

WNSHS

...

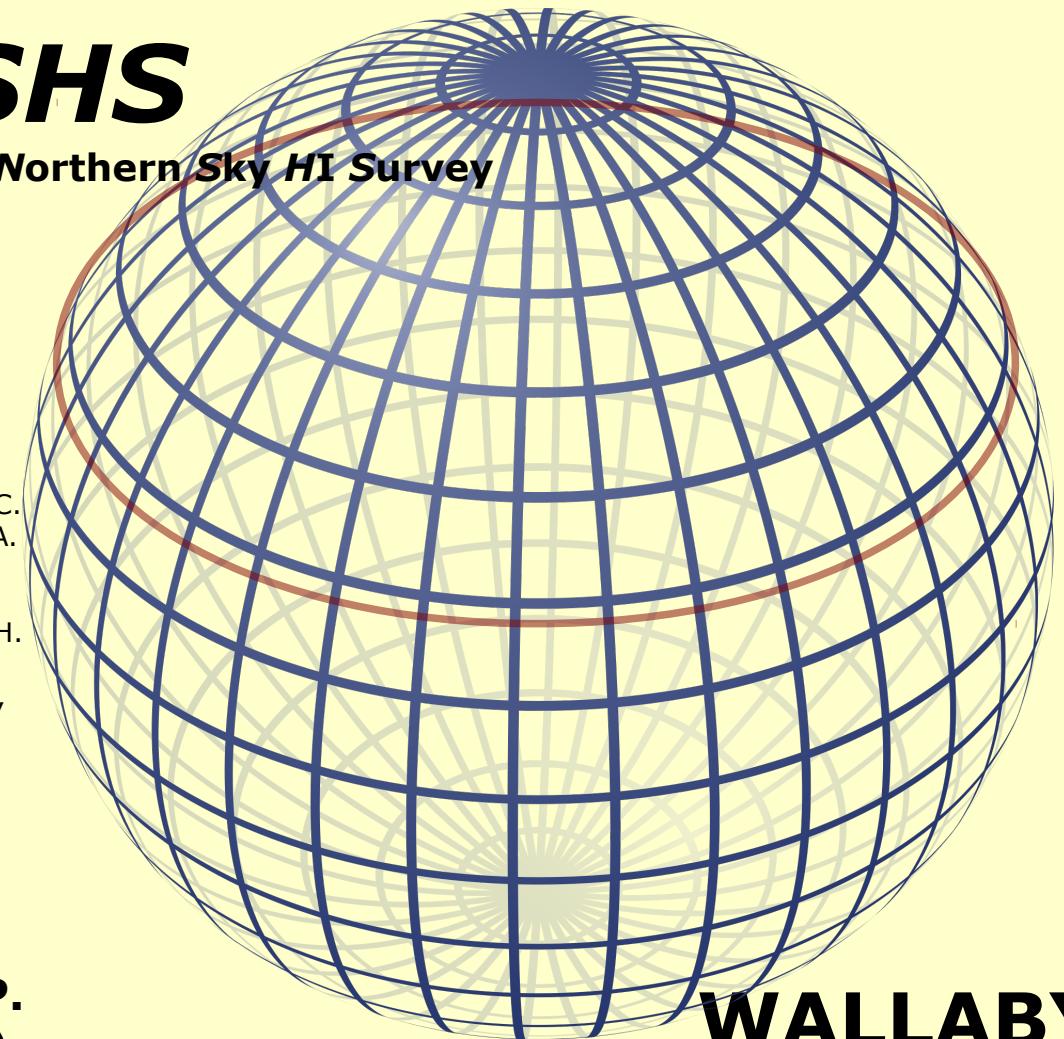
and WSRT

Westerbork Northern Sky HI Survey

Adams, A.K. (ASTRON), Asgekar, A. (SHELL), Ben-Bekhti, N. (AIfA/Univ. Bonn), Best, P. (Univ. Edinburgh), Bigiel, F. (ZAH), Bosma, A. (OAMP), Brinks, E. (CAR/Univ. Hertfordshire), Bundy, K. (Univ. Berkeley), Cantinella, B. (CAS, Swinburne Univ.), Chakrabarti, S. (Univ. Berkeley), Charlot, S. (IAP), Colless, M. (AAO), Courtois, H. (IfA/Univ. Hawaii), de Blok, E. (ASTRON), Duc, P.-A. (CEA-Saclay), Dunne, L. (Univ. Nottingham), Floer, L. (AIfA/Univ. Bonn), Garcia, D. (ESO), Garrett, M. (ASTRON), Gupta, N. (IUCAA), Haynes, M. (Univ. Cornell), Heald, G. (ASTRON), Henning, T. (Univ. New Mexico), Holwerda, B. (ESO), Jarrett, T. (Univ. Capetown), Jones, H. (AAO), Juette, E. (AIUB/Univ. Bochum), Kamphuis, P. (CSIRO), Karachentsev, I. (RAS/SAO), Kauffmann, G. (MPA), Kerp, J. (AIfA/Univ. Bonn), Klein, U. (AIfA/Univ. Bonn), Kloeckner, H. (MPIfR), Kraan-Korteweg, R. (Univ. Cape Town), Lacey, C. (Univ. Durham), Li, C. (SHAO), Lobanov, A. (MPIfR), Lopez-Sanchez, A. (CSIRO), Maehle, E. (Univ. Nagoya), Masters, K. (Univ. Portsmouth), Meurer, G. (ICRAR), Mould, J. (Univ. Melbourne), Overzier, R. (MPA), Popping, A. (ICRAR), Rhee, G. (Univ. Nevada Las Vegas), Rottgering, H. (Univ. Leiden), Saintonge, A. (MPE), Sanchez-Blazquez, P. (Univ. Autonoma Madrid), Sánchez-Janssen, R. (ESO), Schroeder, A. (SAAO), Spekkens, K. (Royal Military College of Canada), Springob, C. (AAO), Staveley-Smith, L. (ICRAR), Szomoru, A. (JIVE), Tully, B. (IfA/Univ. Hawaii), van Gorkom, J. (Columbia Univ.), van Driel, W. (Observatoire de Paris), Vlemmings, W. (Chalmers Univ.), Wakker, B. (Univ. Wisconsin), Warren, B. (ICRAR), Webster, R. (Univ. Melbourne), Weijmans, A.-R. (Univ. Toronto), Winkel, B. (MPIfR), Wong, I. (Univ. Yale), Zwaan, M. (ESO)

WNSHS

Westerbork Northern Sky HI Survey



WALLABY

Kilborn, V. (Swinburne Univ.), Serra, P. (ASTRON) Staveley-Smith, L. (ICRAR), Koribalski, B. (CSIRO)

Gyula I. G. Józsa (ASTRON)



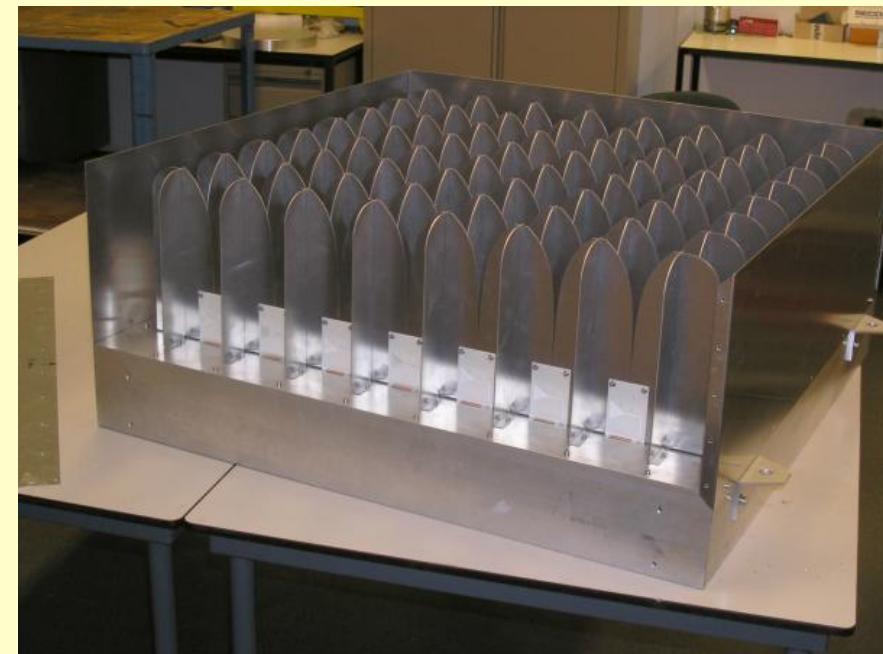
ASTRON



Tom Oosterloo

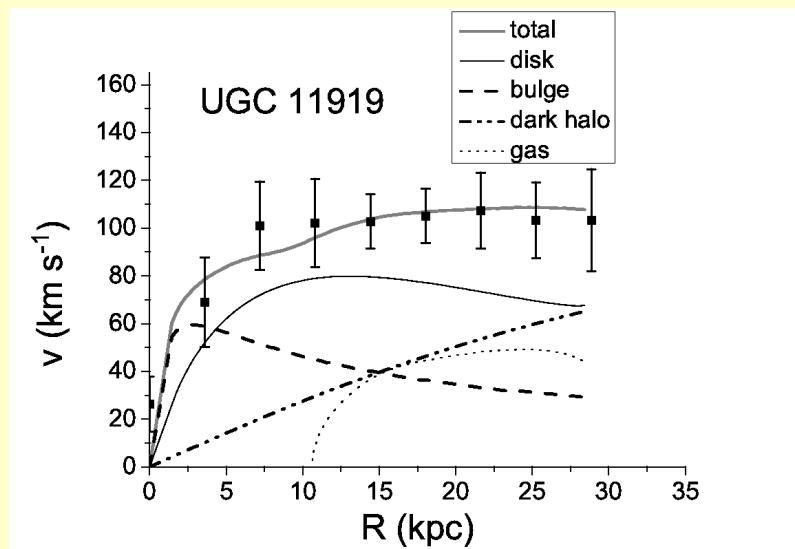
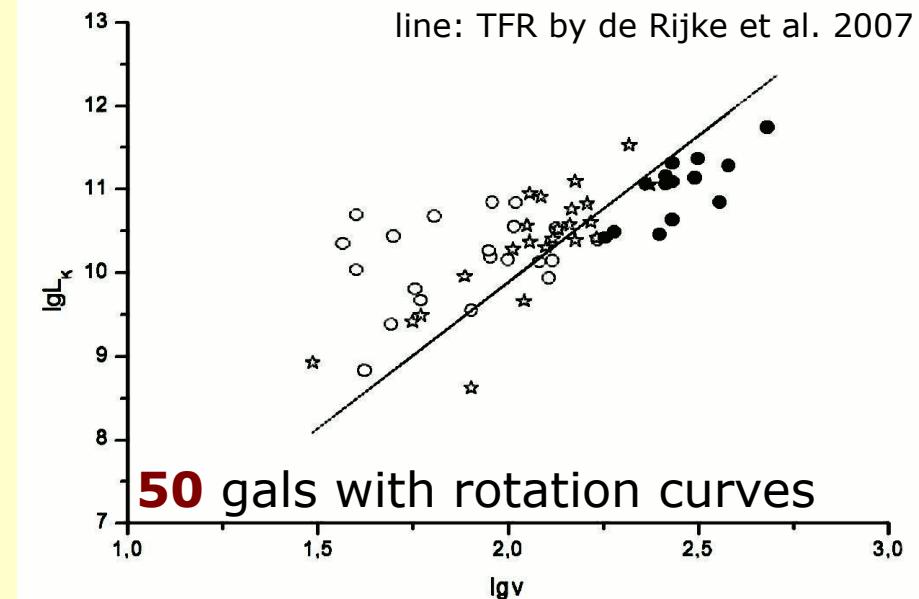
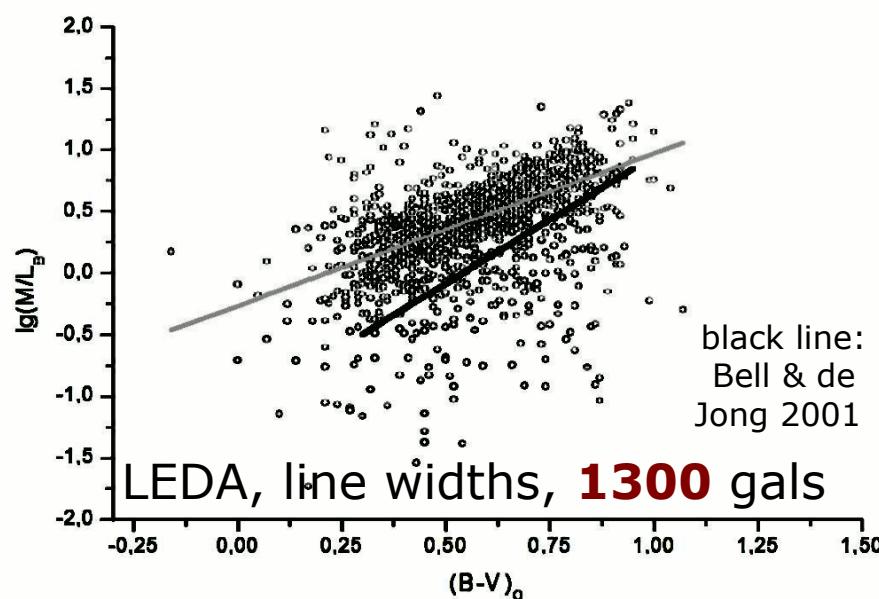
Marc Verheijen

- “**Aperture tile in focus**”: new receiver system at the Westerbork Synthesis Radio Telescope
- 37 compound beams (instead of one)
- FOV increased by factor 25 ($8 \square^\circ$)
- Line sensitivity decreased by factor 2
- 1130 MHz - 1750 MHz (HI: $z < 0.26$)
- Resolution: HPBW: $15'' \times 15''/\sin \delta$
FWHM: 36.6 kHz



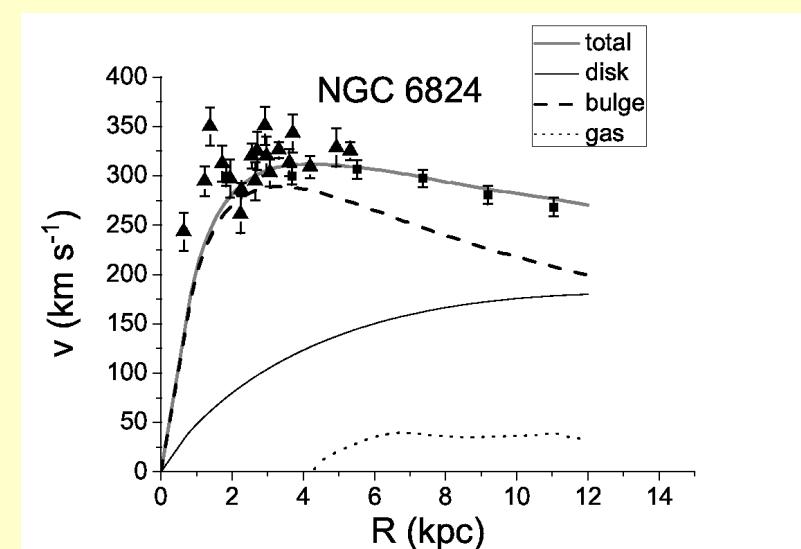
Example

How universal is M_{kin}/L_B vs. B-V?
 (Saburova et al. 2009, Saburova et al. 2013)



2 galaxies reobserved with WSRT and APO

1 galaxy confirmed lightweight for colour



An expression of interest

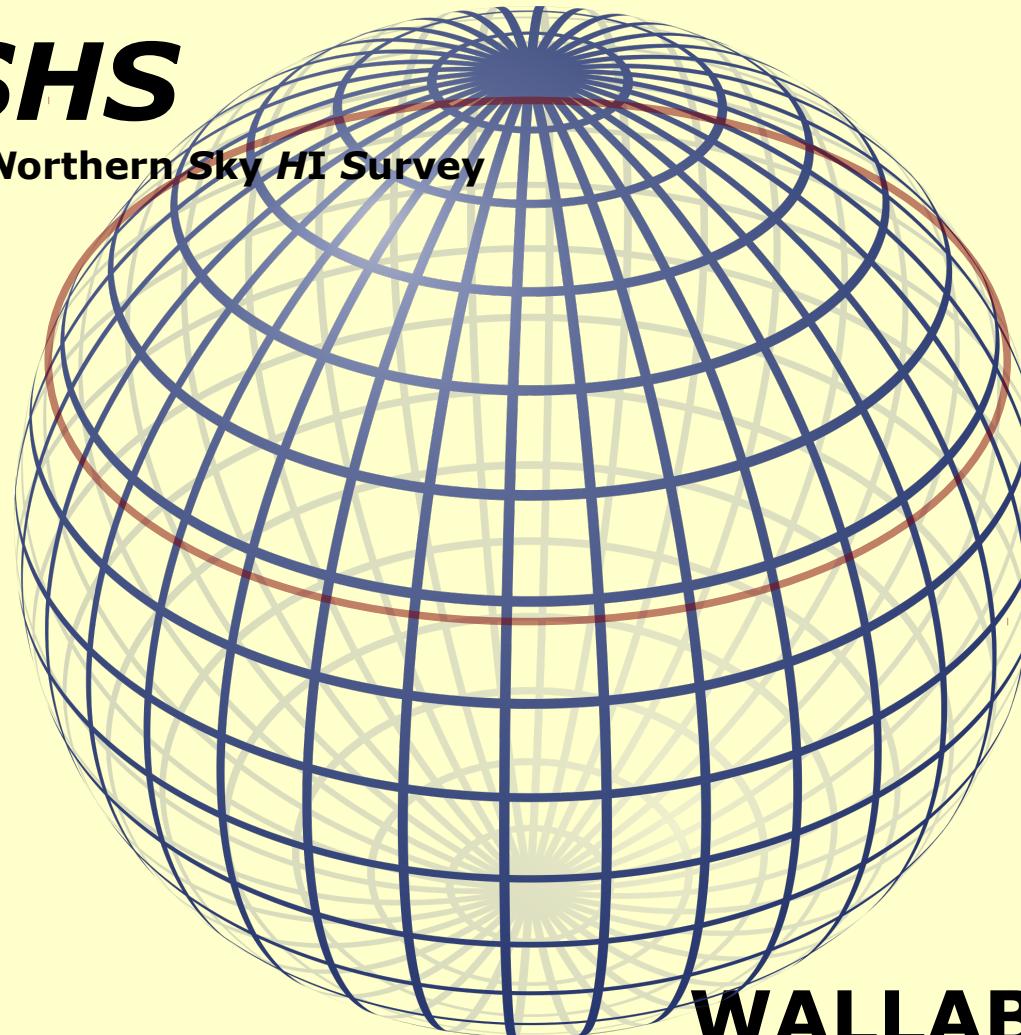
WNSHS
Westerbork Northern Sky HI Survey

The **Westerbork Northern Sky HI Survey** is a proposed shallow Northern sky (mostly) extragalactic HI survey with the WSRT and Apertif.

WNSHS

Westerbork Northern Sky HI Survey

1 π



An expression of interest:

WNSHS
Westerbork Northern Sky HI Survey

The **Westerbork Northern Sky HI Survey** is a proposed shallow Northern sky (mostly) extragalactic HI survey with the WSRT and Apertif.

- **Legacy for all**
- **All-sky** extragalactic HI survey (together with WALLABY -> W²)

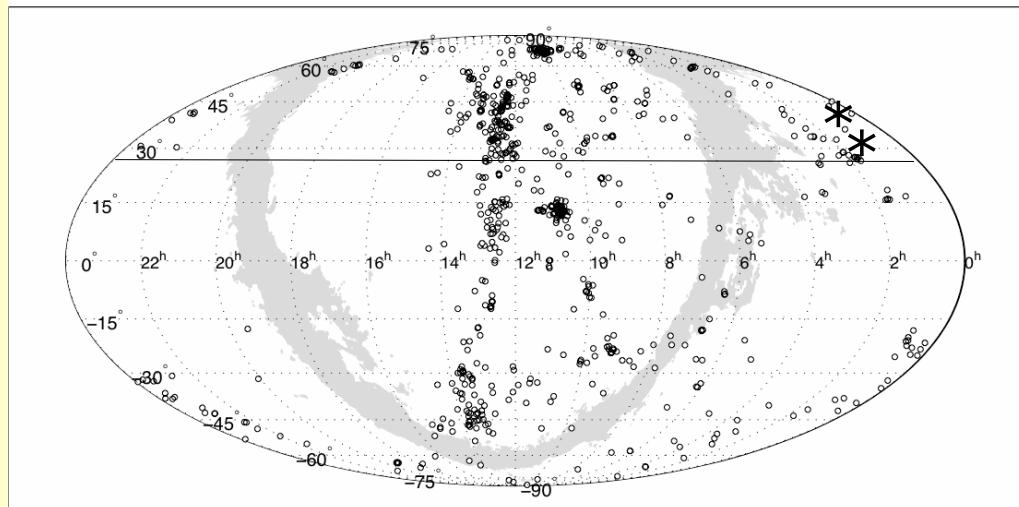
Science:

- **HI mass function**, environmental dependence
- **Total mass function** (in combination with near/mid IR missions)
- **Galaxy flows** via peculiar motions
- **HI content, distribution, environment of galaxies (galaxy evolution)**
(multiwavelength surveys, including Apertif continuum, **WODAN**)
- **Galaxy dynamics**
- **WHIM** (in combination with X-ray missions)

Sky- and frequency coverage

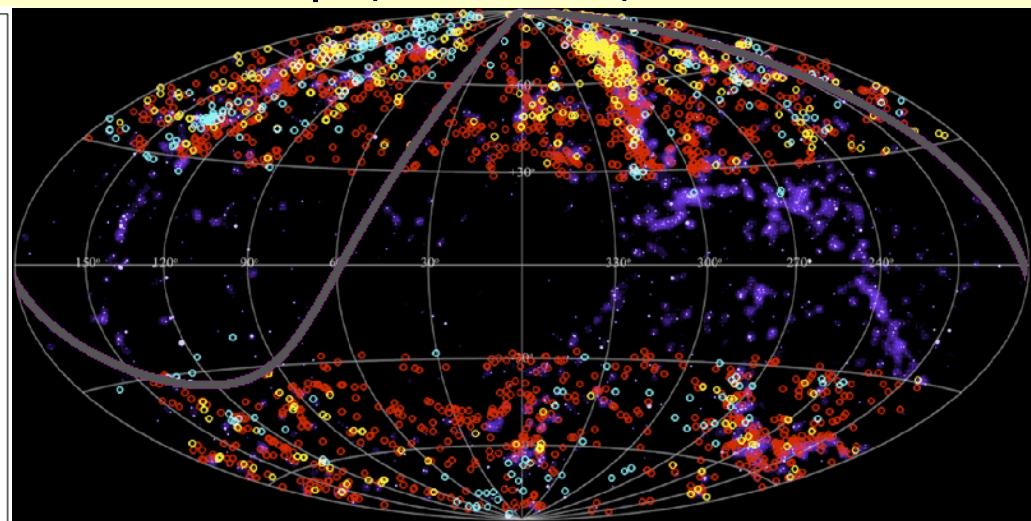
WNSHS
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D < 10 Mpc, equatorial



Karachentsev et al.

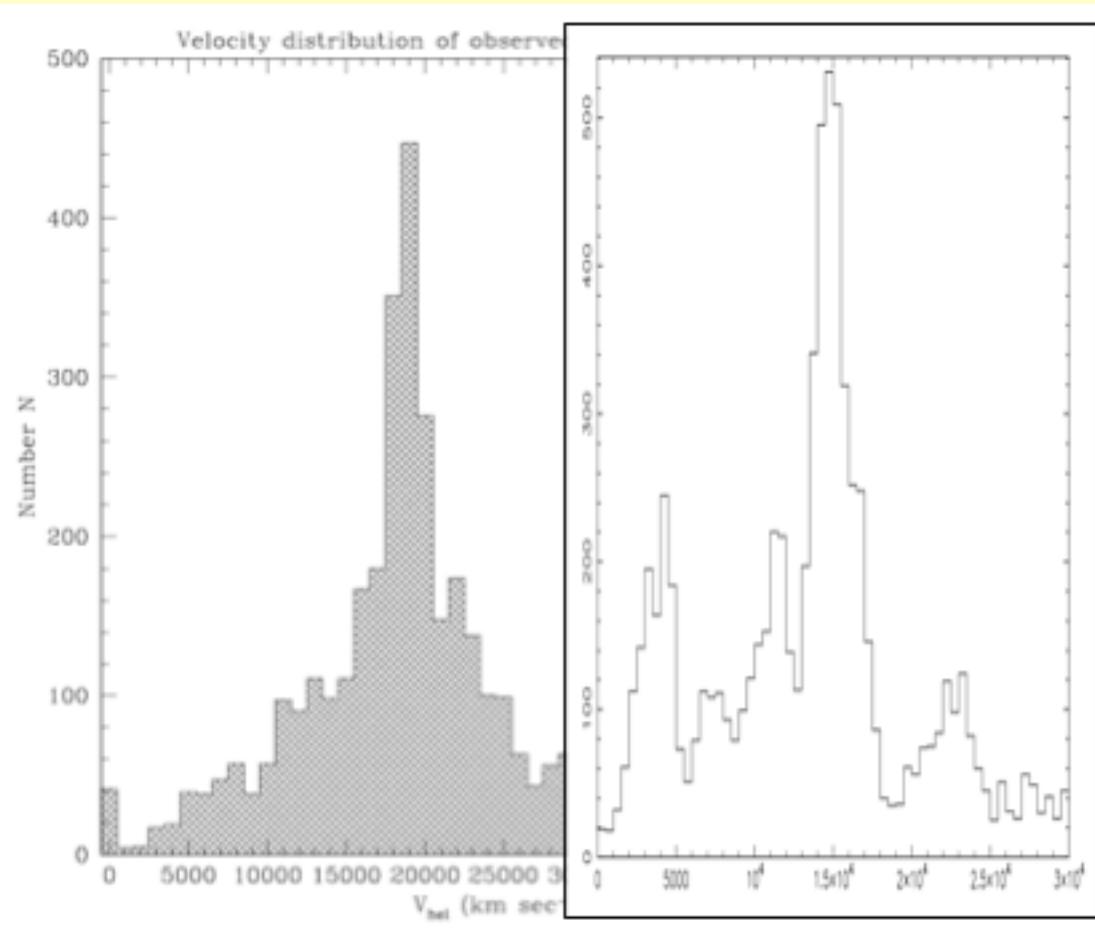
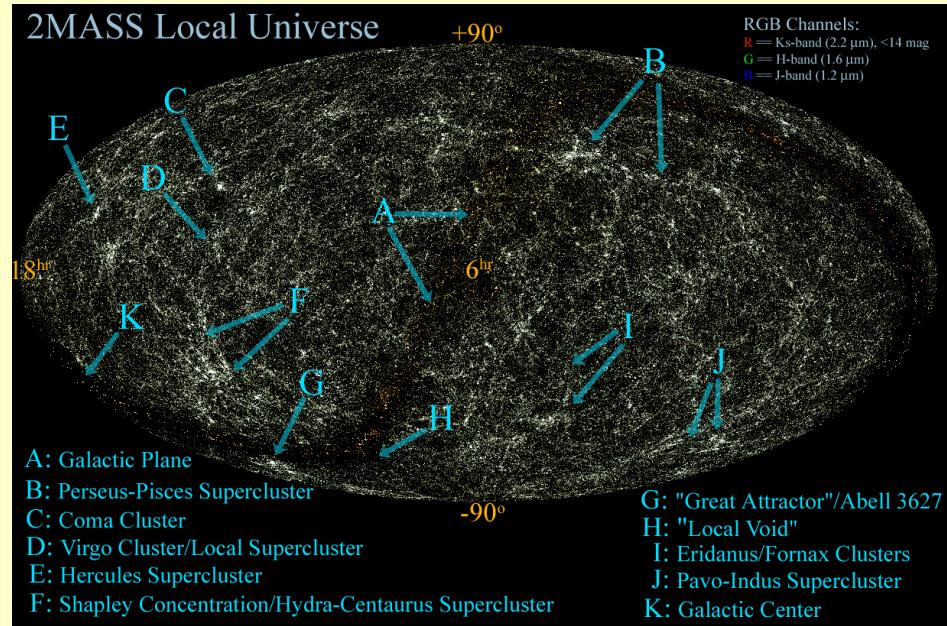
D < 40 Mpc, Galactic, S⁴G



Sheth et al. 2010

- $\delta > 27^\circ \leftrightarrow$ WALLABY/ASKAP (SKA phase 1): $\delta < 30^\circ$
- 1130 MHz - 1430 MHz \rightarrow -2000 km s⁻¹ - 77,000 km s⁻¹

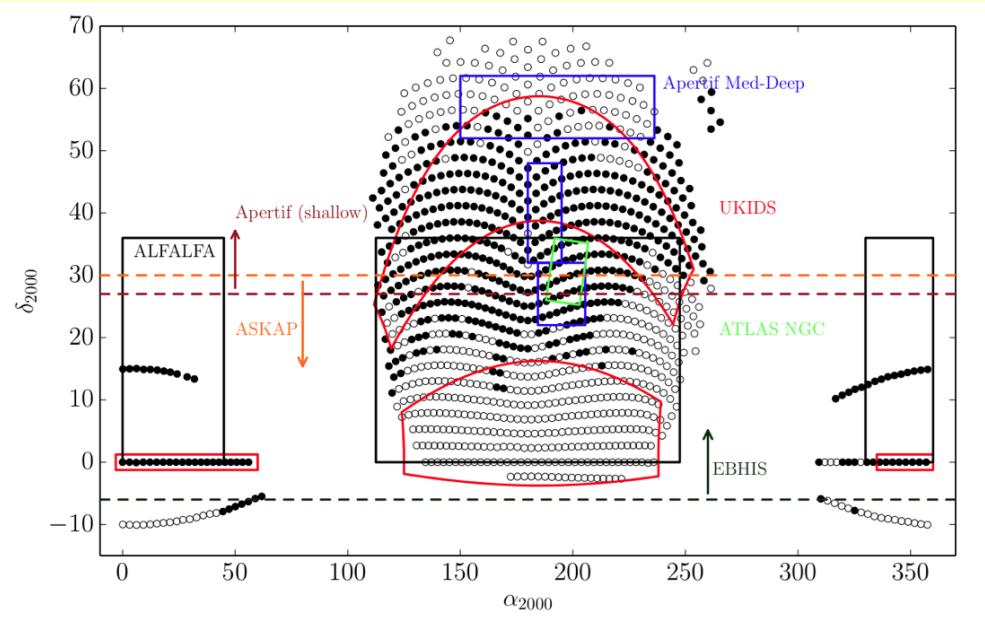
Sky- and frequency coverage



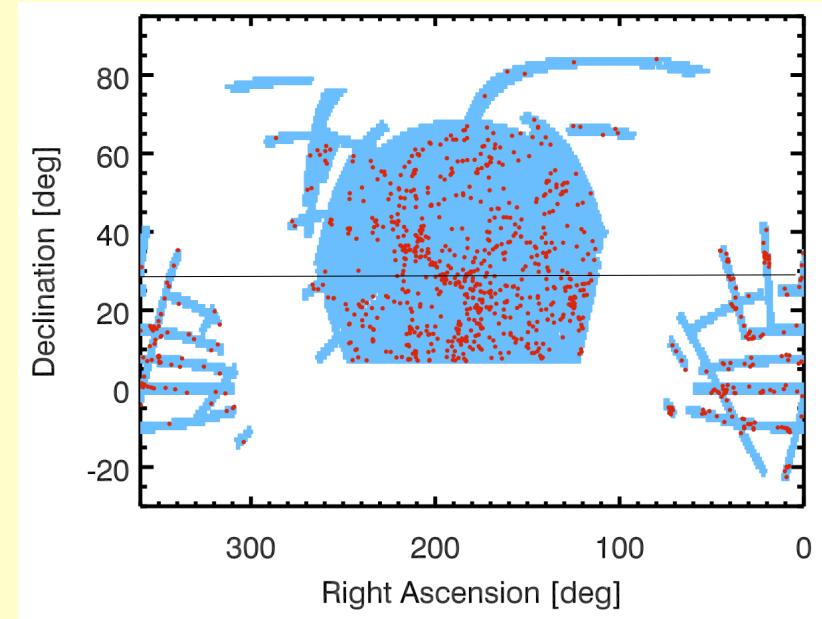
Kraan-Korteweg et al., prel.

Sky- and frequency coverage

MaNGA

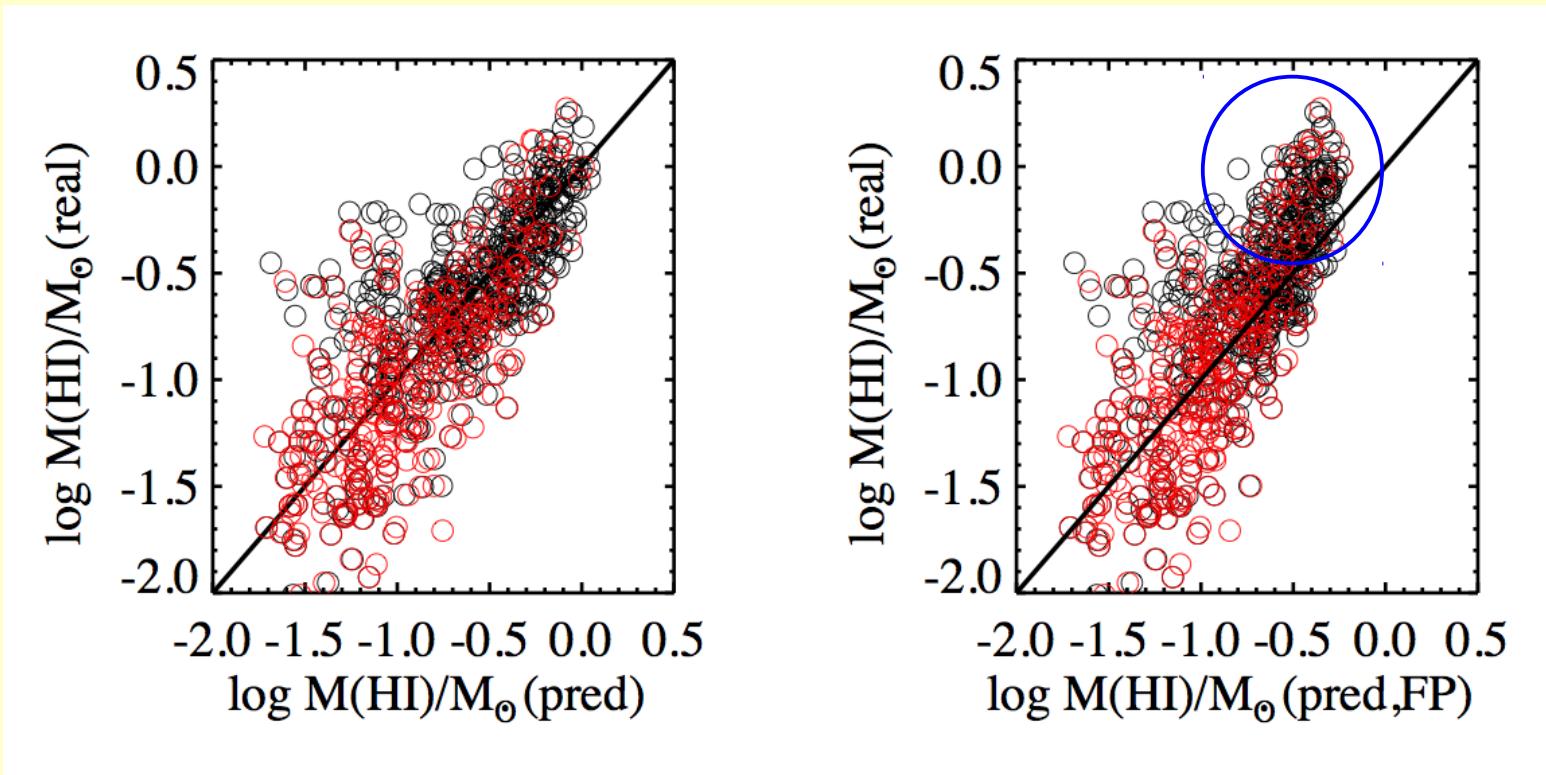


CALIFA



- $\delta > 27^\circ$ \leftrightarrow WALLABY/ASKAP (SKA phase 1): $\delta < 30^\circ$
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Example

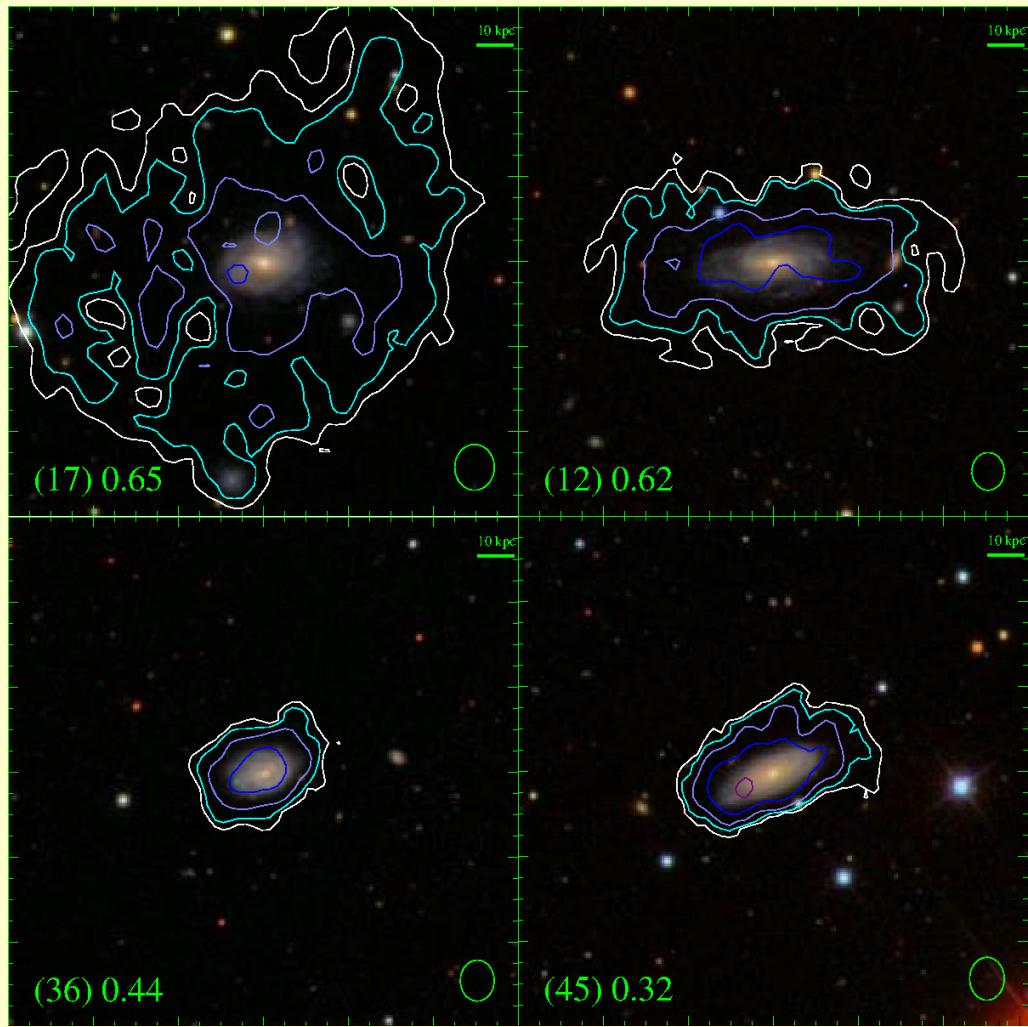


- How is HI distributed in very gas-rich galaxies?
 - Select (very) gas-rich galaxies from SDSS
 - $10 < \log M_{\text{stars}}/M_{\odot} < 11$, GALEX detection, $0.01 < z < 0.03$ (size), $\delta > 30^{\circ}$
- > **25/123** targets (plus 25 normal galaxies) -> Bluedisk

Example

WNSHS

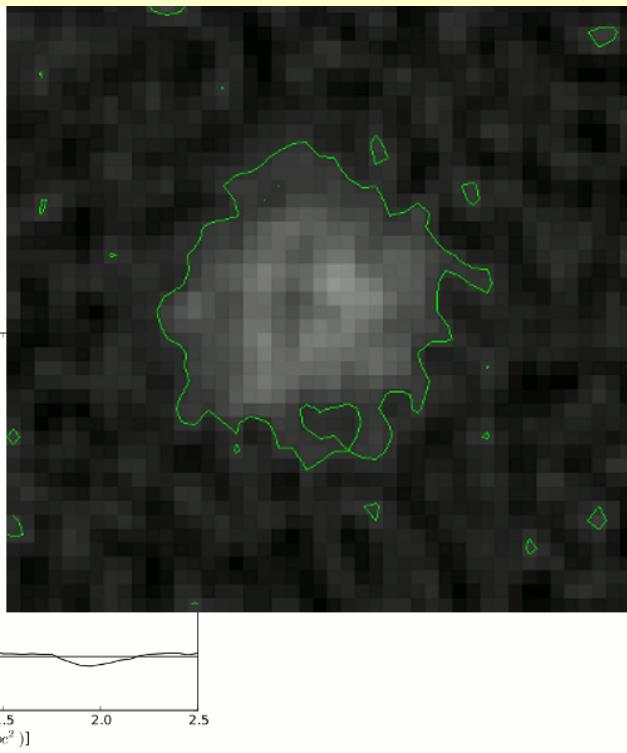
Westerbork Northern Sky HI Survey



Bluedisk
PI: G. Kauffmann
Wang et al. 2013
Wang et al.
den Heijer et al.

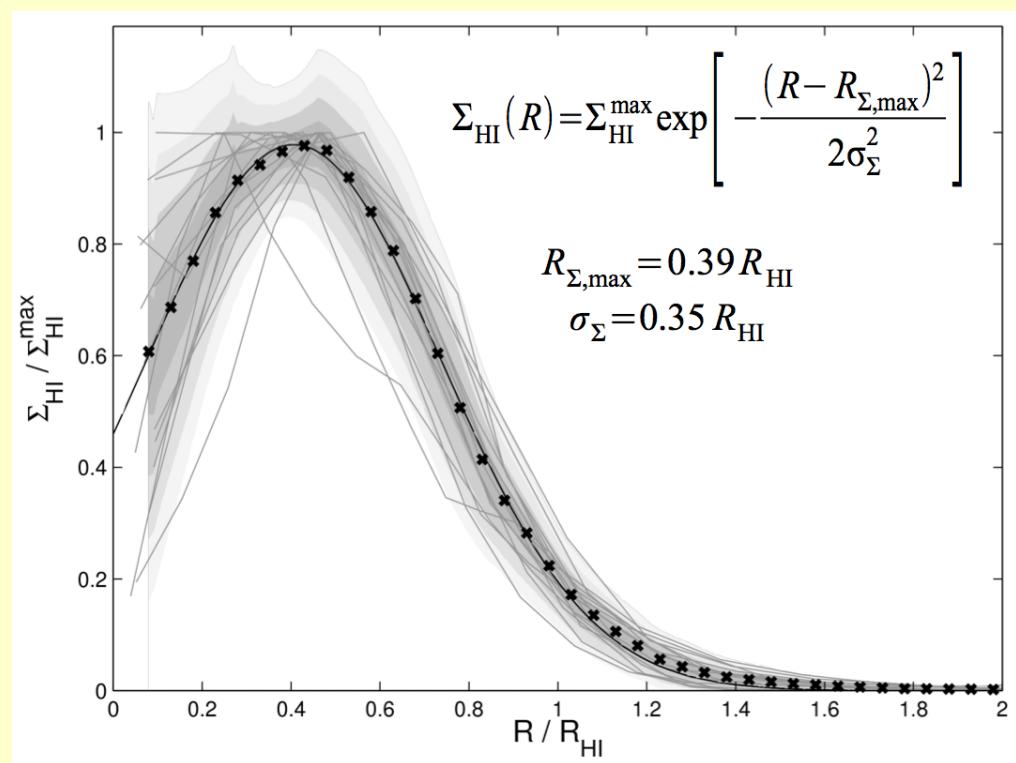
- Sample: 25 H I-rich galaxies, 25 control galaxies
- H I mass-size relation (Broeils & Rhee 1997, Martinsson 2011) still valid
- regular morphology and kinematics -> accretion from a warm/hot IGM rather than major mergers?

Example: self-similar disks



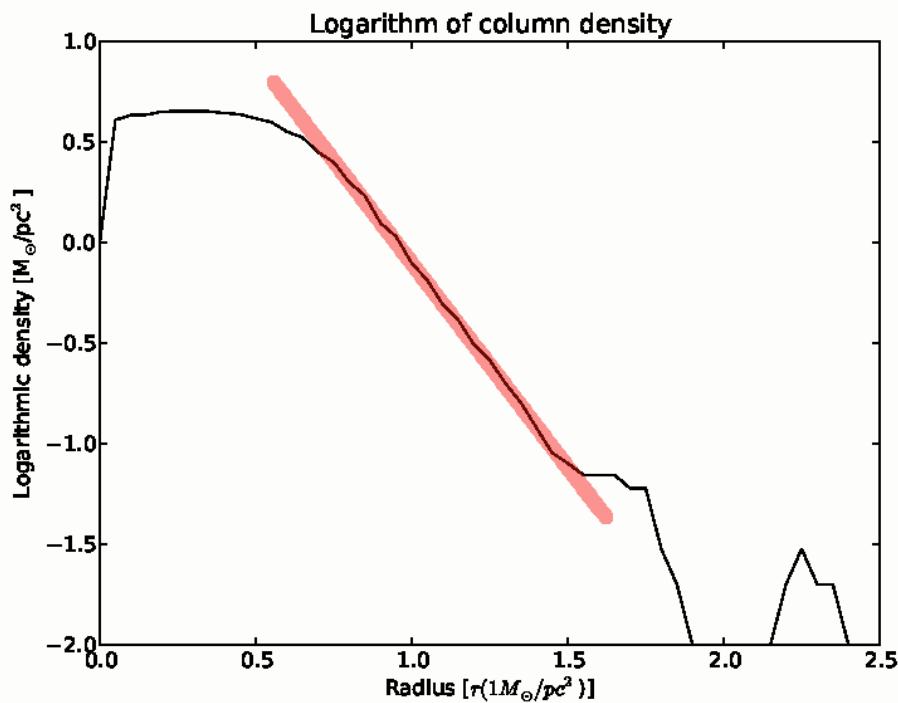
Johansson et al.
(summer student 2012 @ ASTRON)

- Valid over which mass range?
- Type? (not ETGs, Serra et al. 2012)
- Environment?



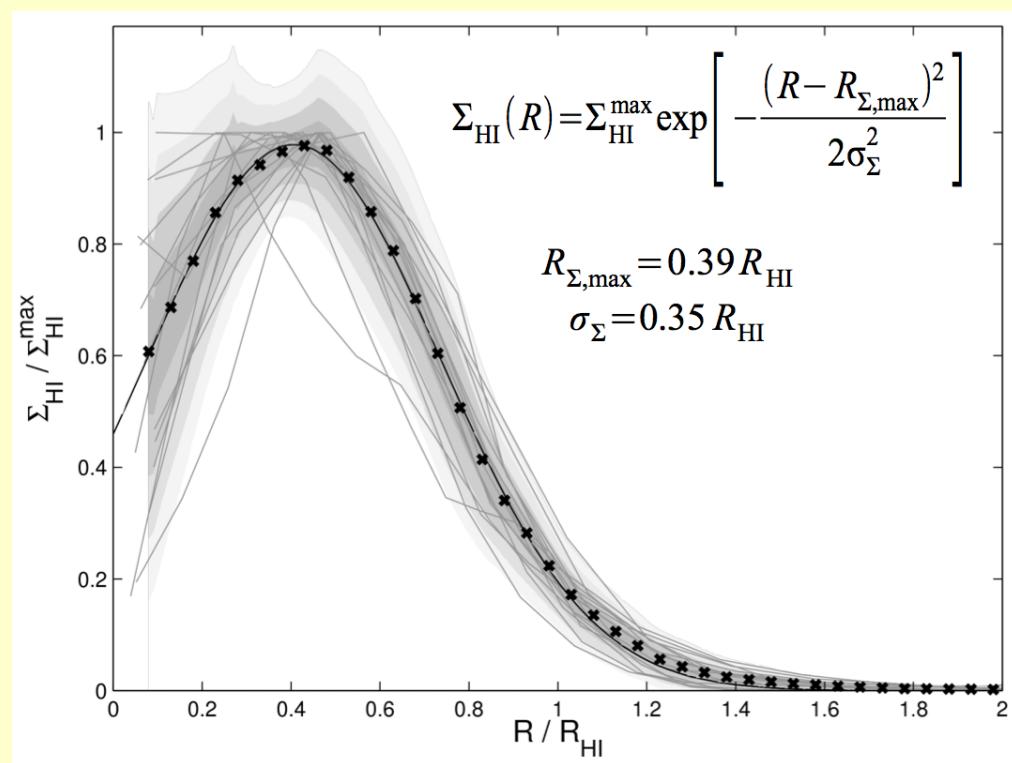
Martinsson et al. 2011

Example: self-similar disks



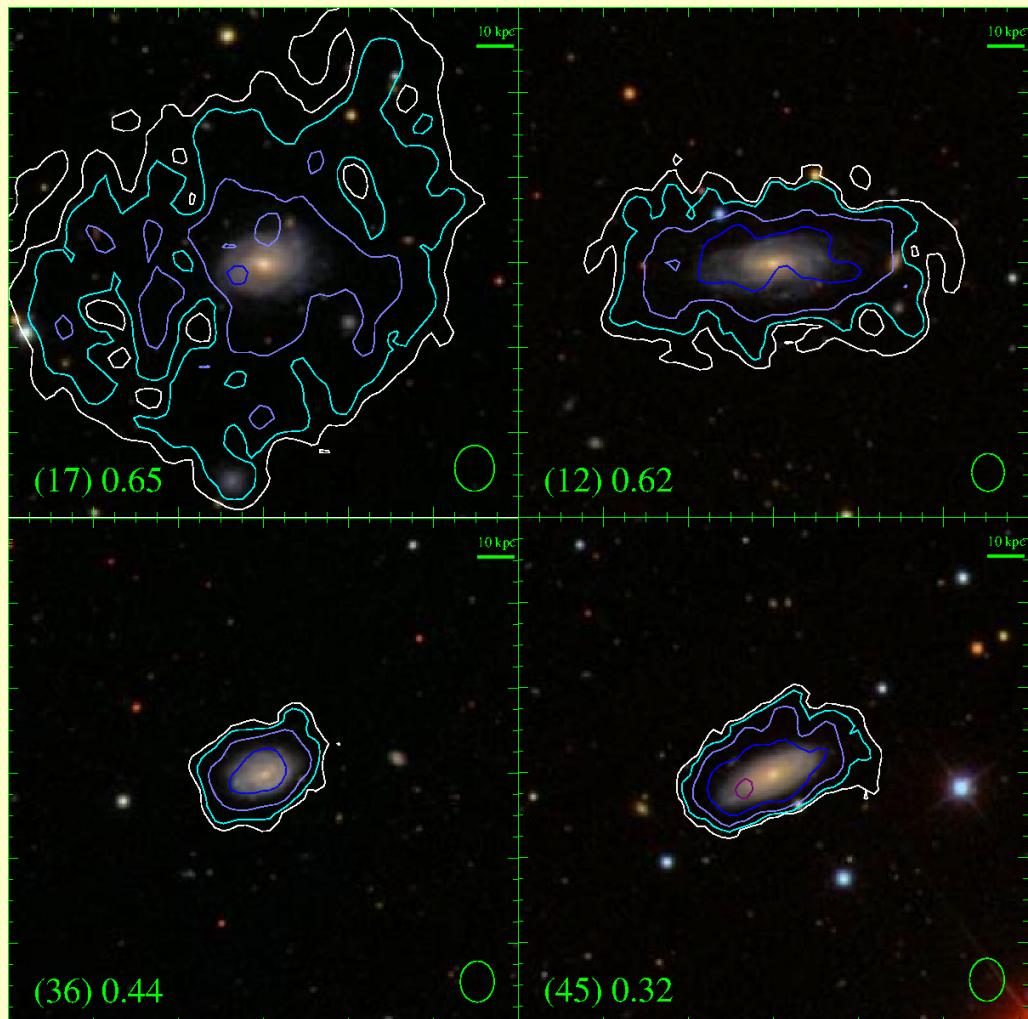
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Martinsson et al. 2011

Example



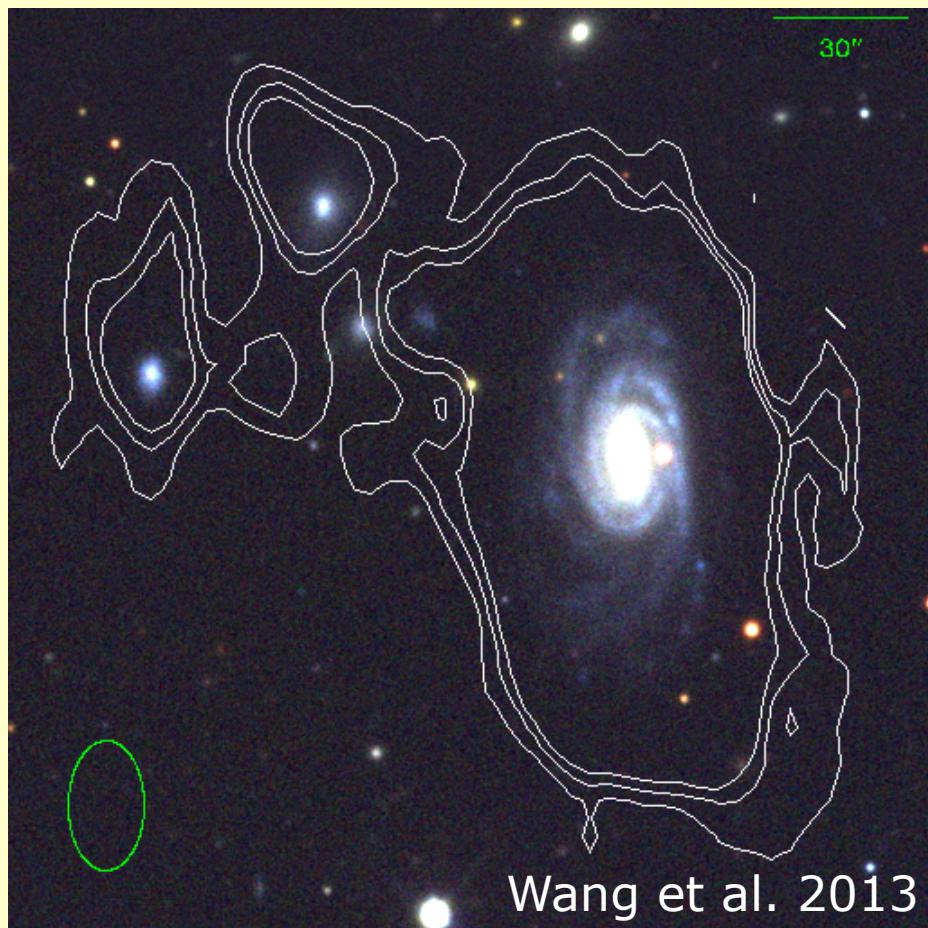
Bluedisk
PI: G. Kauffmann
Wang et al. 2013
Wang et al.
den Heijer et al.

- Sample: 25 H I-rich galaxies, 25 control galaxies
 - H I mass-size relation (Broeils & Rhee 1997, Martinsson 2011) still valid
 - regular morphology and kinematics -> accretion from a warm/hot IGM rather than major mergers?
- **For $\delta > 27^\circ$ “all-sky” 370 targets**
- > considerable increase in statistics only with all-northern-sky survey

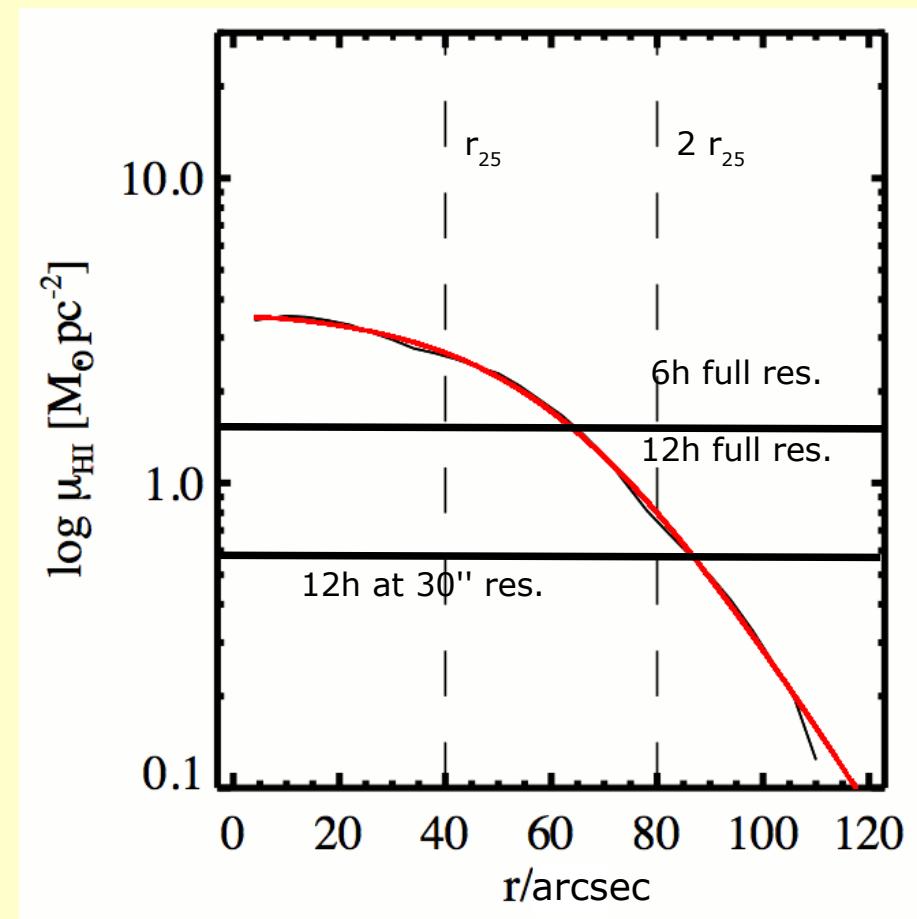
Surface-brightness sensitivity

WNSHS
Westerbork Northern Sky HI Survey

- 12 h integrations per pointing
 - > 5- σ_{rms} sensitivity limit ($\Delta v = 24 \text{ km/s}$):
 $< (1+z)^4 \cdot 2.2 \cdot 10^{20} \text{ atoms cm}^{-2}$ (HPWB = 15'')
 $< (1+z)^4 \cdot 0.7 \cdot 10^{20} \text{ atoms cm}^{-2}$ (HPBW = 30'')



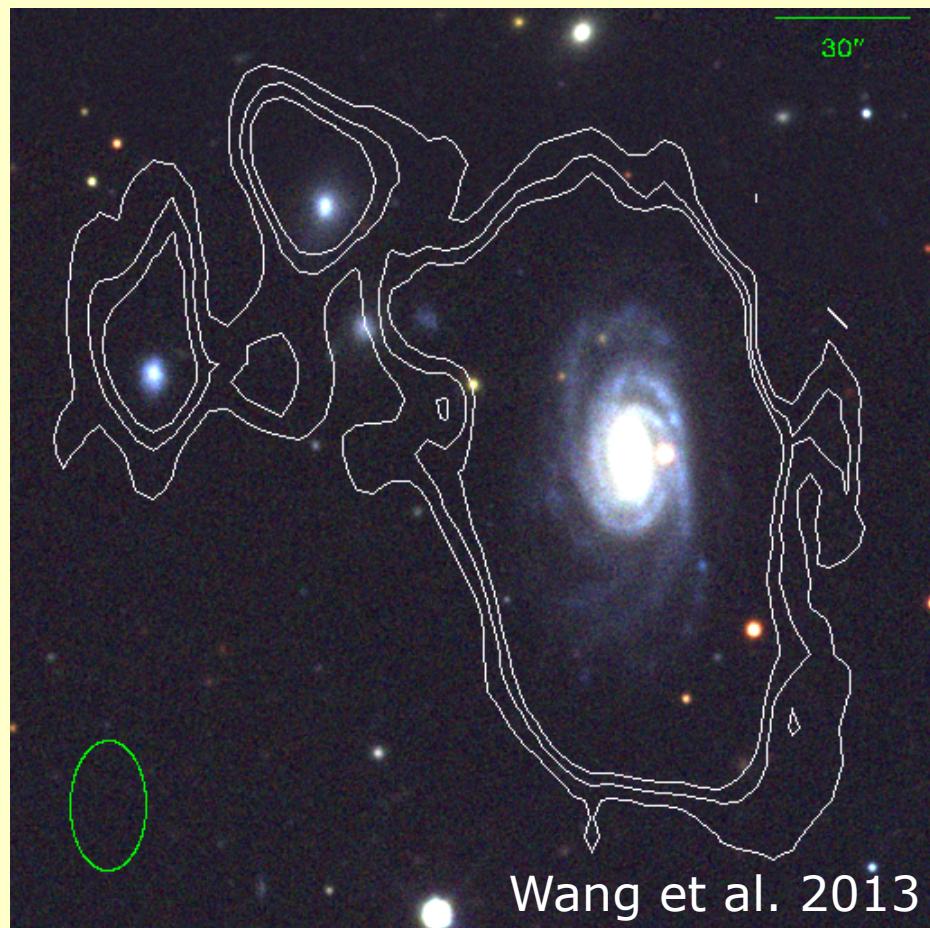
$0.7, 1.4, 2 \cdot 10^{20} \text{ atoms cm}^{-2}$



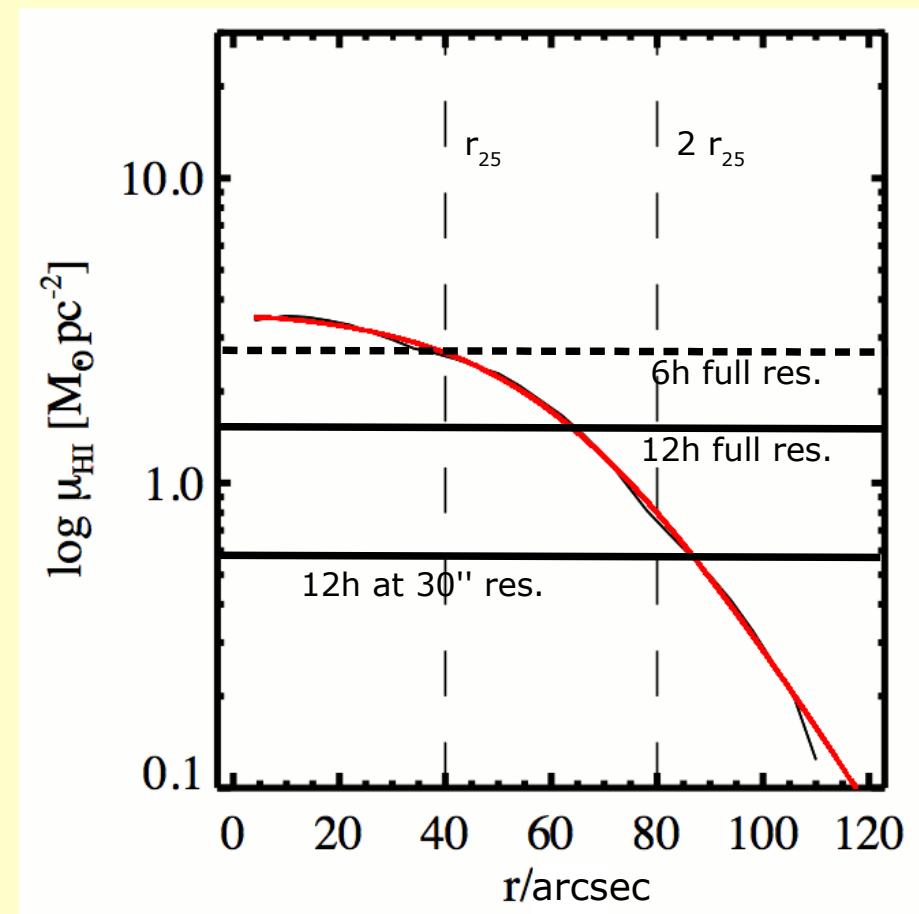
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$0.7, 1.4, 2 \cdot 10^{20} \text{ atoms cm}^{-2}$



Galaxy counts

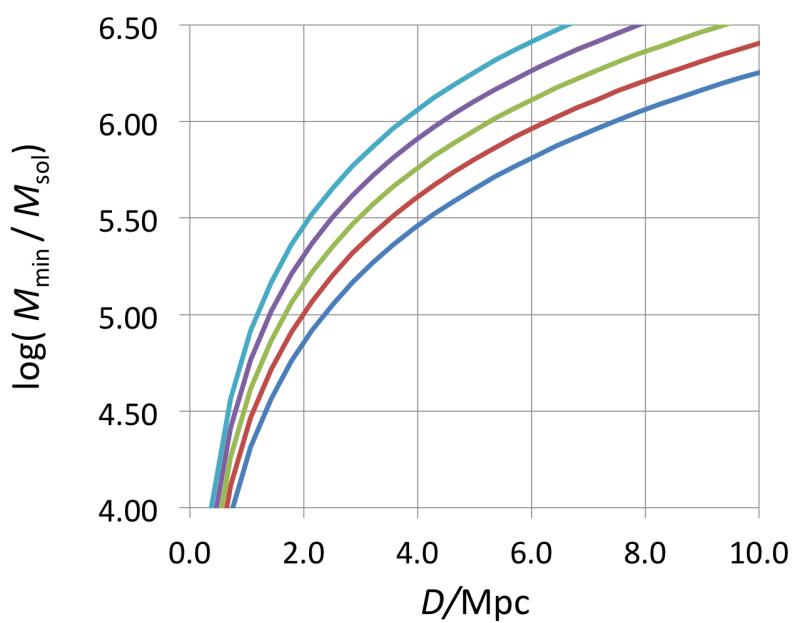
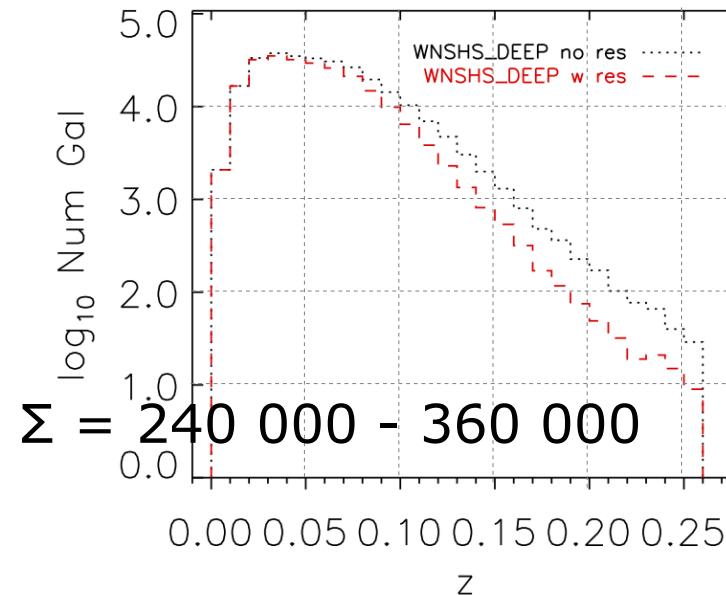
WNSHS

Westerbork Northern Sky HI Survey

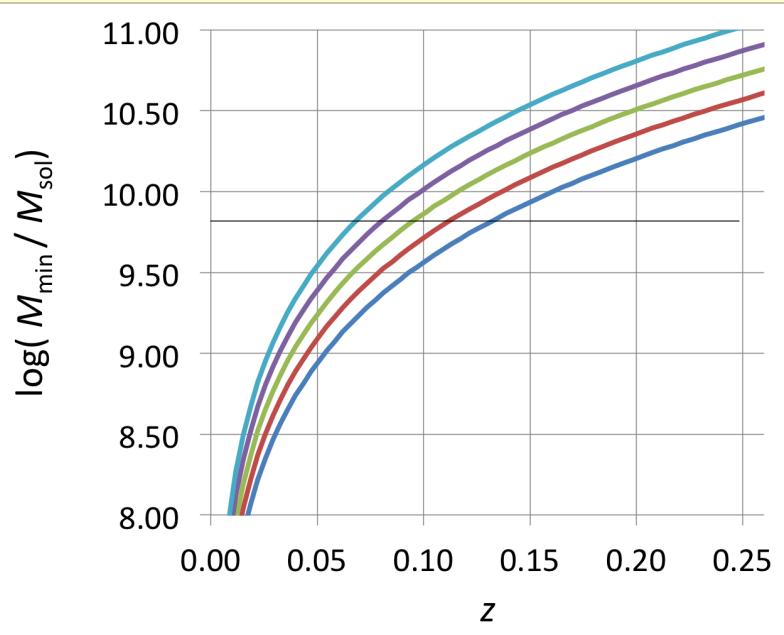
Duffy et al. 2012,

numbers adapted

$\log M_{\text{HI}}/M_{\odot} > 8.5$



$\Delta v = 25 \text{ km/s}$
 $\Delta v = 50 \text{ km/s}$
 $\Delta v = 100 \text{ km/s}$
 $\Delta v = 200 \text{ km/s}$
 $\Delta v = 400 \text{ km/s}$
 $S/N = 6$



angular resolution (at z = 0)

15" ... 30"

sky coverage

$27^\circ \geq \delta \geq 90^\circ$ (11262 sq. deg.)

number of pointings

1410

number of channels

16384

frequency resolution

18.3 kHz channel⁻¹

velocity resolution

3.9 km s⁻¹ - 4.6 km s⁻¹

time resolution

30 s

correlations

Full Stokes

redshift range

0 - 0.26

frequency range

1130 MHz - 1430 MHz

rms sensitivity (0.1 MHz)

0.55 (15") ... 0.67 (30") mJy/beam

rms sensitivity (7.8 km/s)

0.92 (15") ... 1.10 mJy/beam

integration time p.p.

12 h

required observing time

16900 h -> 1.9 years on-source

(WALLABY : 0.7 mJy over 0.1 MHz @ 30" resolution)

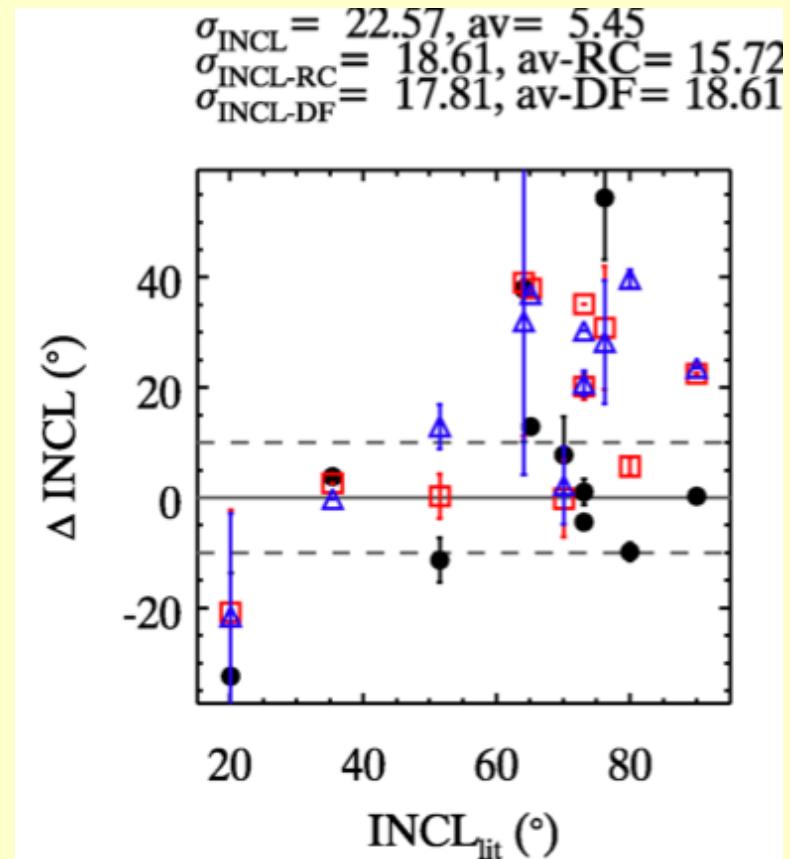
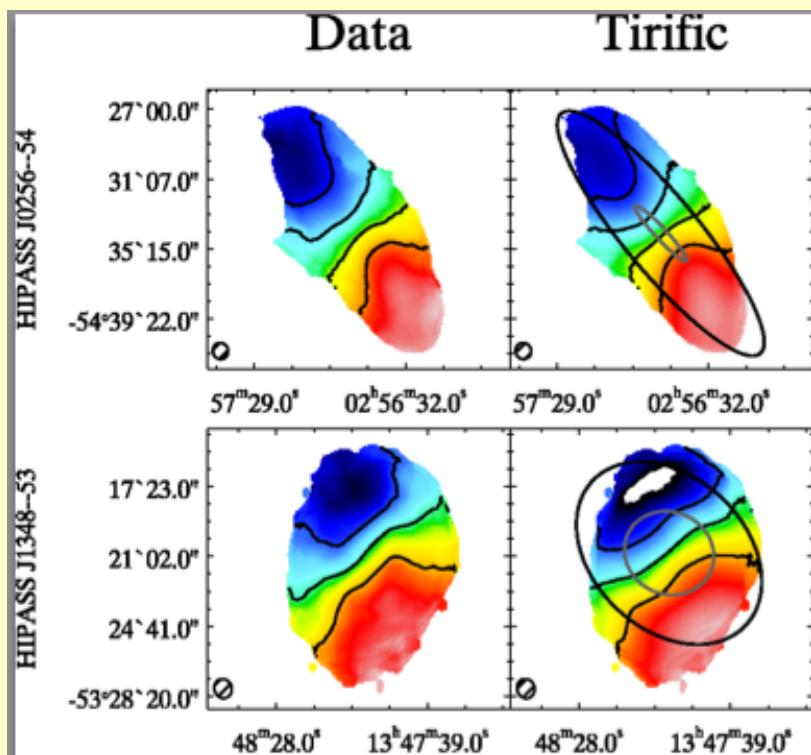
Preparing

WNSHS

Westerbork Northern Sky HI Survey

- Testing and improving technical applications e.g. SoFIA, WSRT data reduction pipelines, source characterisation (see Speekens, Oh), e.g.:

- Full 3d source finding and tilted-ring modelling pipeline from data cube to parametrisation (Kamphuis et al., employing SoFIA and TiRiFiC)



Preparing

- WSRT projects initiated or conducted to ensure Apertif scientific and technical preparation (pipelining, source finding, source characterisation), e.g.:

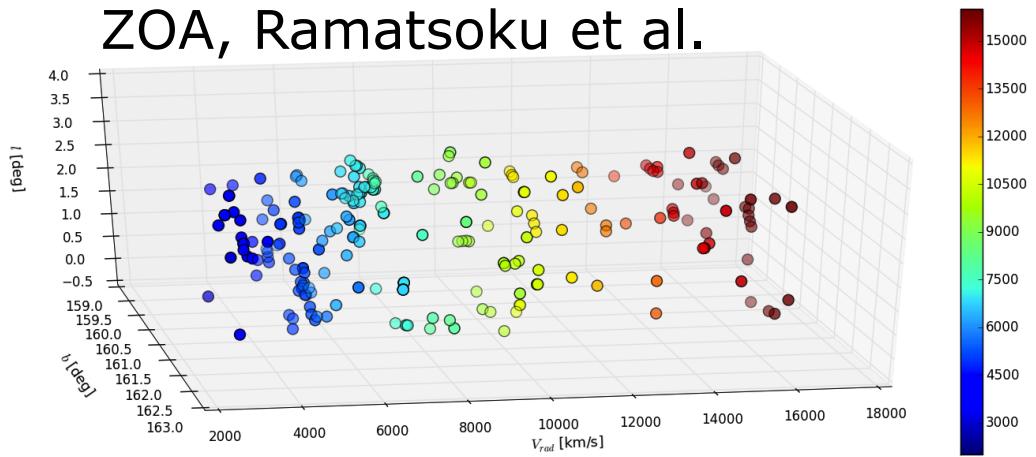
- **ZOA** (Kraan-Korteweg et al., see Ramatsoku et al., galaxy cluster in PP supercluster filament)

- **Bluedisk** (Kauffmann et al., on galaxy formation, 50 galaxies)

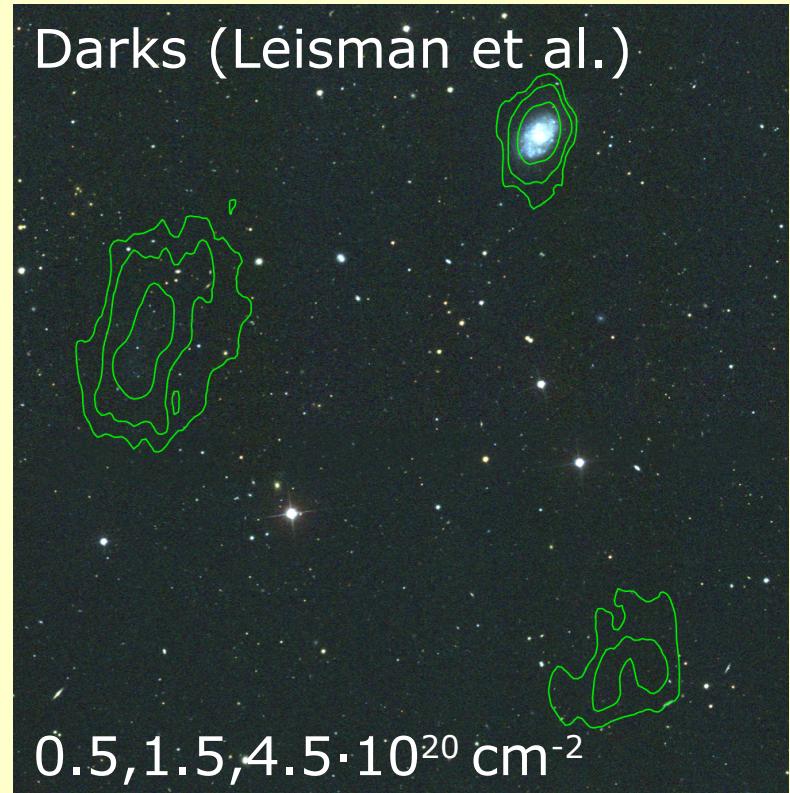
- **Almost Darks** (Leisman, Adams, et al., WSRT follow-up on H I clouds with little stellar counterpart as detected in ALFALFA)

- **Blue ETGs** (Wong, H I content of blue ETGs)

ZOA, Ramatsoku et al.



Darks (Leisman et al.)

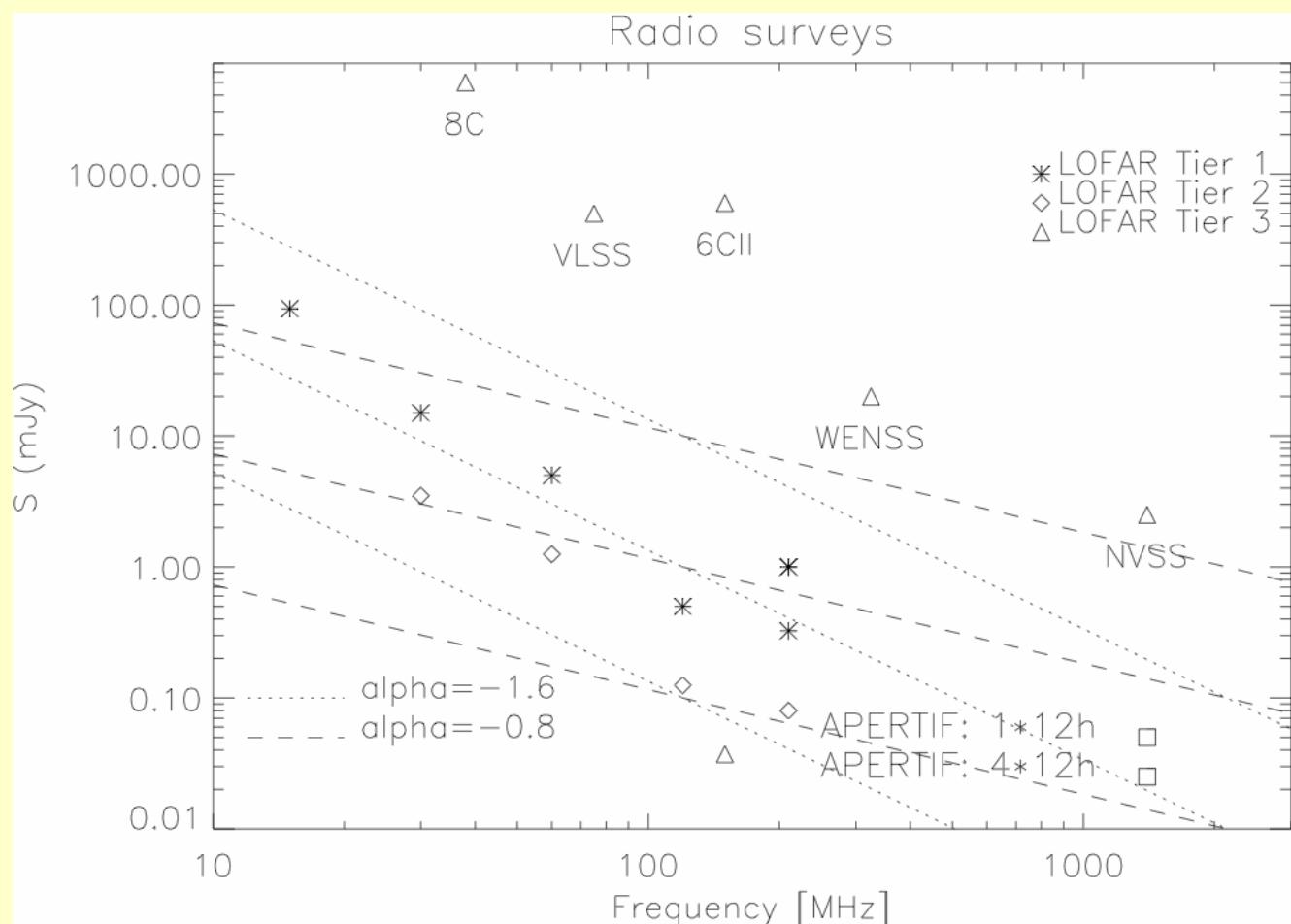


Commensal Apertif surveys

WNSHS

Westerbork Northern Sky HI Survey

- WODAN (Röttgering, continuum)
- H I absorption line survey (Gupta)
- RRL survey (Asgekar)
- H I in combination with EBHIS (Kerp)
- Pointed H I (Klöckner)
- OH (McKean)
- (Galactic H I)



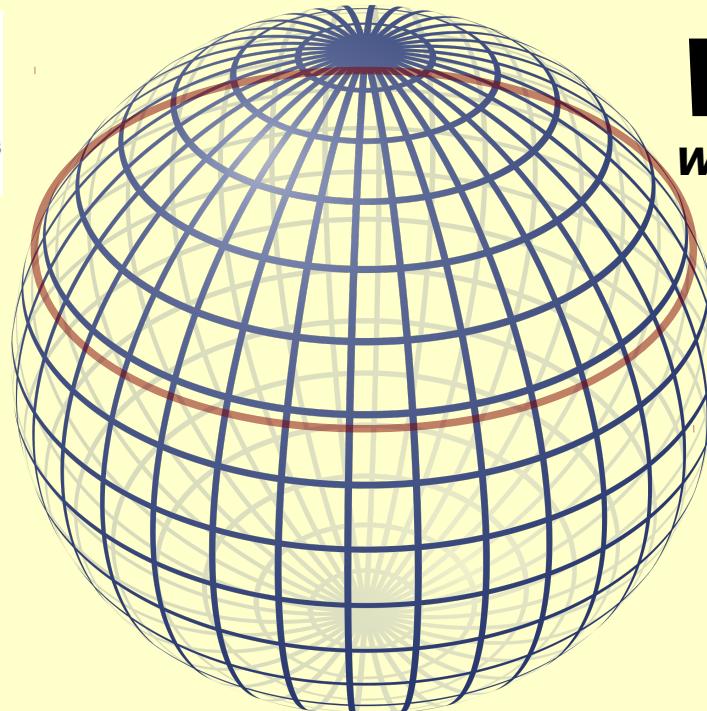
Summary

WNSHS

Westerbork Northern Sky HI Survey



- We propose to use the unique capabilities of **Apertif** for a **1- π survey of the Northern sky, WNSHS**



WNSHS

Westerbork Northern Sky HI Survey

- Preparation using (also) WSRT observations is ongoing
- WNSHS will be complemented by WALLABY (and SKA phase 1) to form an all-sky survey (W^2)
- WNSHS will be **the only Northern all-sky survey** even in the era of the SKA

Email: wnshs@astron.nl

www: www.astron.nl/~jozsa/wnshs/

The screenshot shows a Google search results page for the query "MaNGA". The search bar at the top contains "MaNGA". Below the search bar, there are tabs for "Web", "Images", "Books", "Videos", "News", "More", and "Search". A red horizontal bar highlights the "Web" tab. The search results section starts with a summary: "About 130,000,000 results (0.17 seconds)". The first result is a link to the Wikipedia page for Manga, titled "Manga - Wikipedia, the free encyclopedia". The link is en.wikipedia.org/wiki/Manga. The snippet below the link describes Manga as "comics created in Japan, or by Japanese creators in the Japanese conforming to a style developed in Japan in the late 19th century.". The second result is a link to "Read Manga Online for Free. Online Manga Reader" from www.mangareader.net/. The snippet for this result says "Read your favorite manga scans and scanlations online at Manga Reader. Re Online, Absolutely Free and Updated Daily." and "Popular Manga - Mangareader Manga List Page - The Breaker: New Waves 1".

A screenshot of a Google search results page. The search term 'Apertif' is entered in the search bar. The results are categorized by 'Web', 'Images', 'Shopping', 'Maps', 'Videos', 'More', and 'Search'. It shows approximately 1,890,000 results found in 0.16 seconds. The top result is a link to Wikipedia's article on Apéritifs and digestifs.

Apertif – Google Search

g Apertif – Google Search +

https://www.google.com/search?biw=586&bih=367&noj=1&sclient=psy-ab&q=Apertif&oq=Apertif&gs_lser

Google Deutschland

Apertif

Web Images Shopping Maps Videos More ▾ Search

About 1,890,000 results (0.16 seconds)

Showing results for **Aperitif**
Search instead for [Apertif](#)

Apéritif and digestif - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Aperitif_and_digestif ▾ Wikipedia ▾
Apéritifs and digestifs are alcoholic drinks that are normally served before (ap
after (digestif) a meal. Contents. 1 Apéritifs; 2 Digestifs; 3 History; 4 Types ...
[Apéritifs - Digestifs - History - Types](#)

The screenshot shows a Google search results page for the query "SDSS". The search bar at the top contains "SDSS". Below the search bar, there are tabs for "Web", "Images", "Videos", "Books", "News", "More", and "Search". A red horizontal bar highlights the "Web" tab. The search results section starts with a snippet showing "About 497,000 results (0.14 seconds)". The first result is a purple link to the "Sloan Digital Sky Survey" website, with the URL "www.sdss.org/" in green. The second result is a purple link to "SDSS SkyServer DR7", with the URL "skyserver.sdss.org/" in green. Both results include a brief description below them.

SDSS – Google Search

SDSS – Google Search

https://www.google.com/search?biw=586&bih=367&noj=1&sclient=psy-ab&q=SDSS&oq=SDSS&gs_l=serp.3.

g Google Deutschland

Google

SDSS

Web Images Videos Books News More ▾ Search

About 497,000 results (0.14 seconds)

Sloan Digital Sky Survey
www.sdss.org/ ▾

Aug 1, 2013 - The **Sloan Digital Sky Survey (SDSS)** is one of the most ambitious surveys in the history of astronomy. Over eight years of ...

[M51 - SDSS Data Release 7 - Image Gallery - SDSS Galaxy Map](#)

SDSS SkyServer DR7
skyserver.sdss.org/ ▾

This website presents data from the **Sloan Digital Sky Survey**, a project to map a large part of the universe. We would like to show you the beauty of ...

The screenshot shows a Google search results page for the query "WNSHS". The search bar at the top contains "WNSHS". Below the search bar, there are tabs for "Web", "Maps", "Shopping", "Images", "Videos", "More", and "Search". A red horizontal bar highlights the "Web" tab. The search results section starts with a summary: "About 7,690 results (0.41 seconds)". The first result is a link to "WNSHS - Astron" with the URL "www.astron.nl/~jozsa/wnshs/". The snippet for this result reads: "Jul 18, 2013 - This is the official web page of **wnshs**. Currently, it is designed to professional astronomers about **wnshs**, a proposed Neutral Hydrogen ...". Below this result, there are two more sections: "Survey Layout" with links to "Survey Layout. HOME Science" and "Survey layout Joining ...", and "Joining" with a link to "Join wnshs! An effort like this requires the active participation". At the bottom of the search results, there is a link "More results from astron.nl »".

The screenshot shows a Google search results page for the query "WNSHS". The search bar at the top contains "WNSHS". Below the search bar, there are four navigation links: "Web" (highlighted in red), "Maps", "Shopping", and "Images". The search results section starts with a message: "About 7,690 results (0.41 seconds)". The first result is a link to "WNSHS - Astron" with the URL "www.astron.nl/~jozsa/wnshs/". The snippet for this result includes the text: "Jul 18, 2013 - This is the official web page of wnshs. Currently, it is designed to professional astronomers about wnshs, a proposed Neutral Hydrogen ...". To the right of this snippet, there is a blue cloud icon. Below the snippet, there are two sections: "Survey Layout" with links to "Survey Layout. HOME Science" and "Survey layout Joining ...", and "Joining" with the text "Join wnshs! An effort like this requires the active participation". At the bottom of the search results, there is a link "More results from astron.nl »". The entire screenshot is framed by a yellow border.

WNSHS – Google Search

g WNSHS – Google Search +

https://www.google.com/search?biw=586&bih=367&noj=1&sclient=psy-ab&q=WNSHS&oq=WNSHS&gs_l=sei

Google Deutschland

Google

WNSHS

Web Maps Shopping Images

About 7,690 results (0.41 seconds)

WNSHS - Astron
www.astron.nl/~jozsa/wnshs/ ▾ ESTRON ▾
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Survey Layout
Survey Layout. HOME Science
Survey layout Joining ...

Joining
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More results from astron.nl »

The screenshot shows a Google search results page for the query "WNSHS". The top result is a link to a website featuring three mechanical winches and two blue clouds containing the letters "str" and "OZS". The text below the link reads: "Jul 2013 - This is the official web page of wnshs. Currently, it is designed to professional astronomers about wnshs, a proposed Neutral Hydrogen ...". Below this, there are two sections: "Survey Layout" with links to "Survey Layout. HOME Science" and "Survey layout Joining ...", and "Joining" with a link to "Join wnshs! An effort like this requires the active participation".

WNSHS – Google Search

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