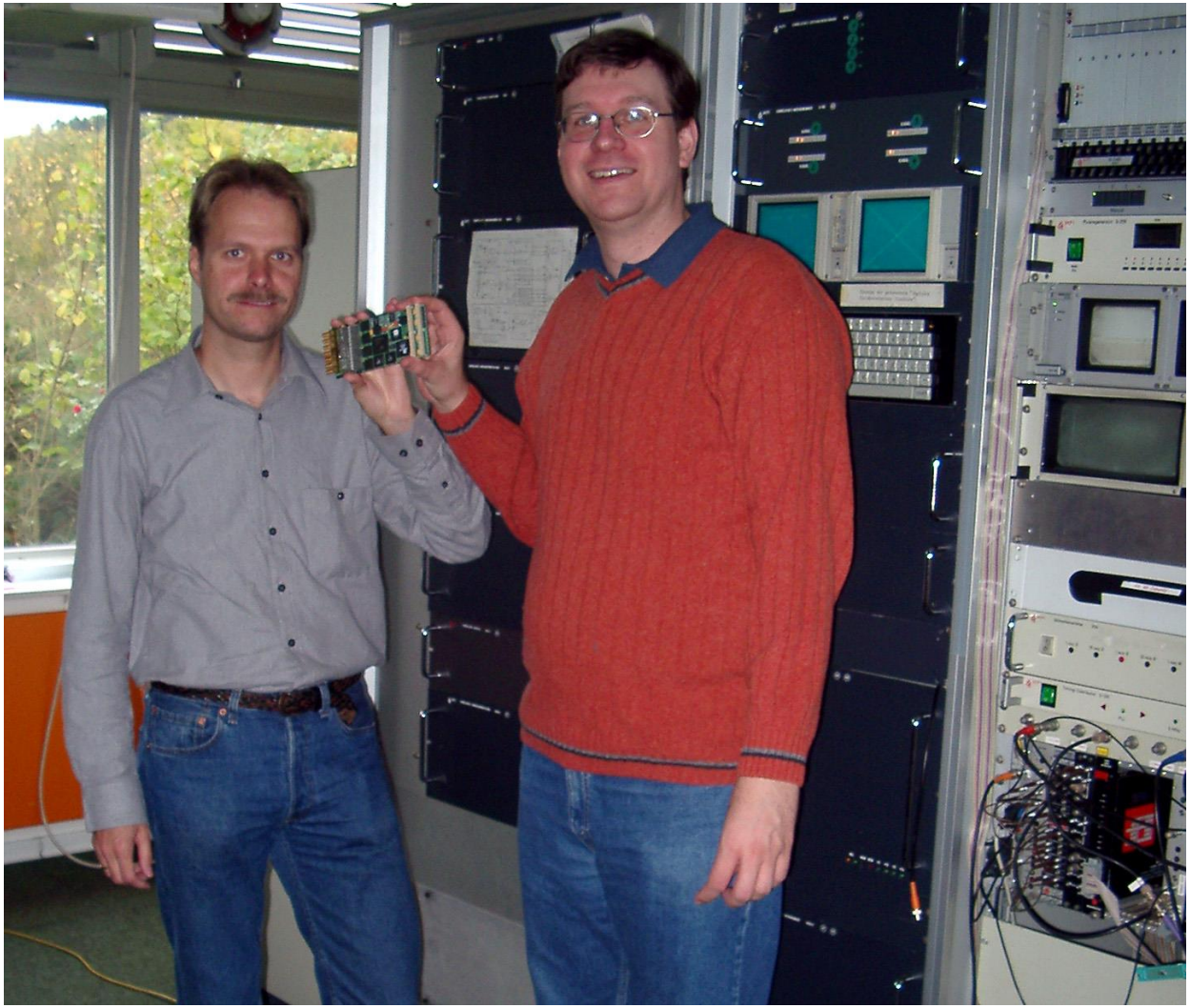


Stanko, Klein & Kerp (2005), A&A, 436, 391

FPGA-FFT spectrometer



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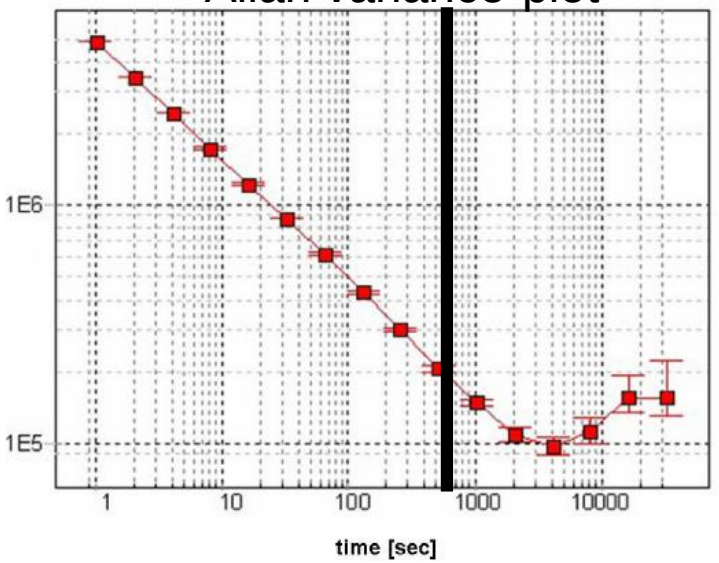
EBHIS FPGA Spektrometer

B. Klein (MPIfR)

Allan variance-plot



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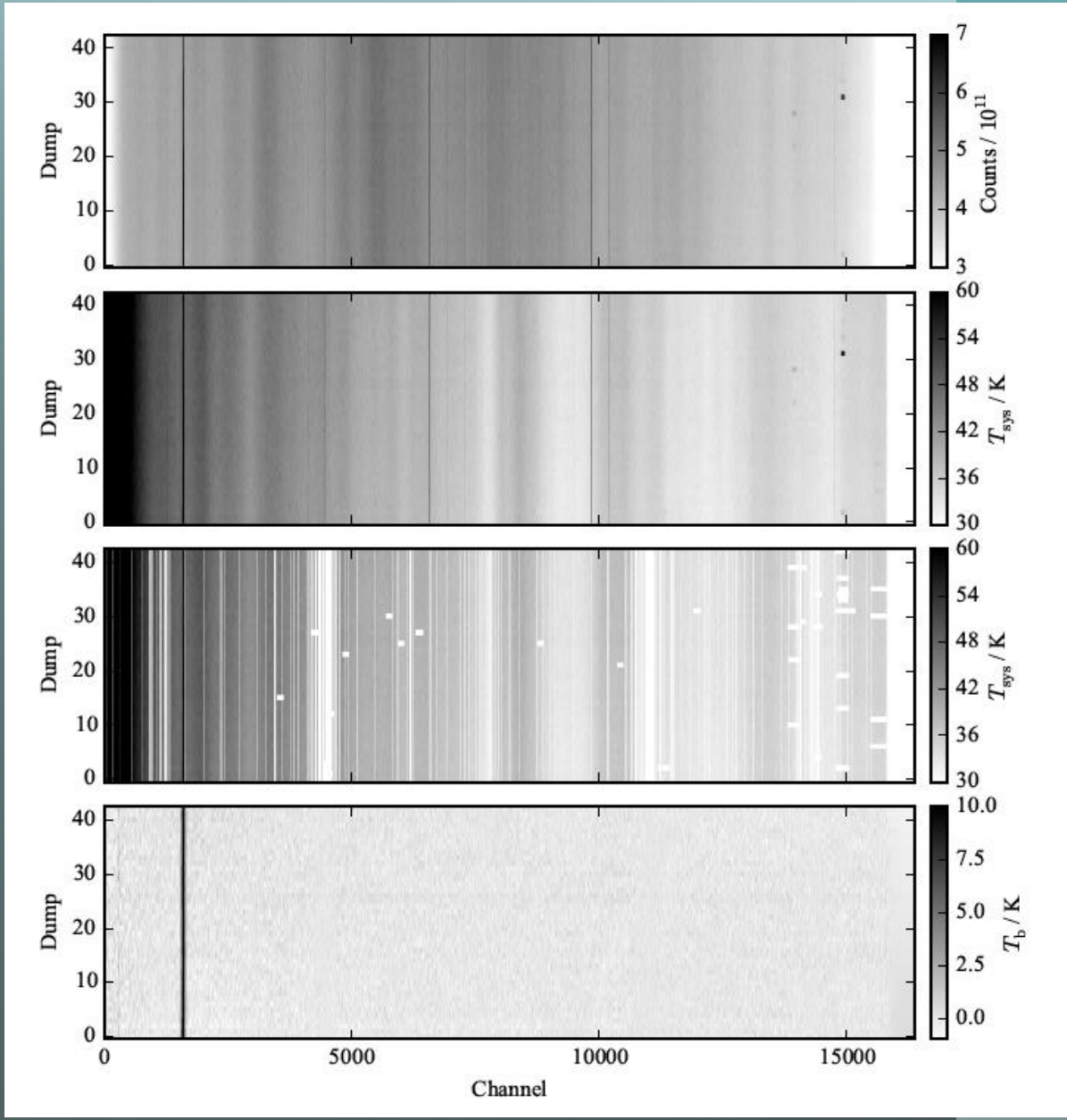
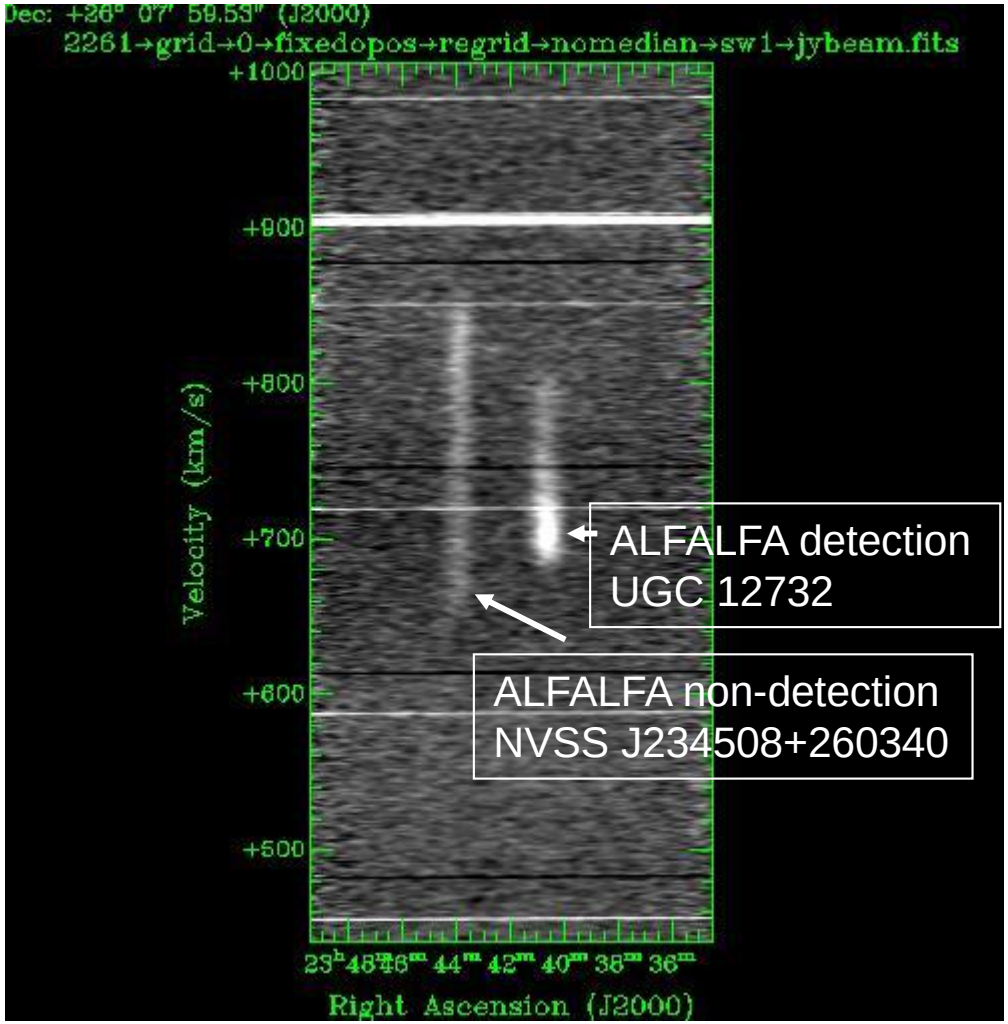


Flöer. L. 2015, PhD Bonn University

EBHIS: galaxy spectra



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Effelsberg-Bonn HI Survey (EBHIS)

- Effelsberg 100-m key-science project

  started in August 2008
  first coverage finished spring 2013
  angular resolution: 10.8’
  velocity resolution: 1.4 km/s
  sensitivity: ~90 mK
  maximum redshift: 0.07
  data are public (CDS)

  Motivated FPGA spectrometer technology!

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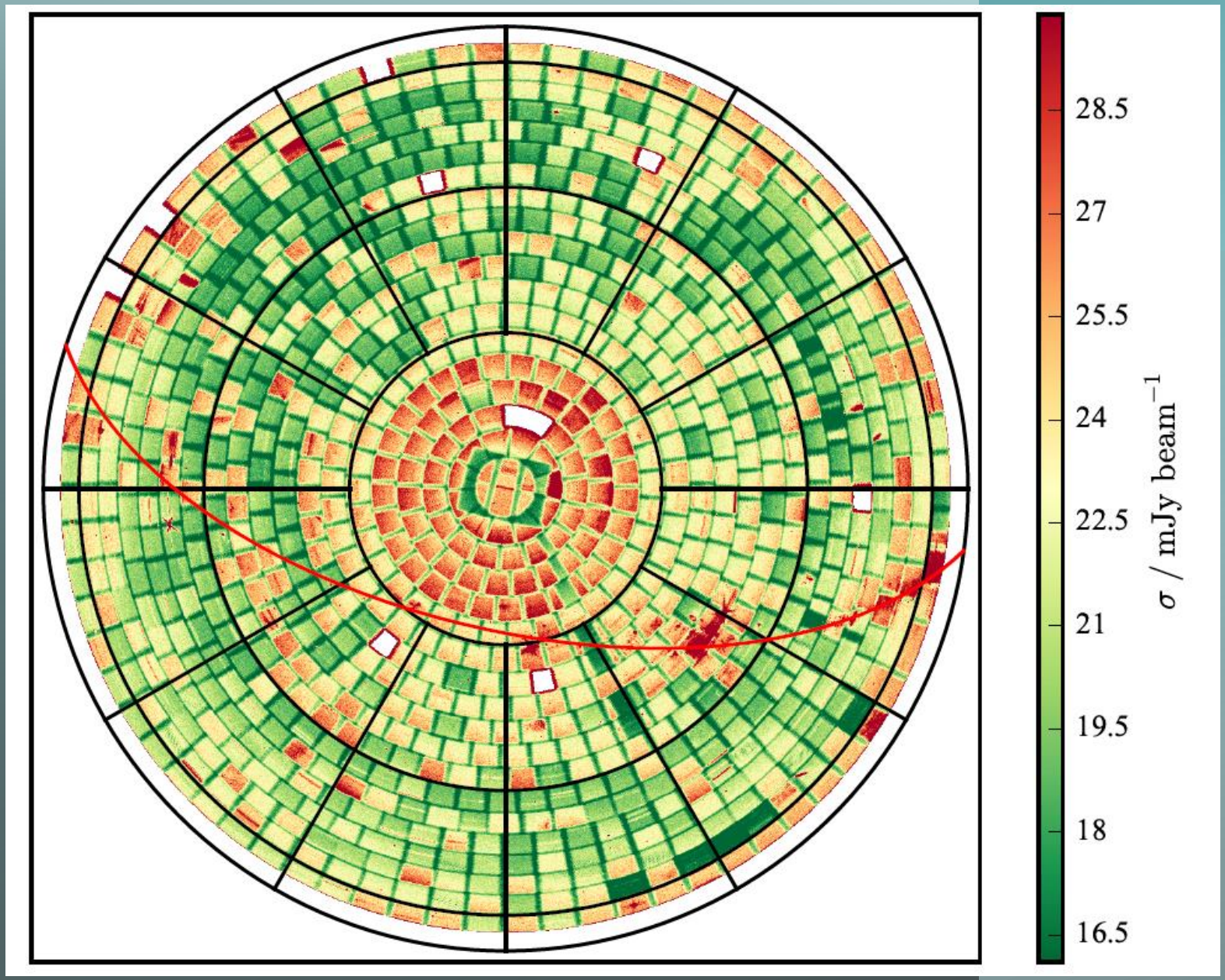

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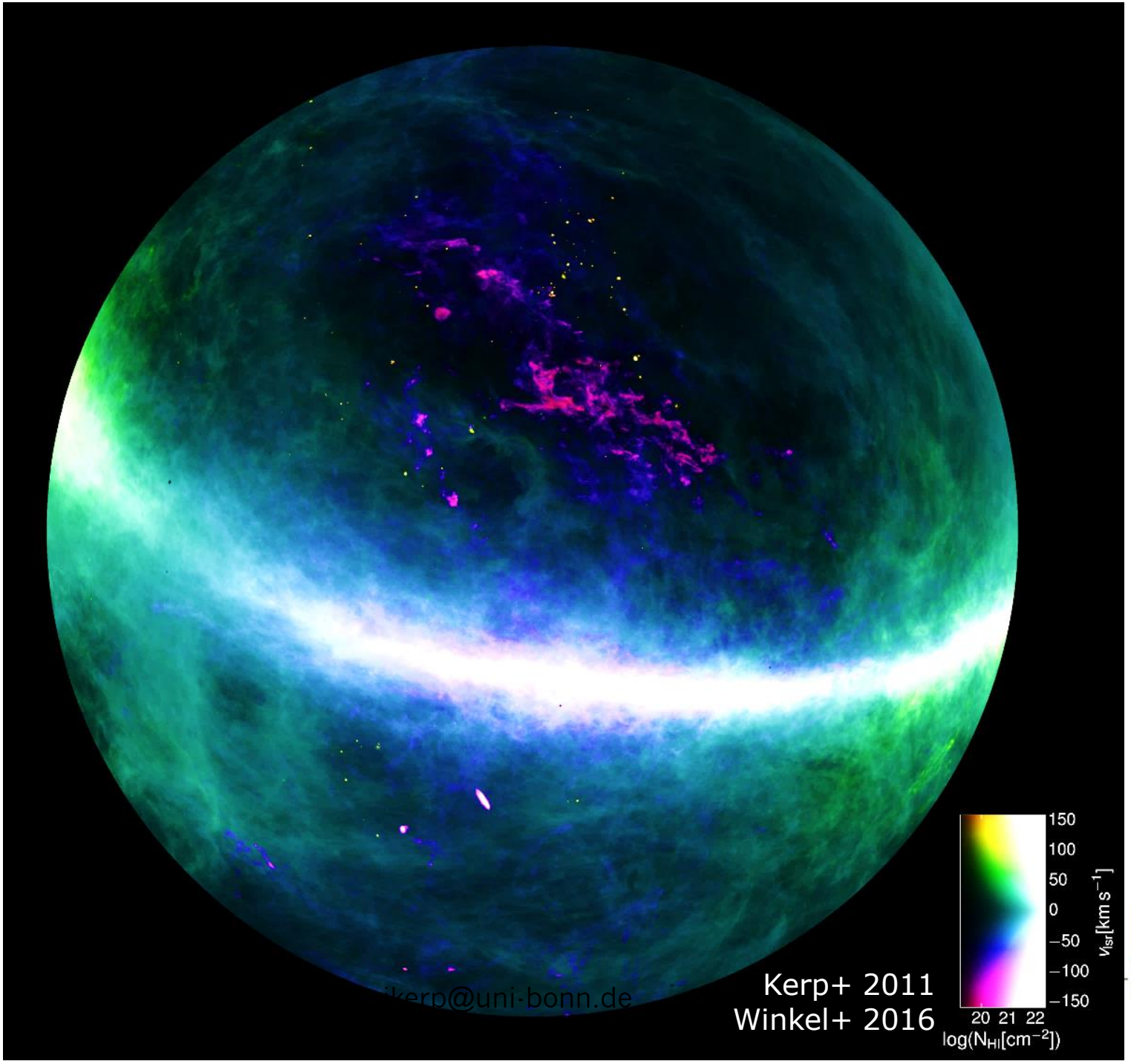

Kerp+ 2011
Winkel+ 2016

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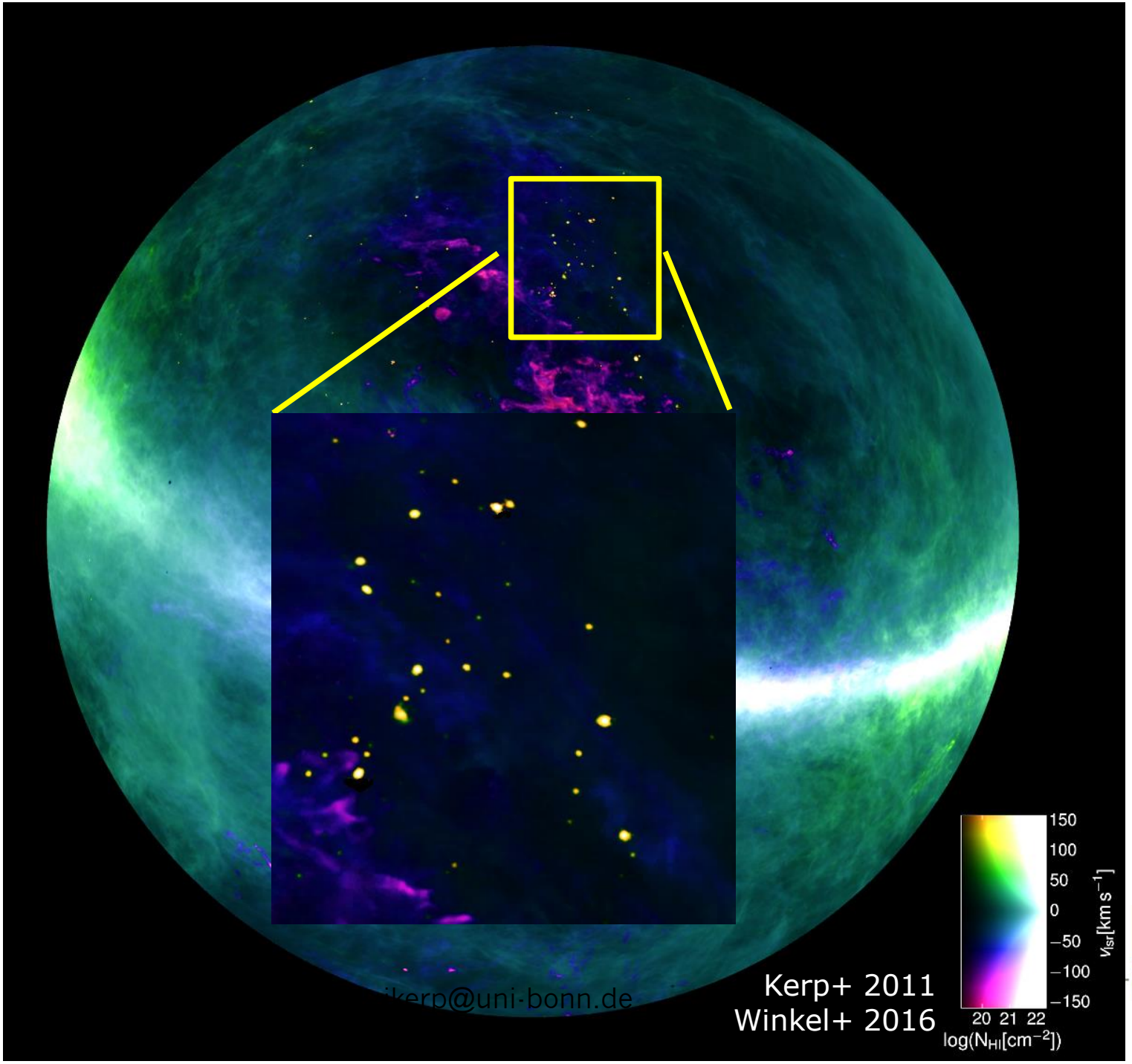

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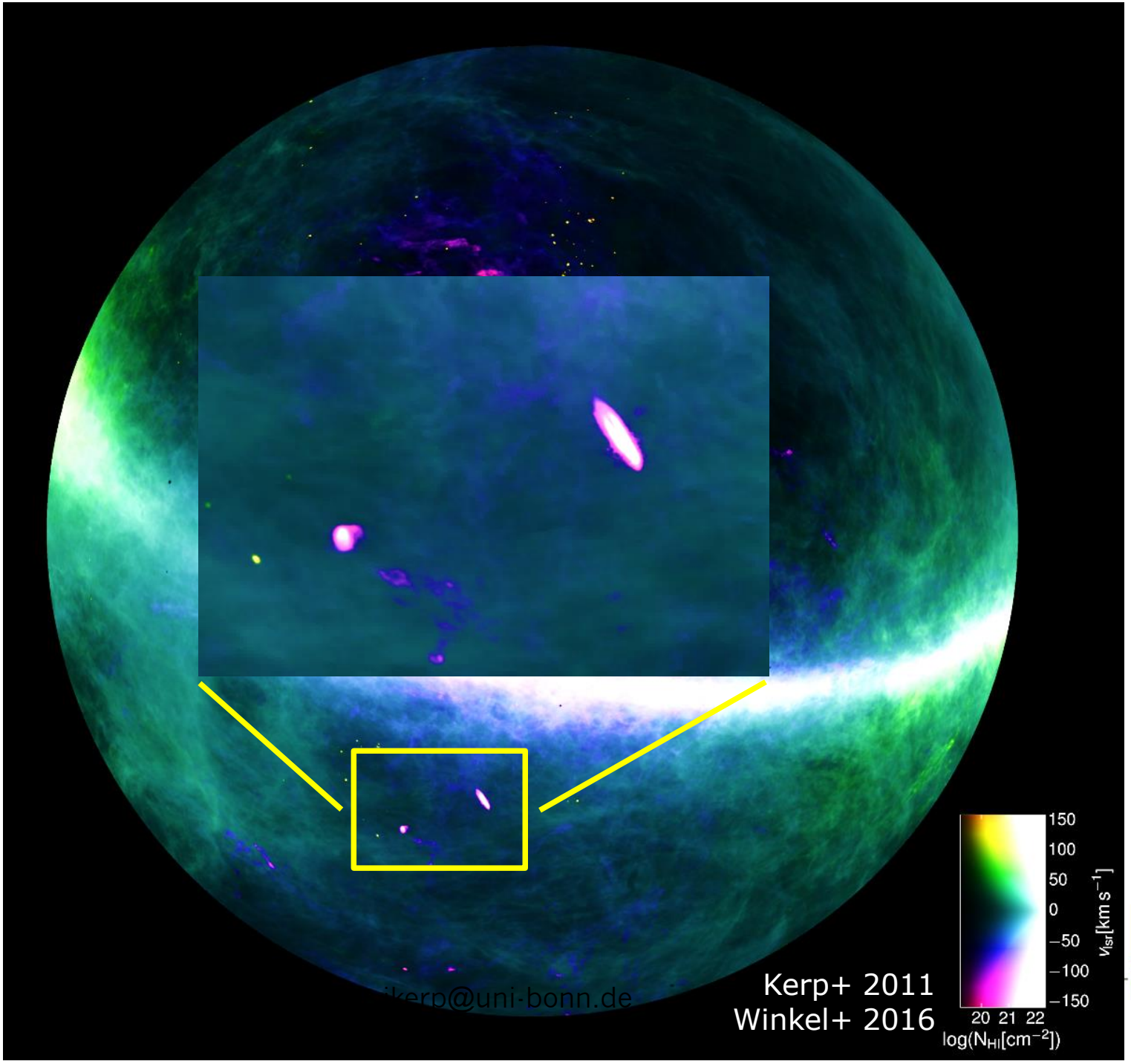

Kerp+ 2011
Winkel+ 2016

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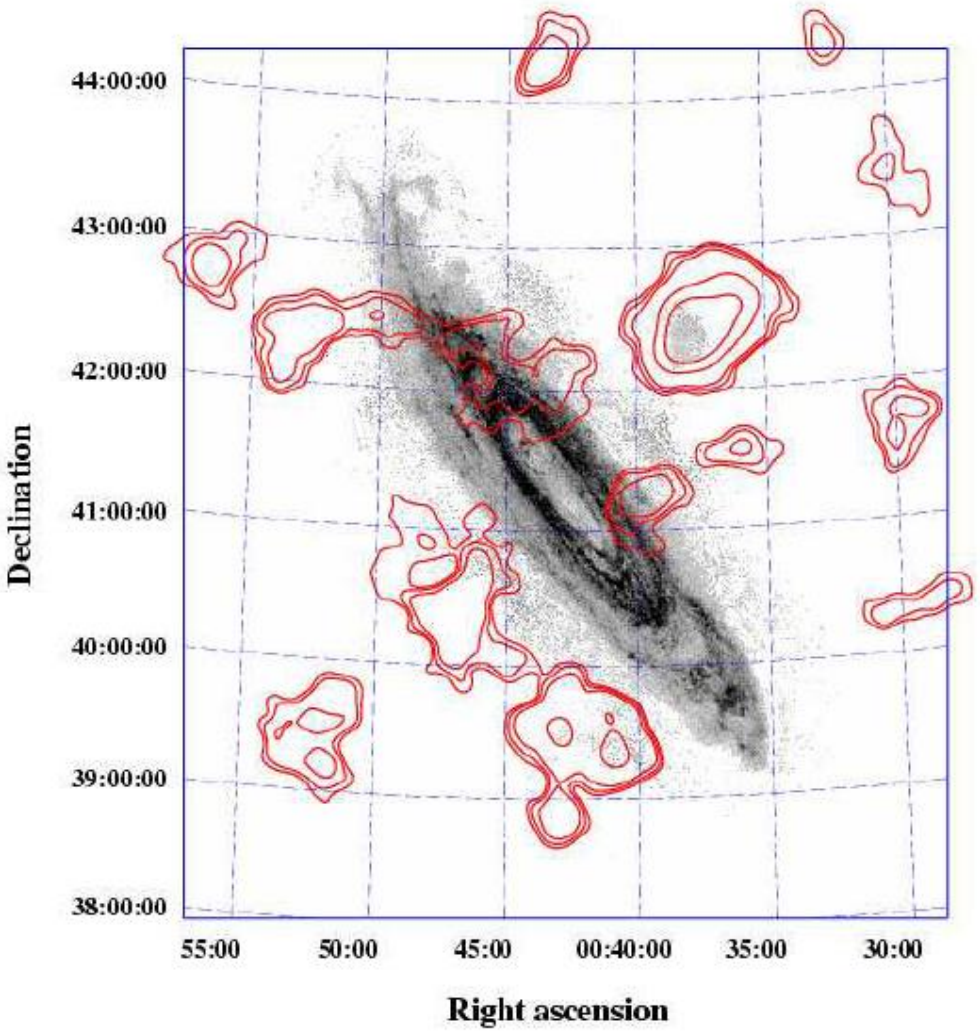
GBT: M31 HVCs (contours)



Thilker, Braun & Westmeier 2005, ASP 331, 113

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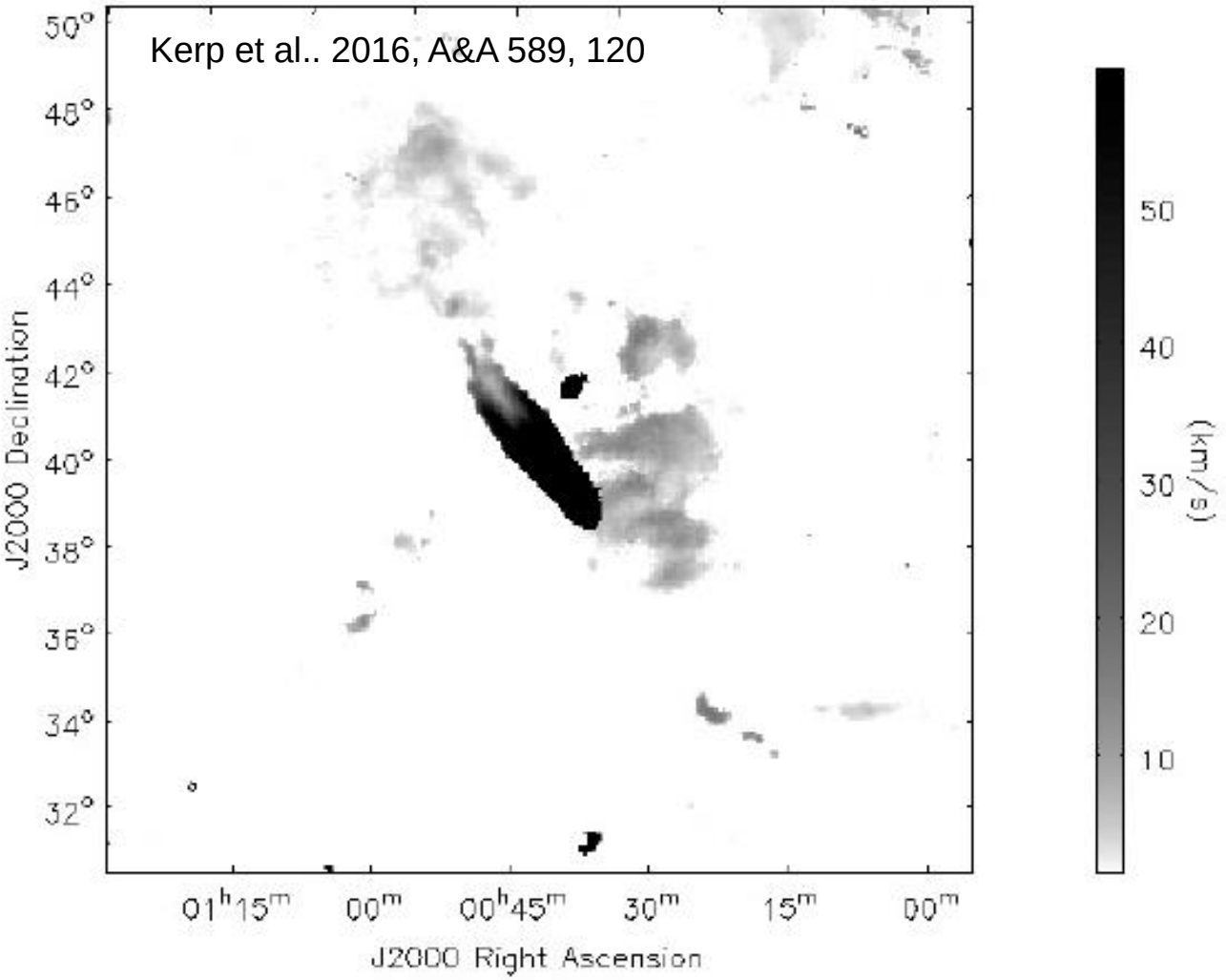
EBHIS: M31 HVCs



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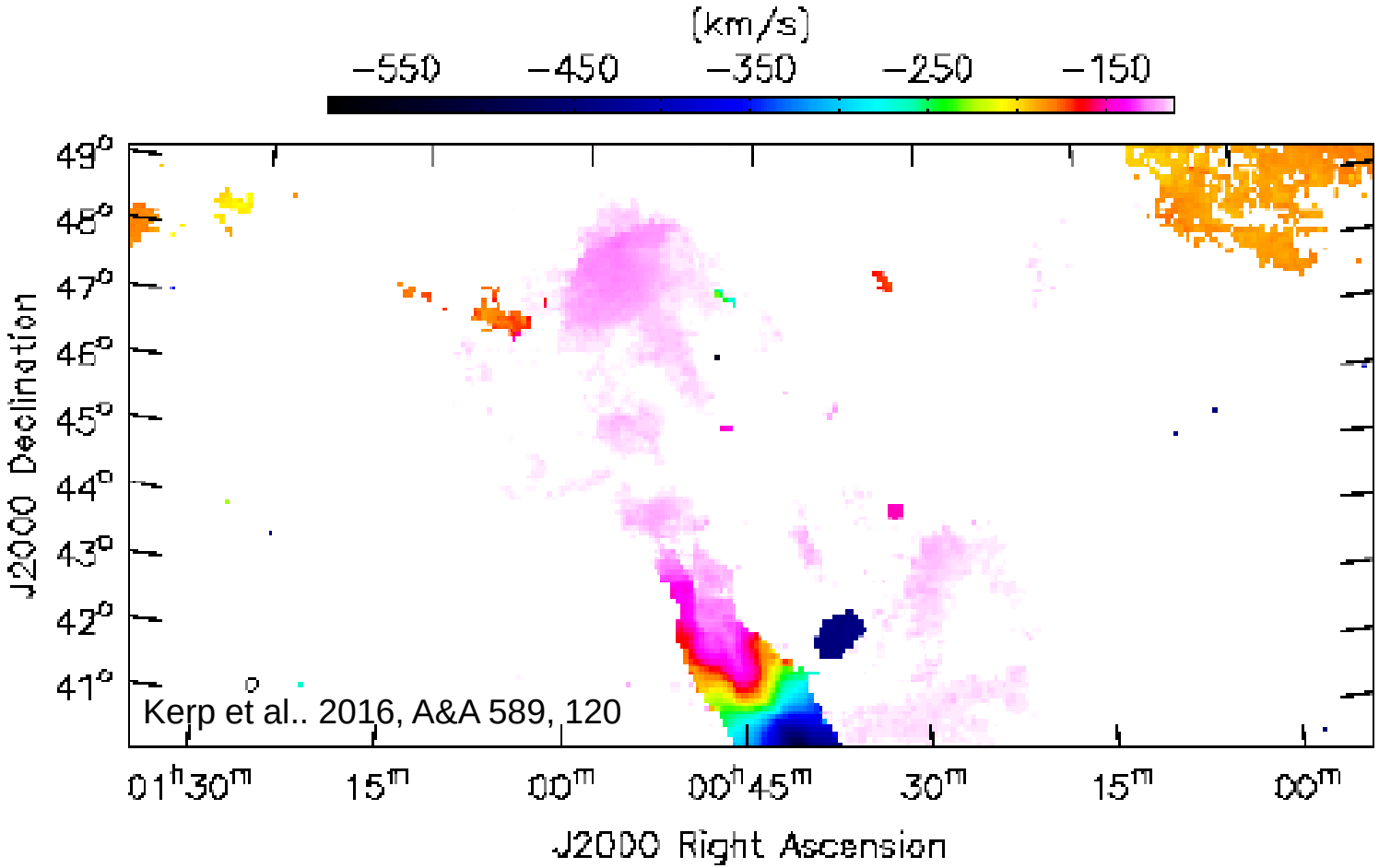

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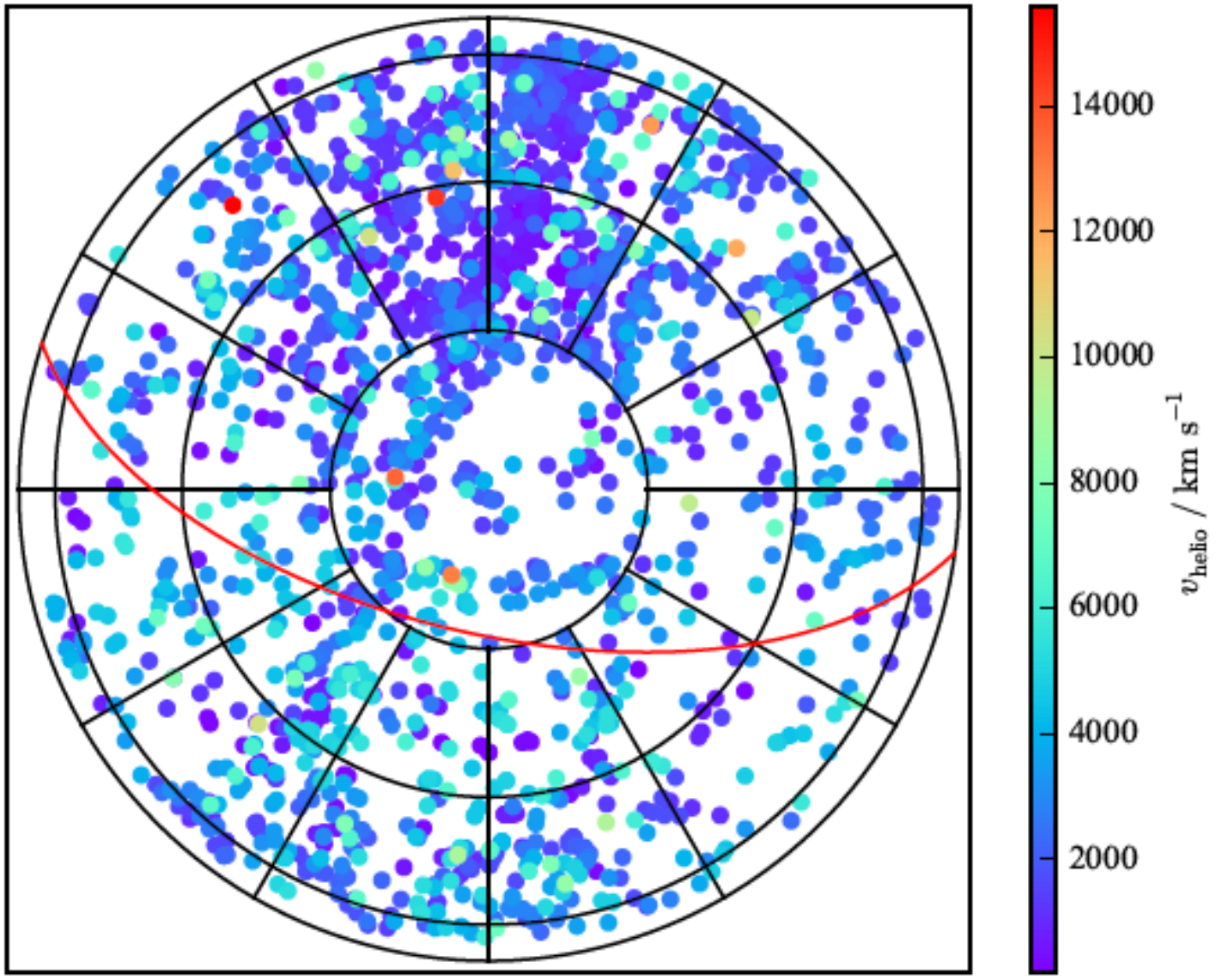
Open



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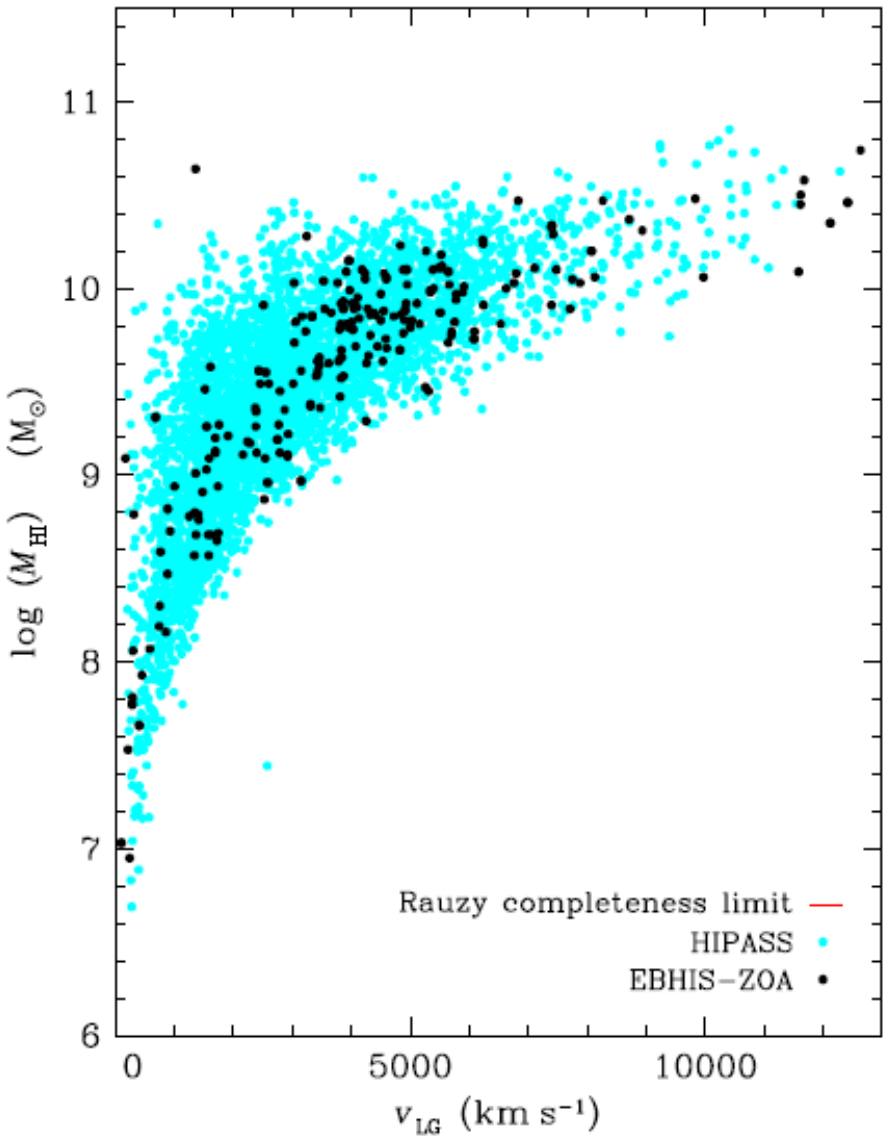


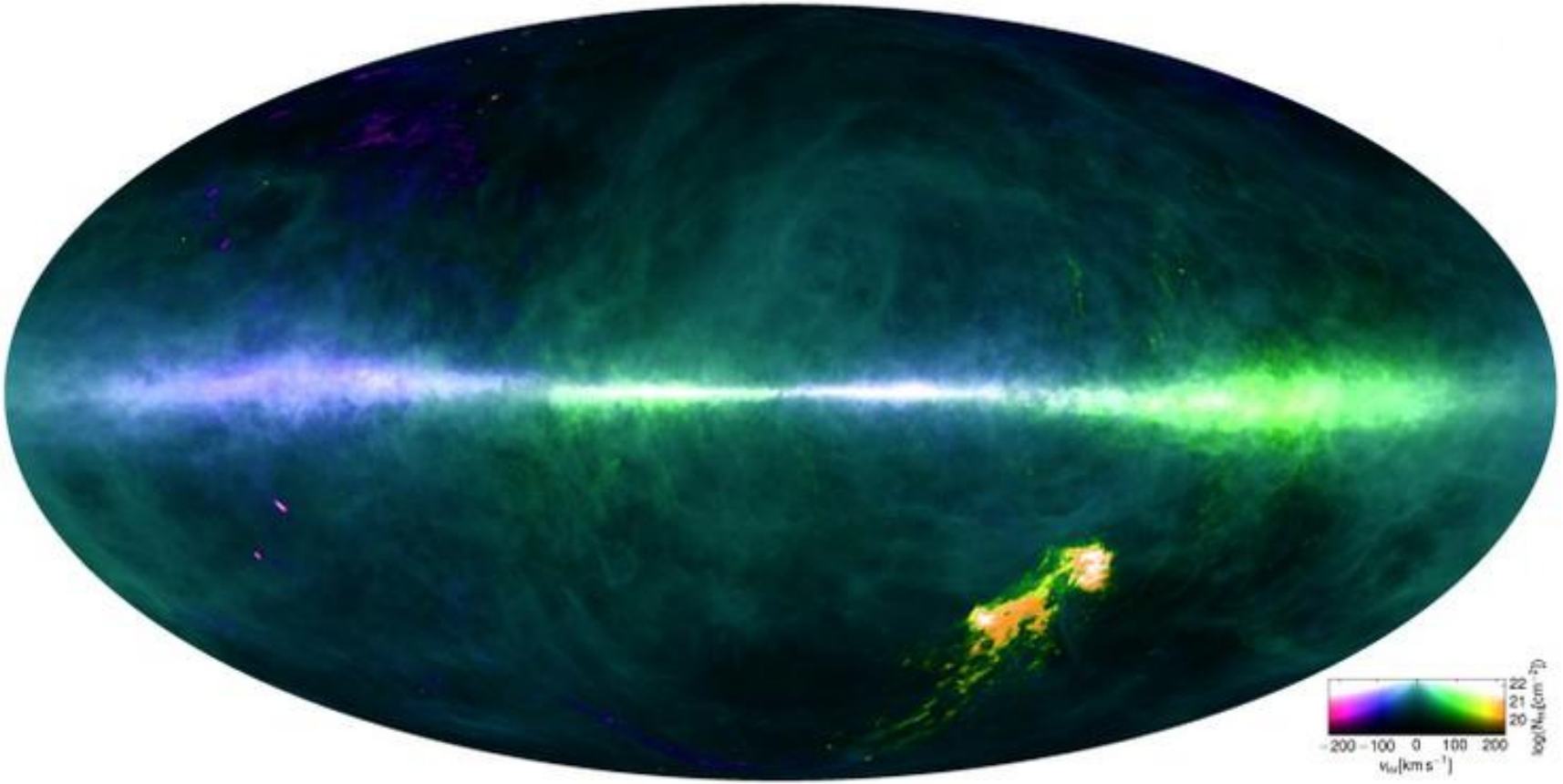
[th]

Schröder et al. (2019), MNRAS 489, 2907

Finally

HI4PI, Oct 2016

HI4PI collaboration: 2016 A&A 594, A116



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