Effelsberg-Bonn HI Survey (EBHIS)

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To make an all-sky survey of Galactic 21-cm emission with a 100m-class telescope has been a dream for many decades, now the dream is finally coming true.

anonymous referee
• 7-beam receiver system
• On-the-fly observing mode
• Fully sampled sky coverage above Dec = -5°
• EBHIS observations started in August 2008
• First full sky coverage finished in April 2013!
EBHIS concept

• Galactic and extragalactic HI survey in parallel:
  • 21,400 square degrees
  • 100 MHz bandwidth $z \leq 0.07$ (270 Mpc)
  • 14 spectrometer with $16384$ spectral channels each
  • High angular resolution $\rightarrow$ fully sampled grid 1/44 LAB

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EBHIS concept

LAB

HVC 289+33+251
Brüns & Westmeier 2004, A&A 426, L9

Beam filling is different!
EBHIS concept

LAB

HVC 142.8-46.9-107.8

EBHIS

Galactic latitude

Galactic longitude

log(N_H/cm^2)

1e19

5

4

3

2

1

1

0

-1
EBHIS: extragalactic science prospects

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EBHIS “The HI Nearby Galaxy Survey”

Walter et al. 2008, AJ 136, 2563

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Table 1: Observational details on the CHVCs. $\alpha$ is the right ascension, $\delta$ the declination, $v_{lsr}$ the local-standard-of-rest velocity, spectral channel resolution $\Delta v$ of Eff/WSRT/comb. data, rms of Eff/WSRT/comb. data, “tot. flux Eff/WSRT/comb. data” the integrated flux of Eff/WSRT/comb. data.

| Name    | RA(2000) | Dec(2000) | D     | $S_{H\alpha}/M_{BH}$ | $S_{H\alpha}/M_{BH}$ | ext | 3-$\sigma$ Mass | $V_{max}$ | $W_0$ | inter group |
|---------|----------|-----------|-------|-----------------------|-----------------------|-----|-----------------|----------|-------|-------------|
| NGC 1569 | 04:30:49 | 64:50:53  | 2.0   | 44.3/0.42             | -/-                   | 42  | 22.7           | -/-       | -/-   | g           |
| NGC 2366 | 07:28:53 | 69:12:51  | 3.4   | 241/8.57              | 267/7.28              | 35.6| 3.3            | -/-       | > 135° | g           |
| NGC 2403 | 07:36:51 | 65:38:03  | 3.2   | -/-                   | -/-                   | 39.2| 98.6           | 100       | 310   | g           |
| MSIA     | 08:23:58 | 71:01:45  | 3.8   | 8.1/0.25              | 4.5/0.14              | 11  | 6.1            | 110°      | 27°   | g           |
| DDO53    | 08:34:07 | 66:10:54  | 3.6   | 12/4.0/38             | 21/8.0/67             | 21  | 6.1            | -/-       | -/-   | g           |
| NGC 2976 | 09:47:15 | 67:55:00  | 3.6   | 36.7/1.12             | 107/3.06              | 40.5| 1.0            | 3.5       | 133   | g           |
| NGC 3031 | 09:55:33 | 69:03:55  | 3.6   | 2688/2.82             | 2626/80.3             | 111.6| 15.3           | -8.5      | 667   | g           |
| NGC 3077 | 10:03:19 | 68:44:02  | 3.8   | > 385/3.2             | 393/6.134             | 17.4| -/-            | -16       | 170   | g           |
| IC2574   | 10:28:27 | 68:24:59  | 4.0   | 349/6/13.20           | 395/5/14.33           | 36  | 17.1           | > 100     | --    | --          |
| NGC 4449 | 12:28:12 | 44:05:40  | 4.2   | 593/24.7              | 457/19.0              | 67  | 15.6           | 207       | 160   | g           |
| NGC 6946 | 20:34:52 | 60:09:14  | 5.9   | 434.9/35.7            | 713/2/58.6            | 55.2| 23.4           | 63.7      | 151   | g           |

confused with M. W.

separated f. M. W.

Kerp et al. 2013, in prep.

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EBHIS: THINGS ensemble

Table 1: Observational details on the CHVCs. $\alpha$ is the right ascension, $\delta$ the declination, $v_{\text{LSR}}$ the local-standard-of-rest velocity, spectral channel resolution $\Delta v$ of Eff/WSRT/comb. data, rms of Eff/WSRT/comb. data, "tot. flux Eff/WSRT/comb. data" the integrated flux of Eff/WSRT/comb. data.

| Name | (RA(2000)) | Dec(2000) | D | $S_{\text{HI}}/M_{\odot}$ | $S_{\text{HI}}/M_{\odot}$ | ext | $M_3$ Mass | $v_{\text{esc}}$ | $W_{50}$ | inter |
|------|------------|------------|---|-------------------|-------------------|-----|------------|-------------|--------|-------|
|      | (h:m:s)    | (°:′:″)    | [Mpc] | [Jy km s$^{-1}$/10$^{10} M_{\odot}$] | [Jy km s$^{-1}$/10$^{10} M_{\odot}$] | [arcmin] | [10$^{10} M_{\odot}$] | [km s$^{-1}$] | [km s$^{-1}$] | group |
|      |            |            |       |                   |                   |       |            |            |        |       |
| EBHIS 713.2/58.6 | 713.2/58.6 | 55.2 | 23.4 | 63.7 | 151 | g |
| EBHIS 267/7.28 | 267/7.28 | 42.6 | 22.7 | -- | -- | > 135° |
| EBHIS 114/27.67 | 114/27.67 | 38.6 | 3.3 | -- | -- | 100 | 310 | g |
| EBHIS 45/0.14 | 45/0.14 | 11 | 6.1 | 110' | 27° | g |
| EBHIS 218/0.67 | 218/0.67 | 21 | 6.1 | -- | -- | -- |
| EBHIS 107/3.06 | 107/3.06 | 40.5 | 1.0 | 3.5 | 133 | g |
| EBHIS 263/80.3 | 263/80.3 | 111.6 | 15.3 | 8.5 | 667 | g |
| EBHIS 393/6/13.4 | 393/6/13.4 | 17.4 | -- | -- | 170 | g |
| EBHIS 395.5/14.93 | 395.5/14.93 | 36 | 17.1 | > 100 | -- | g |
| EBHIS 457/19.0 | 457/19.0 | 67.2 | 15.6 | 207 | 160 | g |
| EBHIS 713.2/58.6 | 713.2/58.6 | 55.2 | 23.4 | 63.7 | 151 | g |
| EBHIS 457/19.0 | 457/19.0 | 67.2 | 15.6 | 207 | 160 | g |

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EBHIS vs. THINGS: flux comparison I

THINGS/EBHIS Spectra [Jy km/s]

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THINGS: NGC 3031 (M81)

Walter et al. 2008, AJ 136, 2563

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ETHINGS: NGC 3031 (M81)

Kerp et al. 2013, in prep.

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ETHINGS: NGC 3031 (M81)

Background: EBHIS
Inset: THINGS
ETHINGS: NGC 3031 (M81)

Background: EBHIS
Inset: THINGS

Poster: Shahram Faridani
EBHIS vs. HyperLeda: flux comparison II
EBHIS: Milky Way science prospects
The northern polar cap (LAB)

l=90°  b=30°  l=270°
The northern polar cap (EBHIS)
The northern polar cap (EBHIS)

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The northern polar cap (EBHIS)

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EBHIS-Planck correlation

-80.4137 km/s

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EBHIS-Planck correlation ($\text{H}_2$ formation)
EBHIS-Planck correlation (H$_2$ formation)

\[ I_\nu = a + b \cdot N_H = a + b \cdot (N_{H_1} + 2N_{H_2}) \]

Ph. D. Tobias Röhser

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EBHIS-Planck correlation ($\text{H}_2$ formation)

Ph. D. Tobias Röhser

Poster: Tobias Röhser
The northern polar cap (EBHIS)
IVC 135+53 (velocity bridge)

Lenz et al., in prep.

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IVC 135+53 (HVC deceleration)

Lenz et al., in prep.
IVC 135+53 (dust-to-gas ratio)

-0.43±0.12 dex (Feige 48) Hernandez et al. 2013, submitted

Lenz et al., in prep.
IVC 135+53 (EBHIS-Planck $\rightarrow$ H$_2$ map)

$\alpha = 0.28 \pm 0.03$

$\beta = 0.24 \pm 0.03$

Lenz et al., in prep.

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IVC 135+53 (EBHIS-Planck → H₂ map)

Lenz et al., in prep.

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H$_2$ rain? (HVC triggered IVC H$_2$ formation?)

1. Towards the northern polar cap we observe about 1·10$^6$ M$_{\odot}$ @ 500 pc altitude
2. Say 10% of the mass H$_2$
3. Northern polar cap 1sr
4. Yielding 1·10$^6$ M$_{\odot}$ of H$_2$ full sky
5. Free fall time t ~ 10$^6$

1 M$_{\odot}$/year (low metallicity)

Extent 5 pc distance about 500 pc
→ 35’ @ 500 pc
→ 21” @ 50 kpc (LMC/SMC)
→ 0.3” @ 3.5 Mpc (Ursa Major)

“Dark Gas” Wolfire, Hollenbach & McKee 2010, ApJ 716, 1191

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EBHIS products

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The future: second coverage > 30°
Thank you!

DFG
KE757/7-1 to 7-3

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