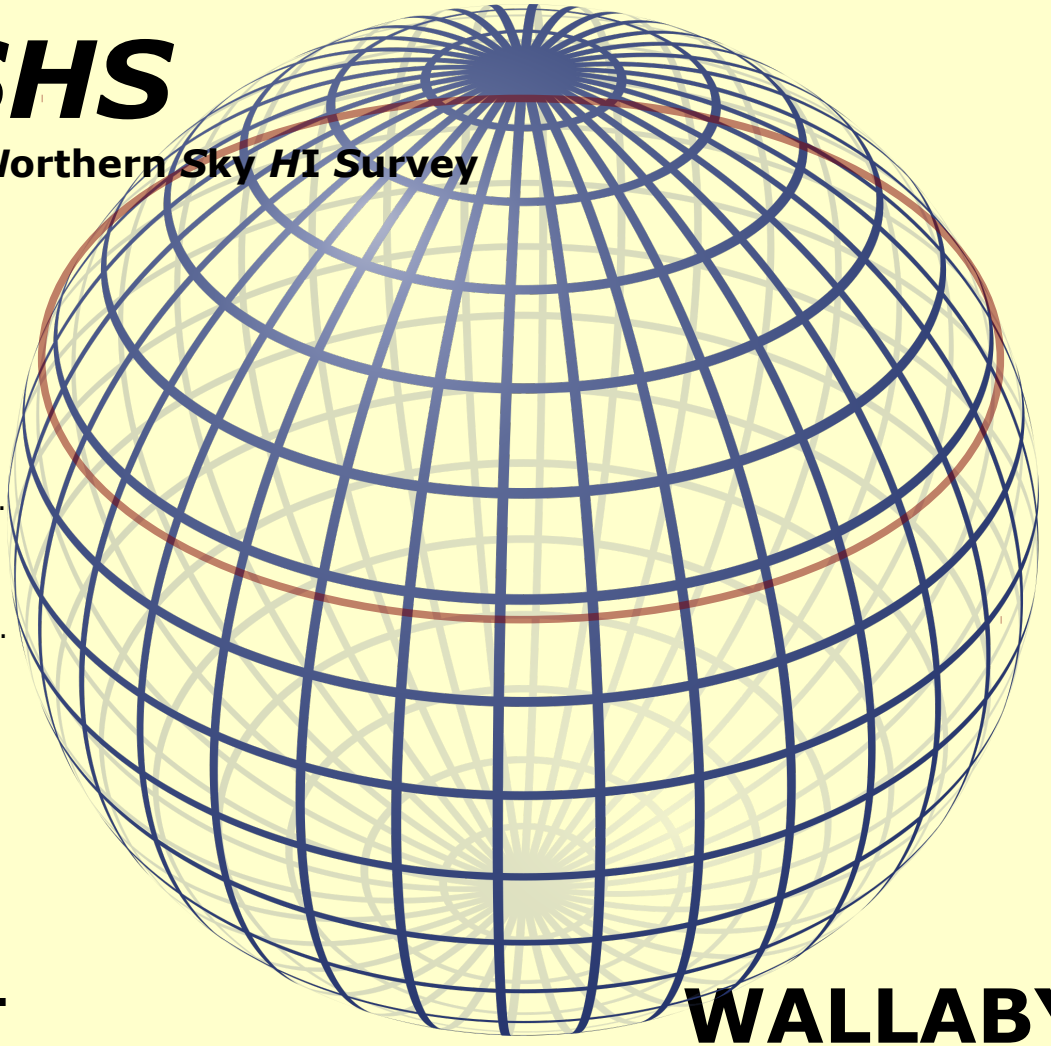
WNSHS ... and WSRT

***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

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), Floeer, 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

***W**esterbork **N**orthern **S**ky **HI** **S**urvey*



WALLABY

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

Gyula I. G. Józsa (ASTRON)

Apertif @ WSRT

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

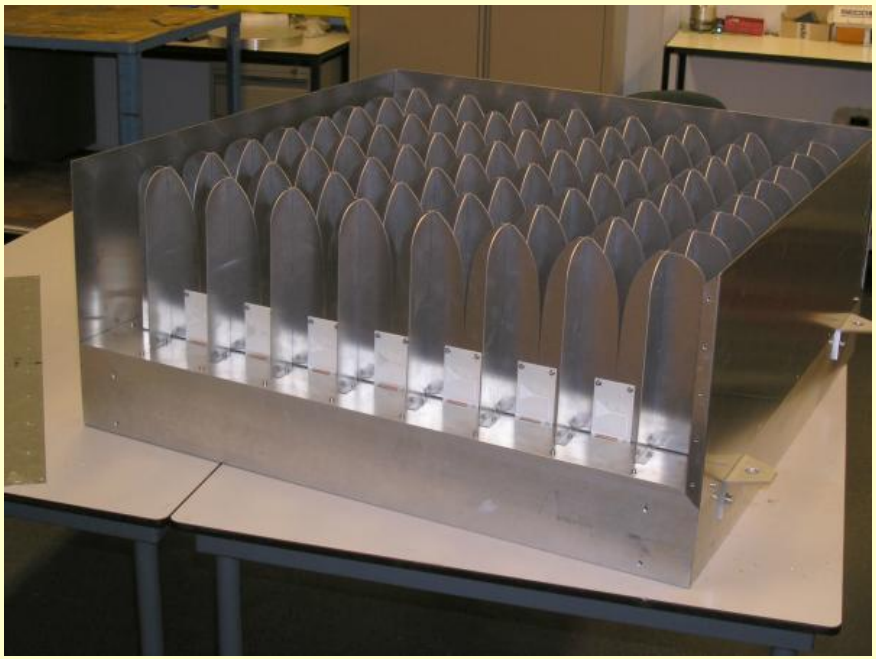
ASTRON

APERTIF
APERture Tile In Focus

Tom Oosterloo

Marc Verheijen

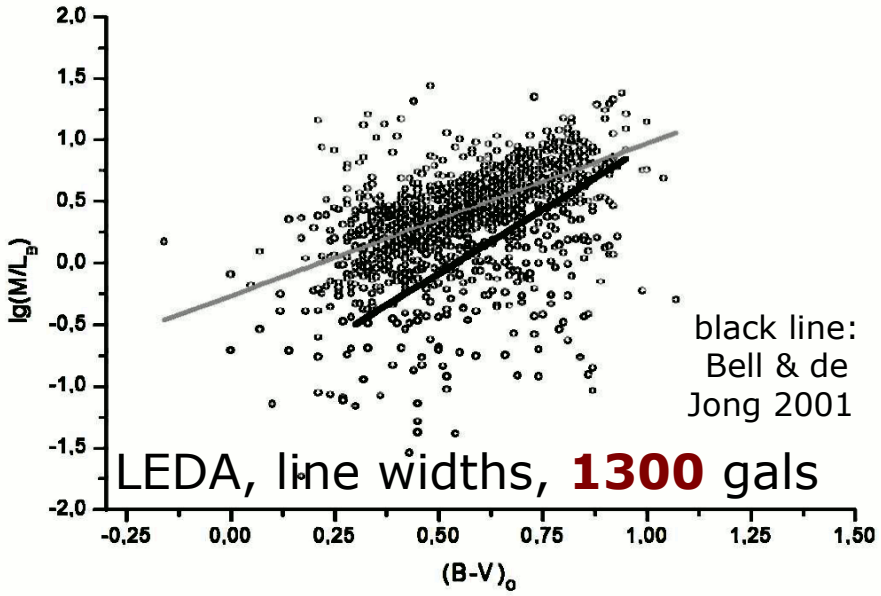
- "**Aper**ture **ti**le in **f**ocus": new receiver system at the Westerbork Synthesis Radio Telescope
- 37 compound beams (instead of one)
- FOV increased by factor 25 (8 □°)
- Line sensitivity decreased by factor 2
- 1130 MHz - 1750 MHz (HI: z < 0.26)
- Resolution: HPBW: 15'' x 15''/sin δ
  FWHM: 36.6 kHz

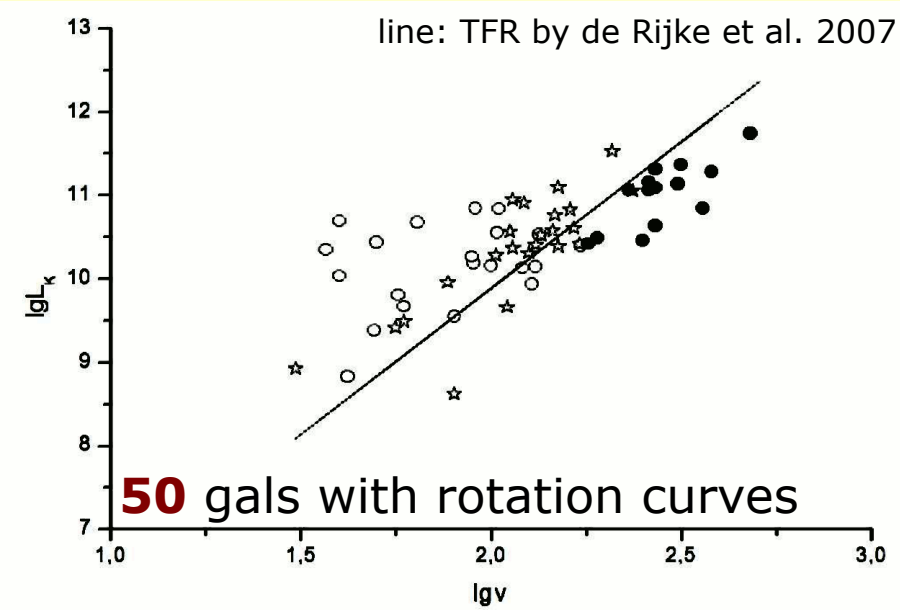


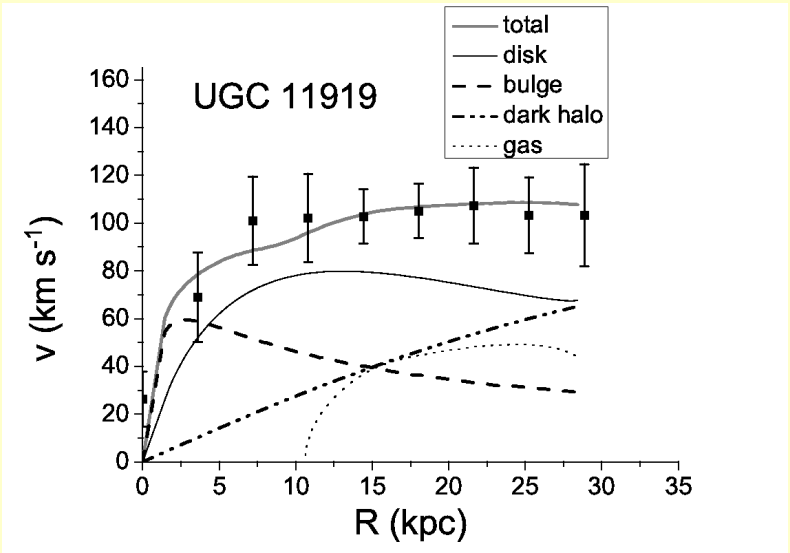
Example

WNSHS
Westerbork Northern Sky HI Survey

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

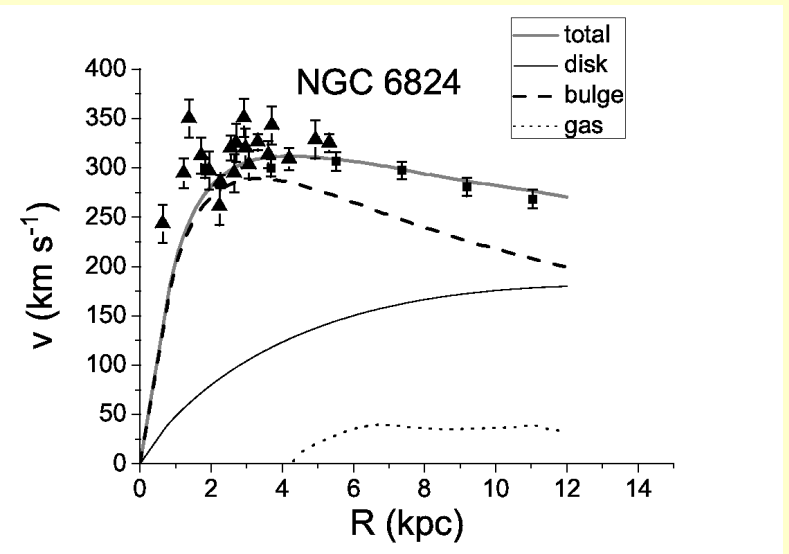






2 galaxies reobserved with WSRT and APO

1 galaxy confirmed lightweight for colour

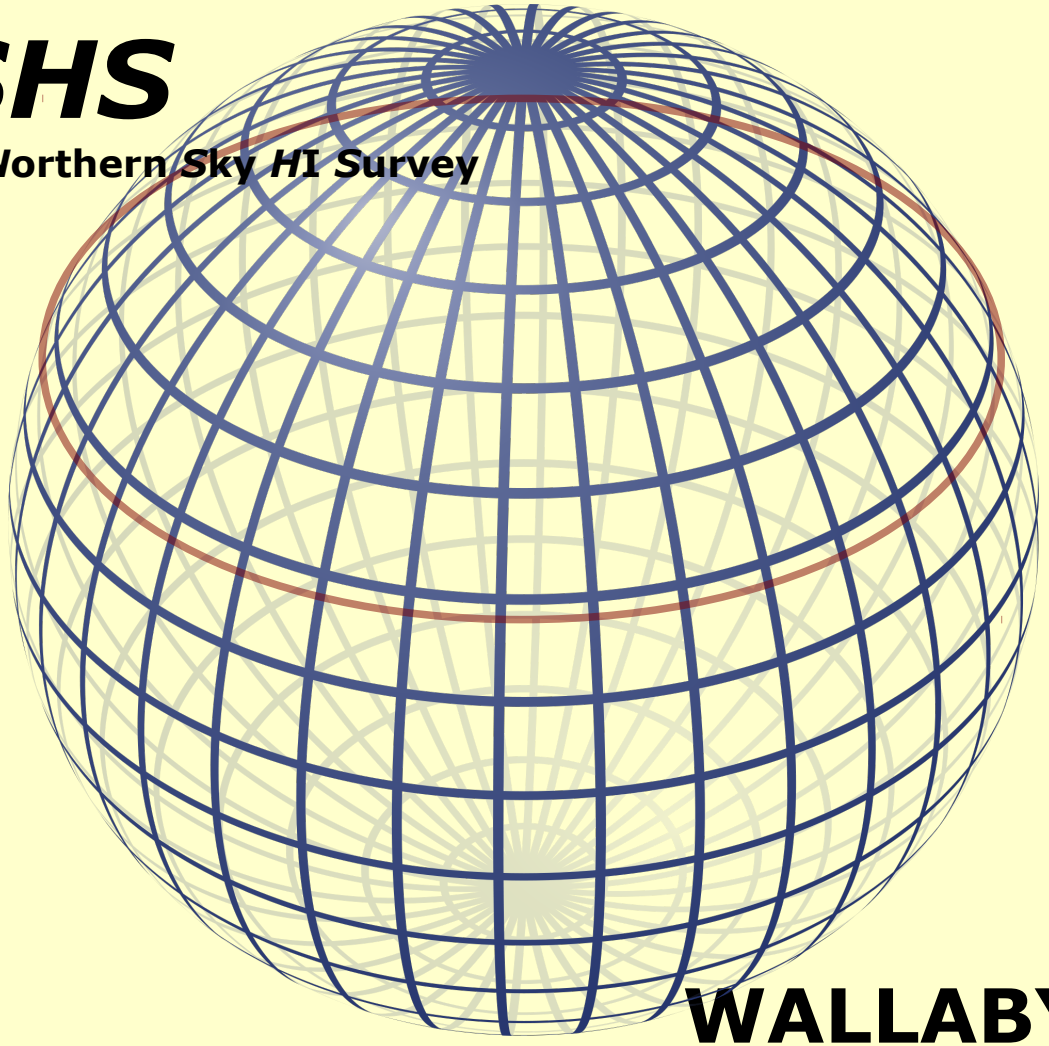


An expression of interest

WNSHS
***W**esterbork **N**orthern **S**ky **HI S**urvey*

The **W**esterbork **N**orthern **S**ky **H**I **S**urvey is a proposed shallow Northern sky (mostly) extragalactic HI survey with the WSRT and Apertif.

WNSHS
***W**esterbork **N**orthern **S**ky **HI S**urvey*



1 π

WALLABY

An expression of interest:

WNSHS

***W**esterbork **N**orthern **S**ky **HI S**urvey*

The **W**esterbork **N**orthern **S**ky **H**I **S**urvey 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 -> W^2)

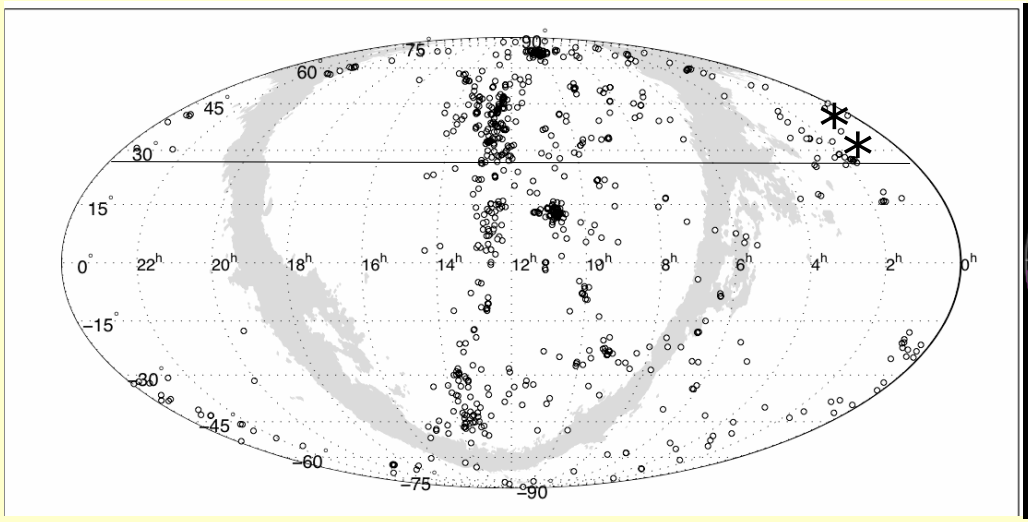
Science:

- **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

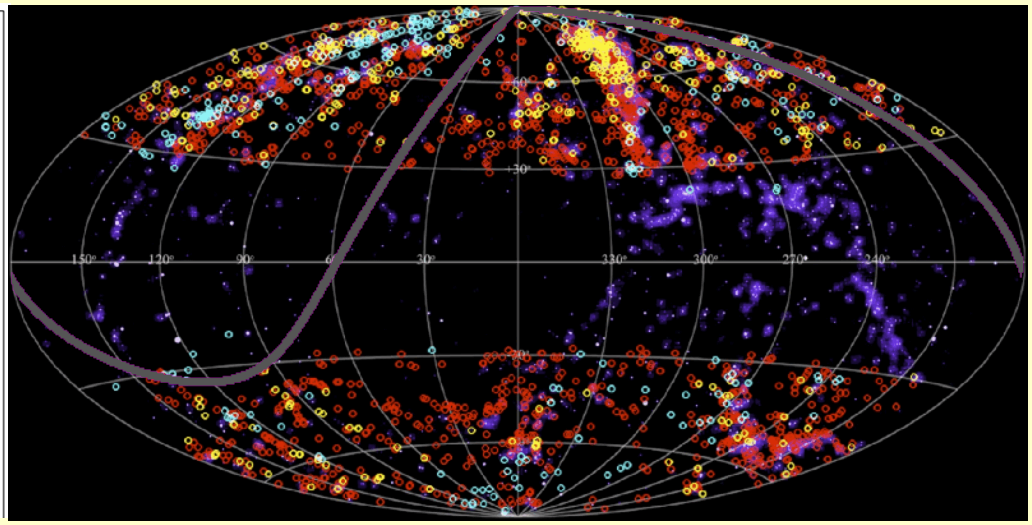
WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

D < 10 Mpc, equatorial



Karachentsev et al.

D < 40 Mpc, Galactic, S^{4}G

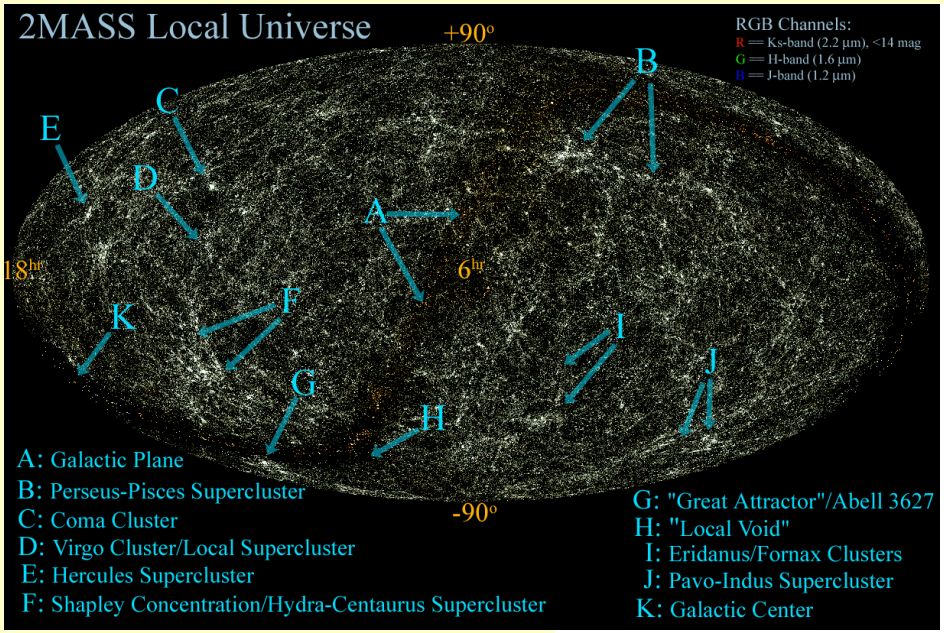


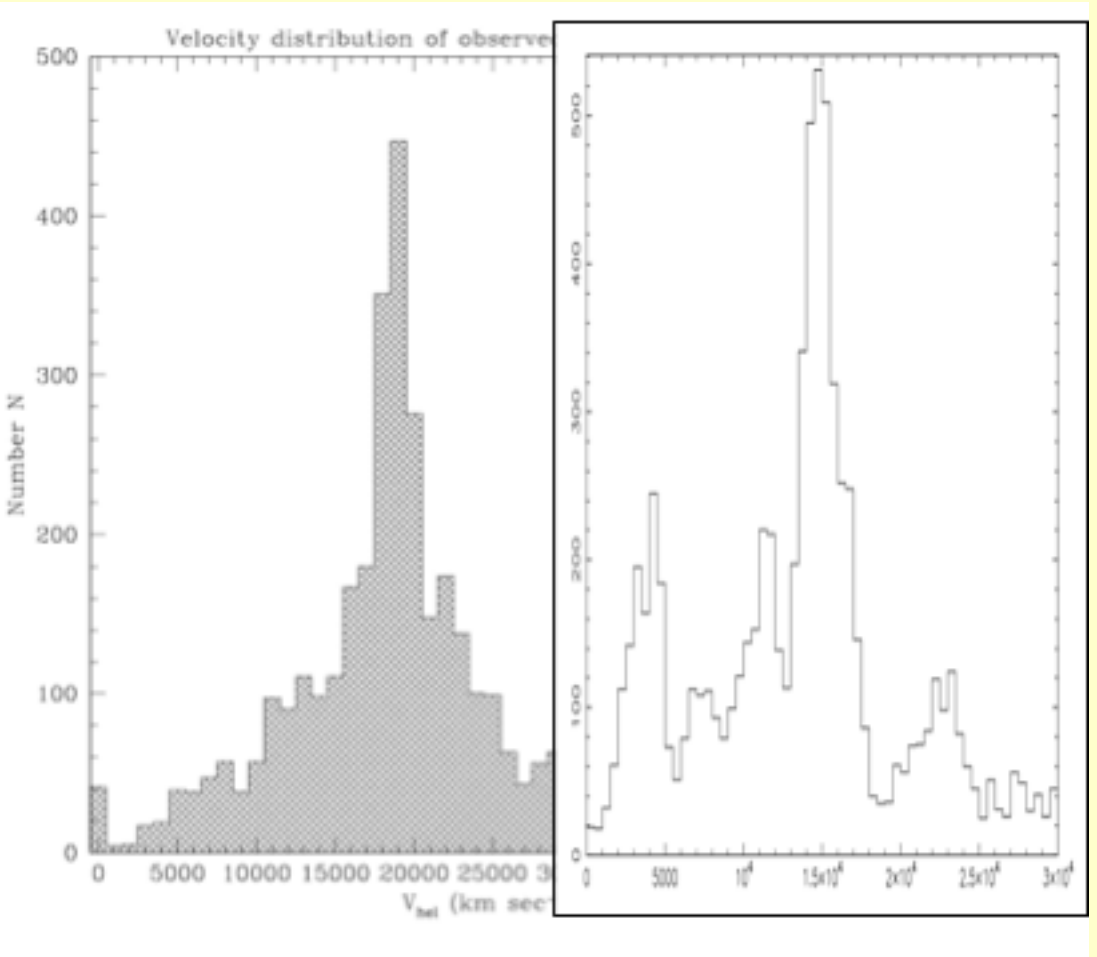
Sheth et al. 2010

- δ > 27° <-> WALLABY/ASKAP (SKA phase 1): δ < 30°
- 1130 MHz - 1430 MHz -> -2000 km s^{-1} - 77,000 km s^{-1}

Sky- and frequency coverage

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*



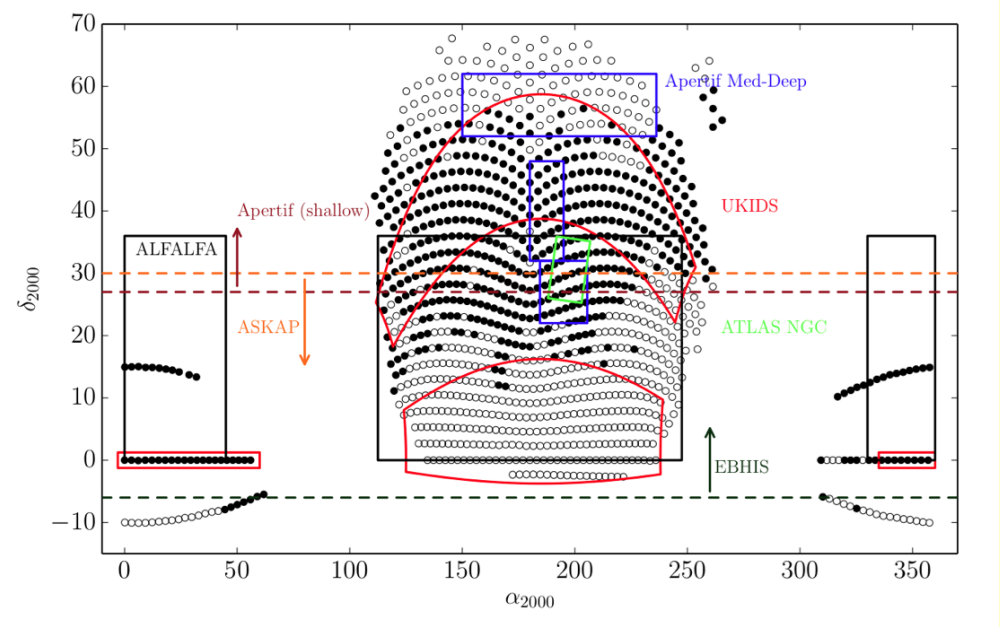


Kraan-Korteweg et al., prel.

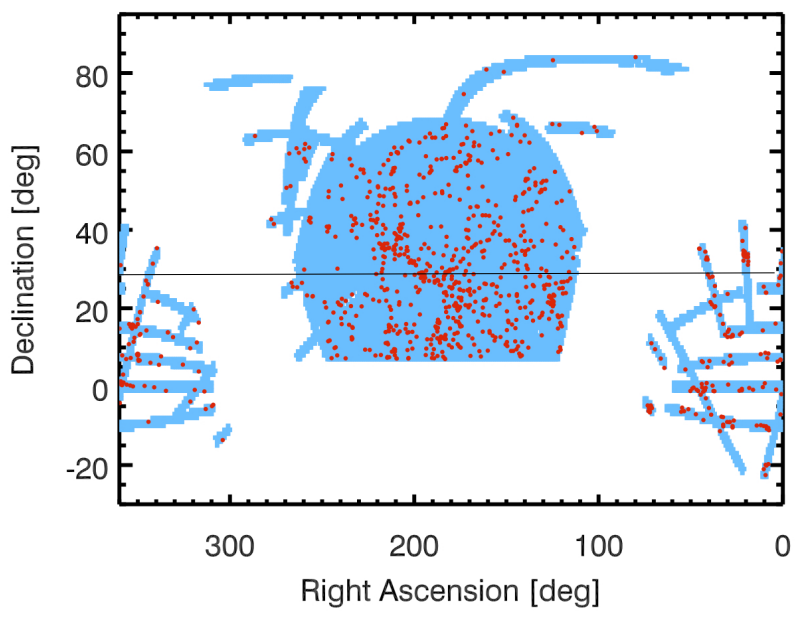
Sky- and frequency coverage

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

MaNGA



CALIFA



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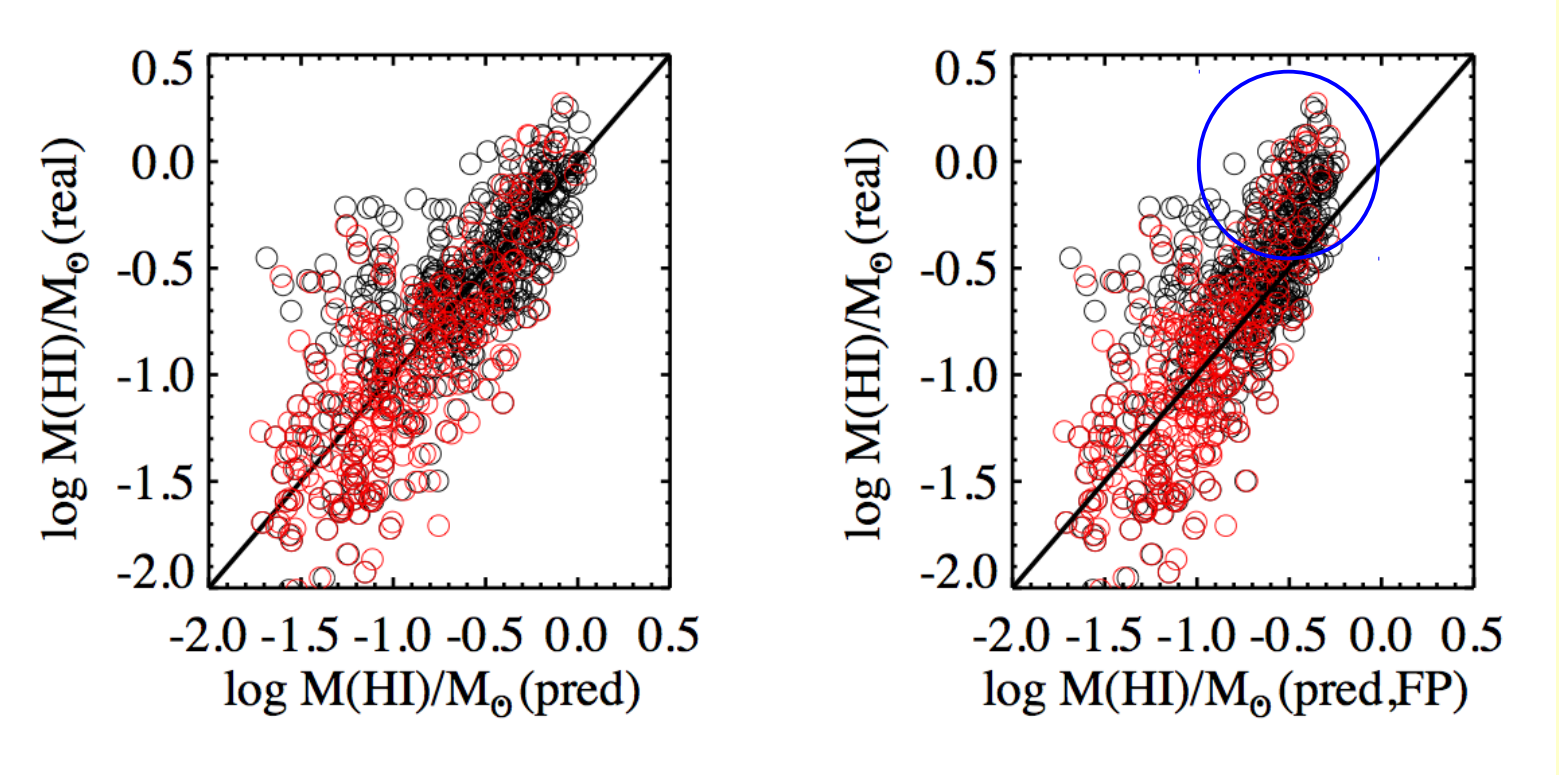
- 1130 MHz - 1430 MHz -> -2000 km s^{-1} - 77,000 km s^{-1}

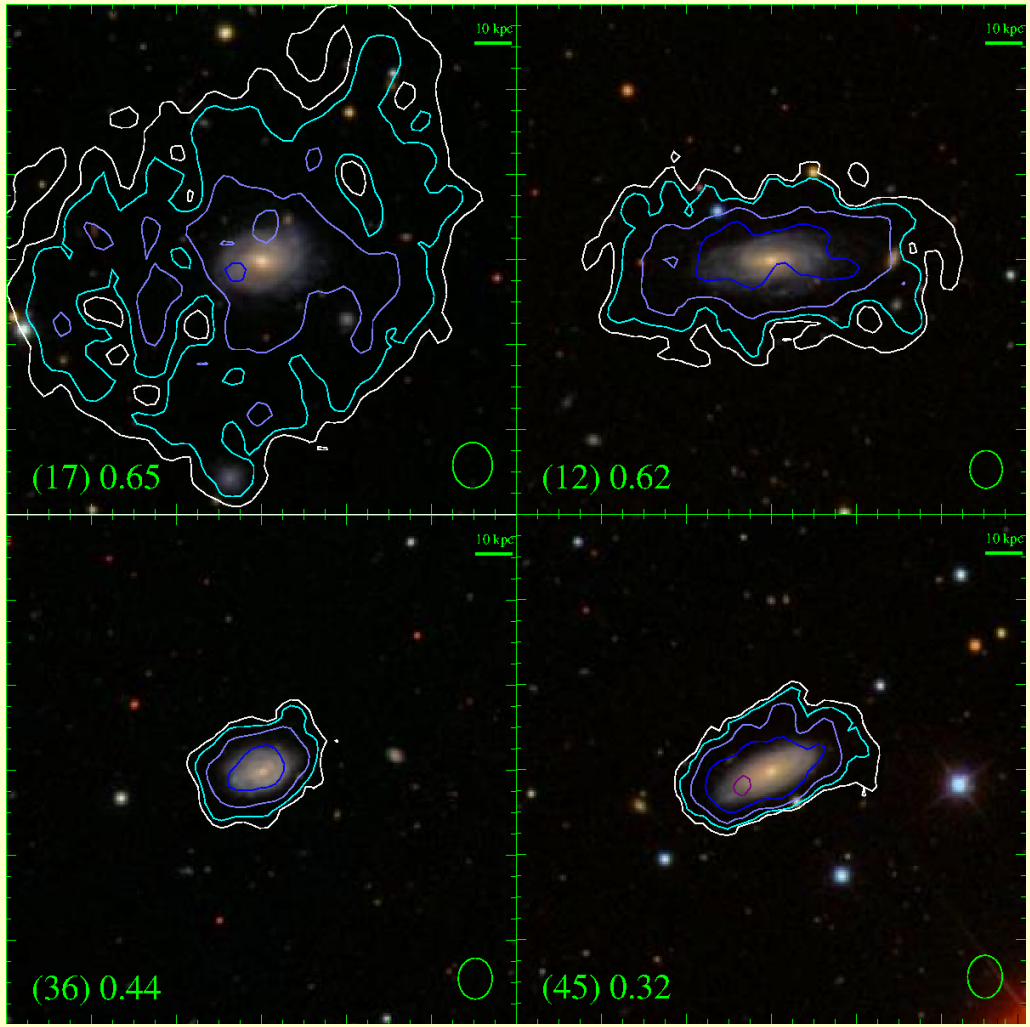
Example



- How is HI distributed in very gas-rich galaxies?
- Select (very) gas-rich galaxies from SDSS
- $10 < \log M_{stars}/M_{\odot} < 11$, GALEX detection, $0.01 < z < 0.03$ (size), $\delta > 30°$

-> **25/123** targets (plus 25 normal galaxies) -> Bluedisk

Example



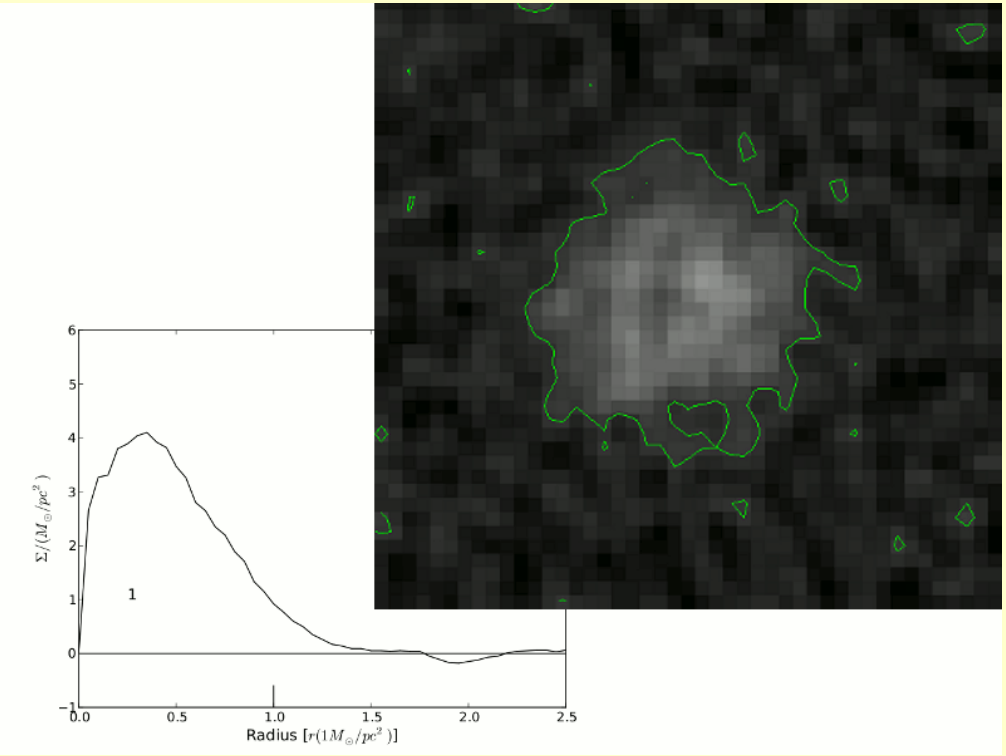
Bluedisk
PI: G. Kauffmann
Wang et al. 2013
Wang et al.
den Heijer et al.

- Sample: 25 H I-rich galaxies, 25 control galaxies

- H I mass-size relation (Broeils & Rhee 1997, Martinsson 2011) still valid

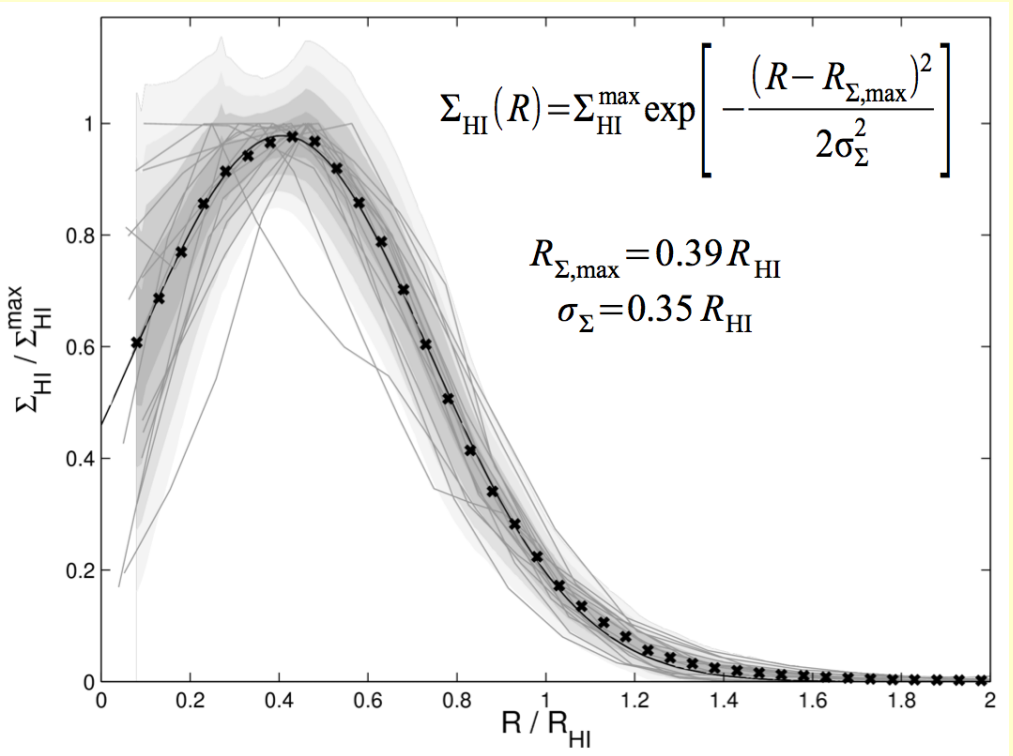
- regular morphology and kinematics -> accretion from a warm/hot IGM rather than major mergers?

Example: self-similar disks



Johansson et al.
(summer student 2012 @ ASTRON)

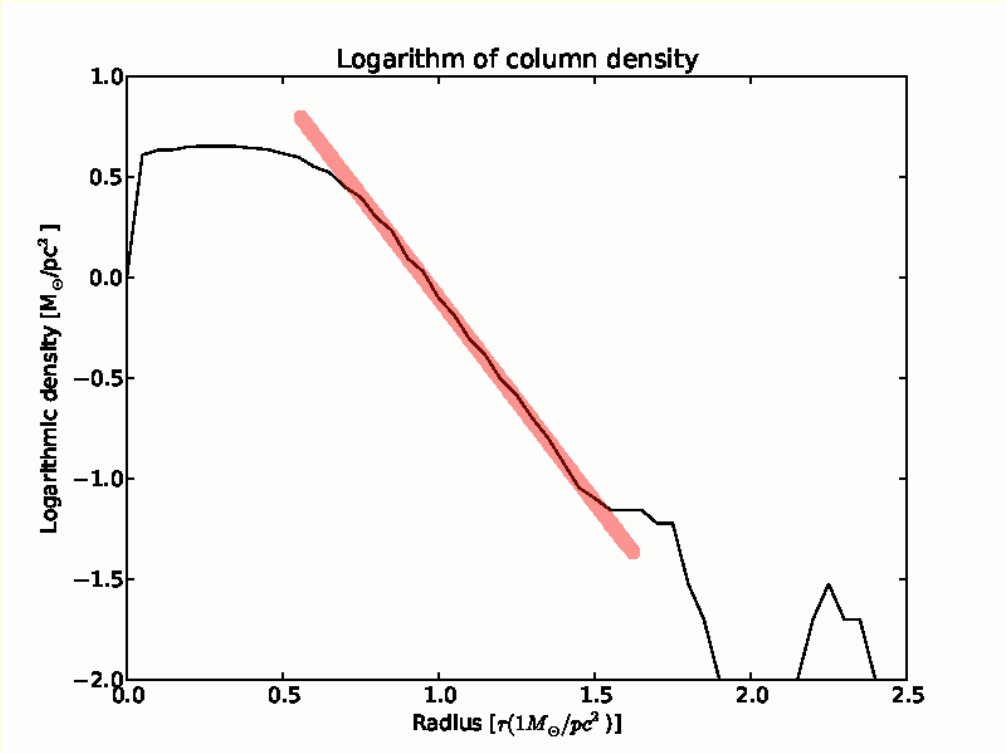
- Valid over which mass range?
- Type? (not ETGs, Serra et al. 2012)
- Environment?



Martinsson et al. 2011

Example: self-similar disks

WNSHS
Westerbork Northern Sky HI Survey



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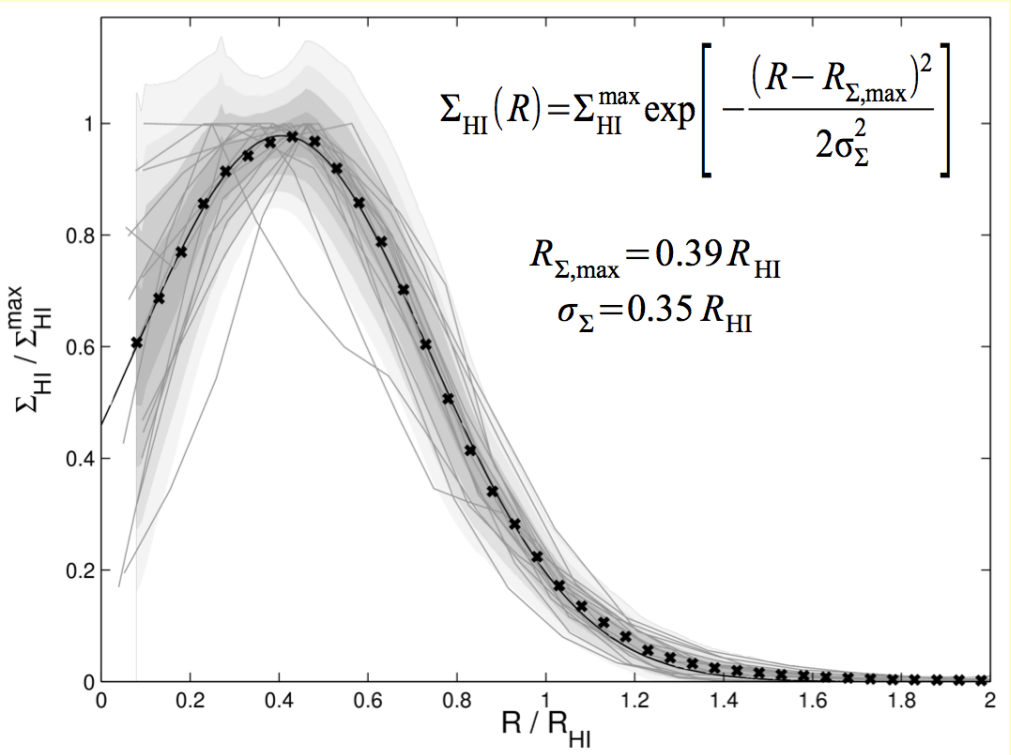
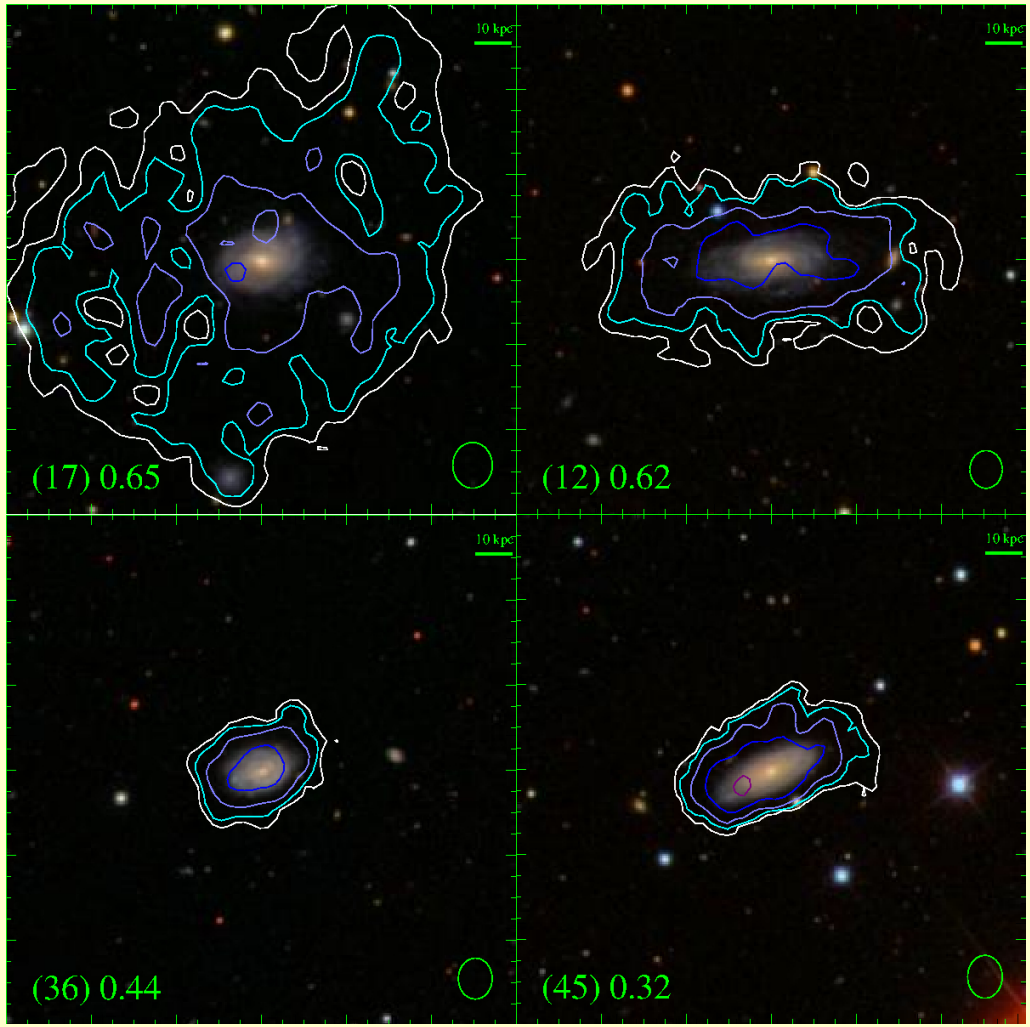


Martinsson et al. 2011

Example



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PI: G. Kauffmann
Wang et al. 2013
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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?

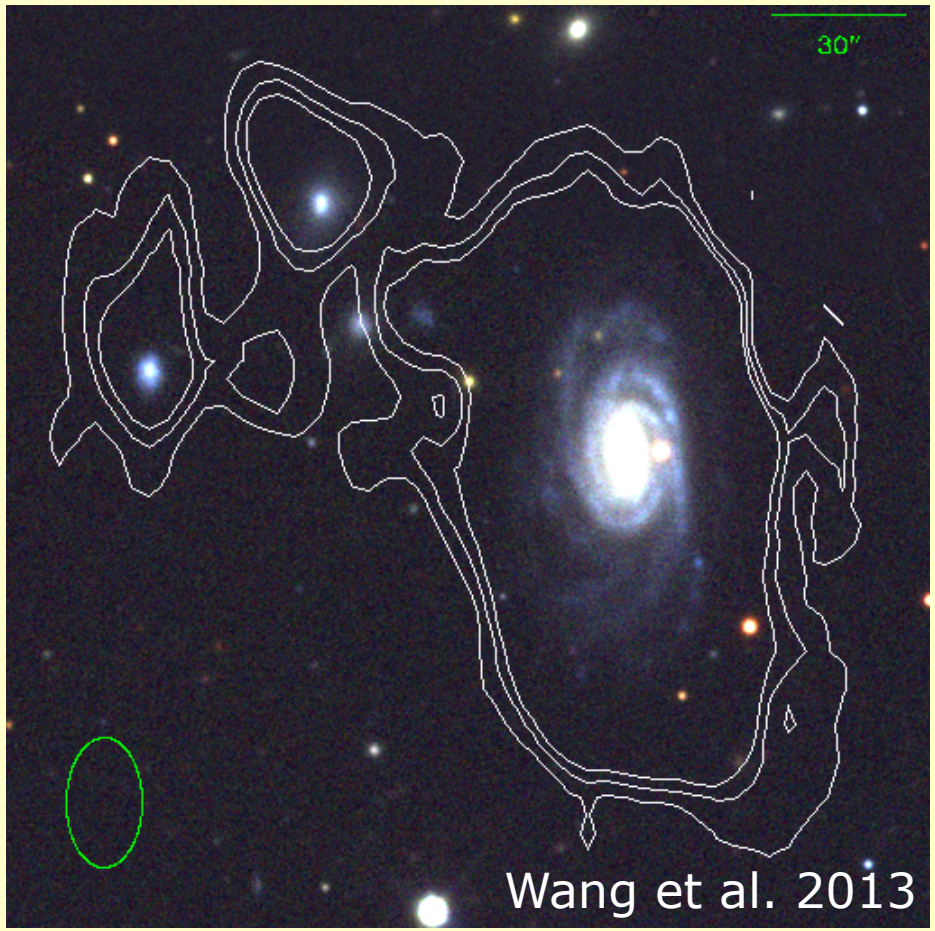
- **For δ > 27° "all-sky" 370 targets**

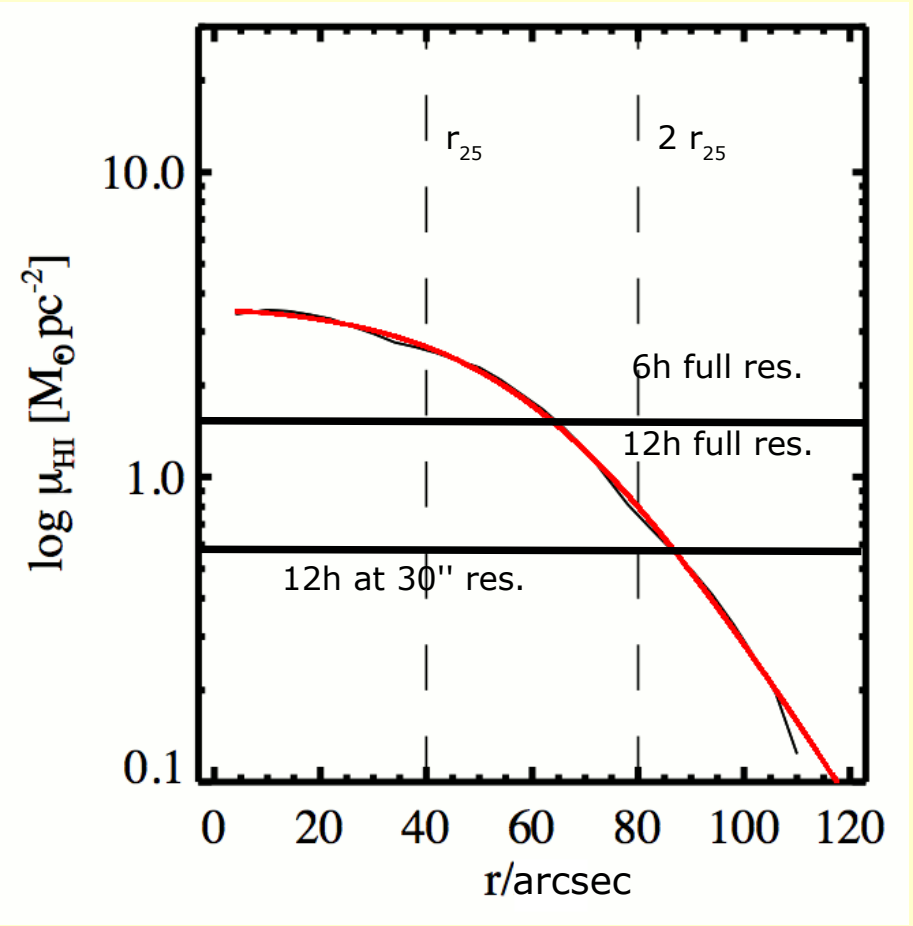
-> considerable increase in statistics only with all-northern-sky survey

Surface-brightness sensitivity

WNSHS
Westerbork Northern Sky HI Survey

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





0.7, 1.4, 2·10^{20} atoms cm^{-2}

Surface-brightness sensitivity

WNSHS
Westerbork Northern Sky HI Survey

- 12 h integrations per pointing
  -> 5-σ_{rms} sensitivity limit (Δv = 24 km/s):
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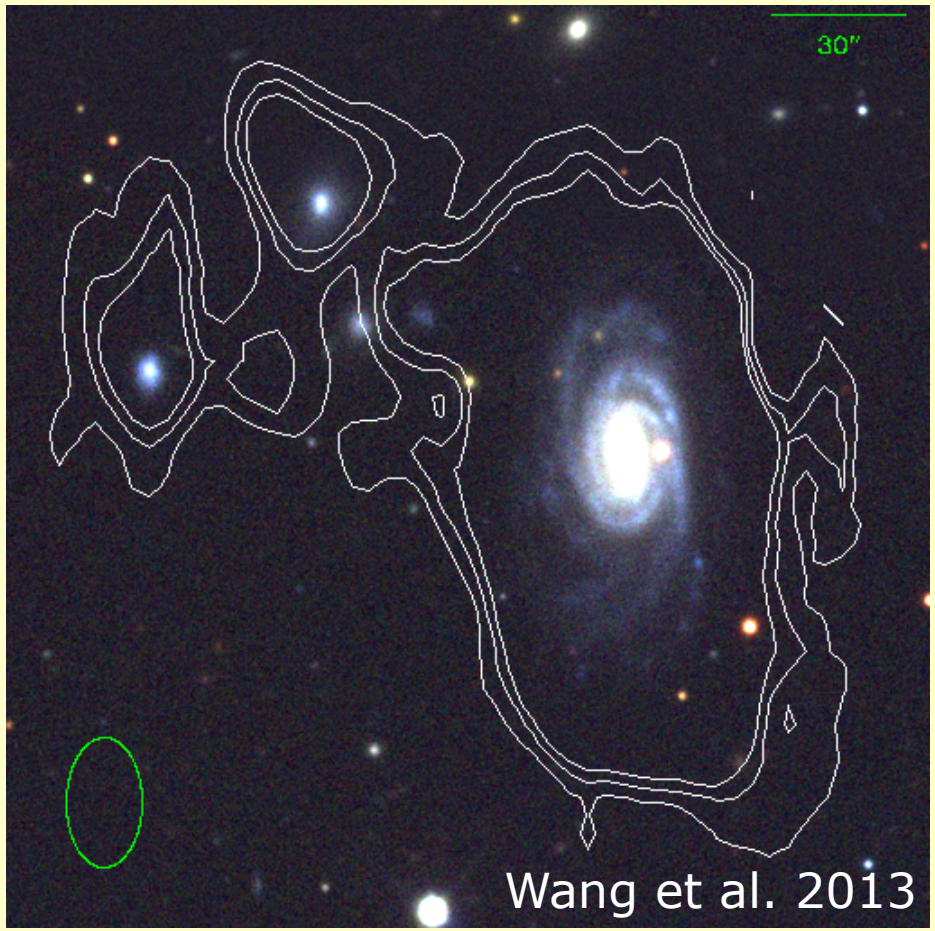
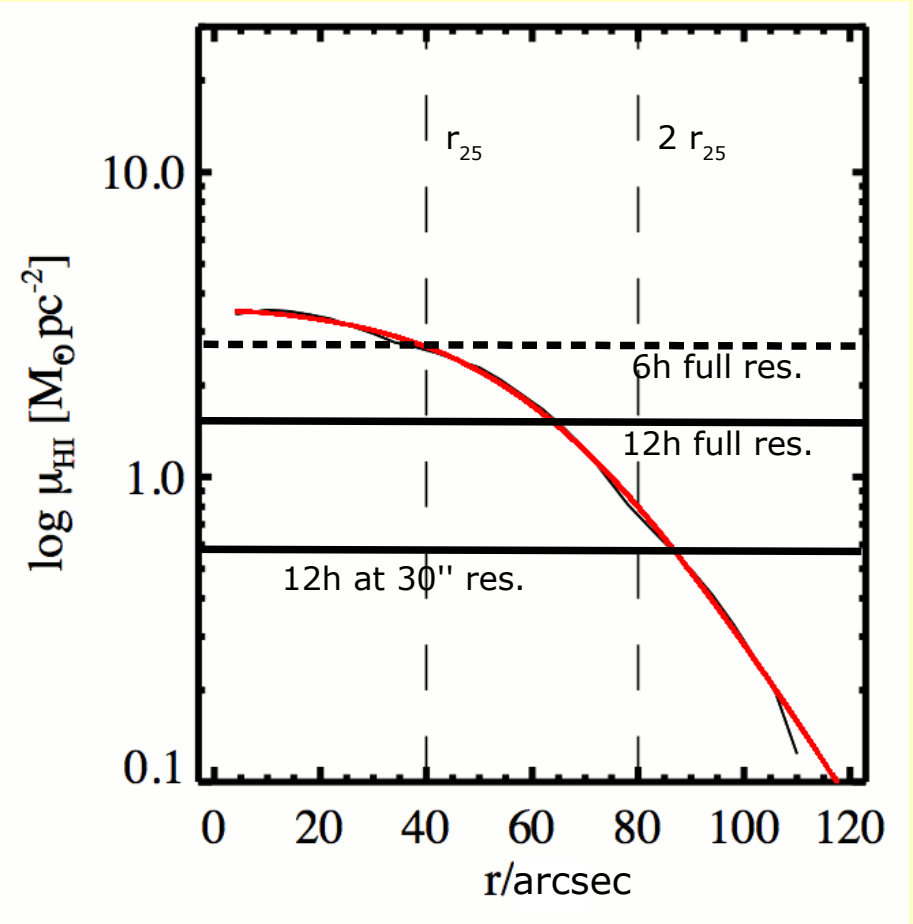
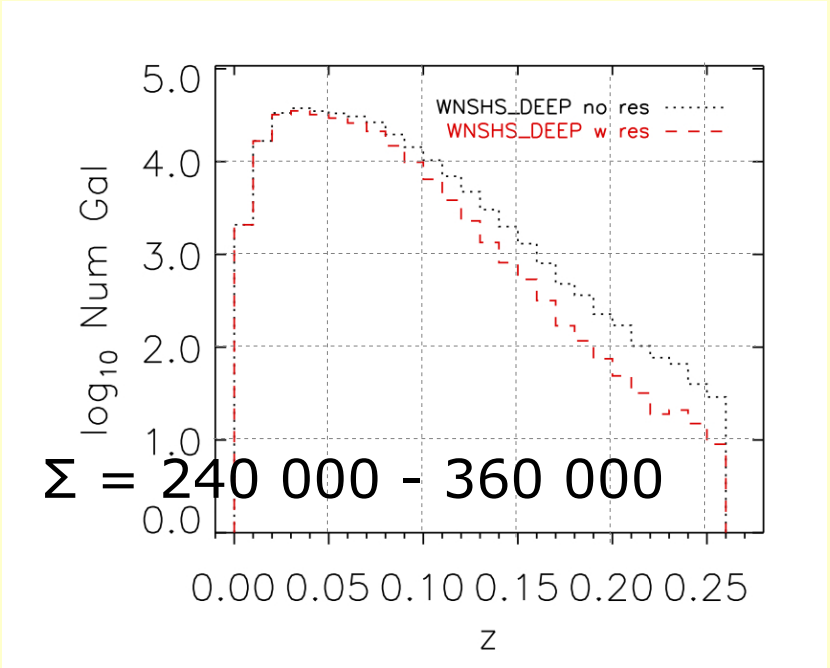




0.7, 1.4, 2·10^{20} atoms cm^{-2}

Galaxy counts

WNSHS
Westerbork Northern Sky HI Survey

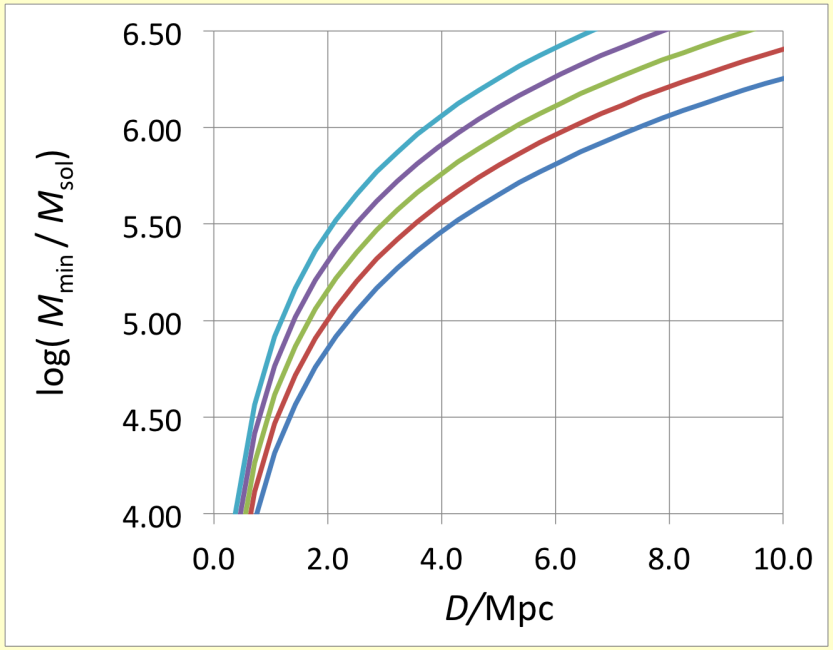


Σ = 240 000 - 360 000

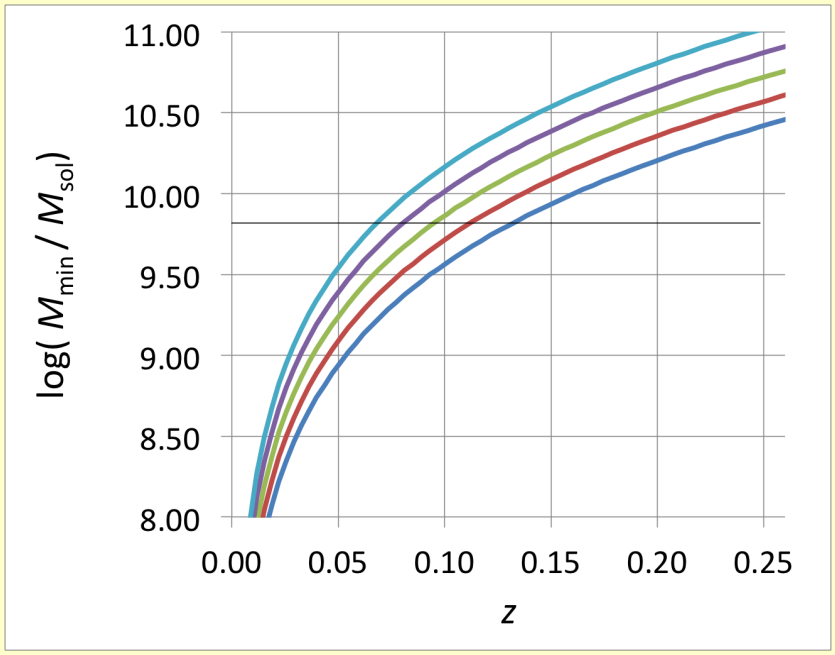
Duffy et al. 2012,

numbers adapted

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



Δ*v* = 25 km/s
Δ*v* = 50 km/s
Δ*v* = 100 km/s
Δ*v* = 200 km/s
Δ*v* = 400 km/s
S/N = 6



Specs

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

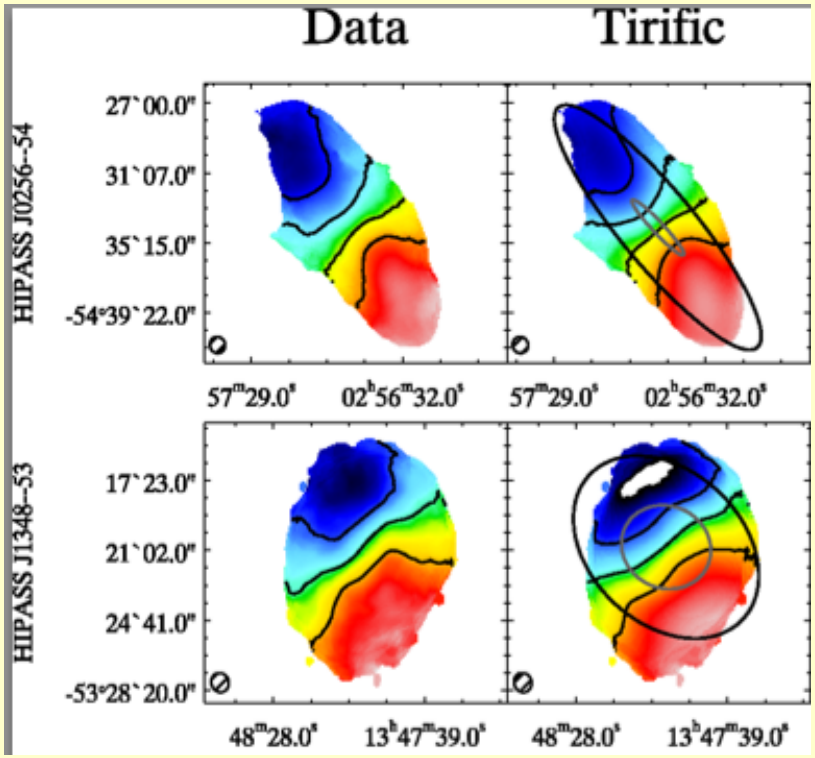
angular resolution (at z = 0)	**15” ... 30”**
sky coverage	**27° ≥ δ ≥ 90° (11262 sq. deg.)**
number of pointings	1410
number of channels	16384
frequency resolution	18.3 kHz channel^{-1}
velocity resolution	3.9 km s^{-1} - 4.6 km s^{-1}
time resolution	30 s
correlations	Full Stokes
redshift range	0 - 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**

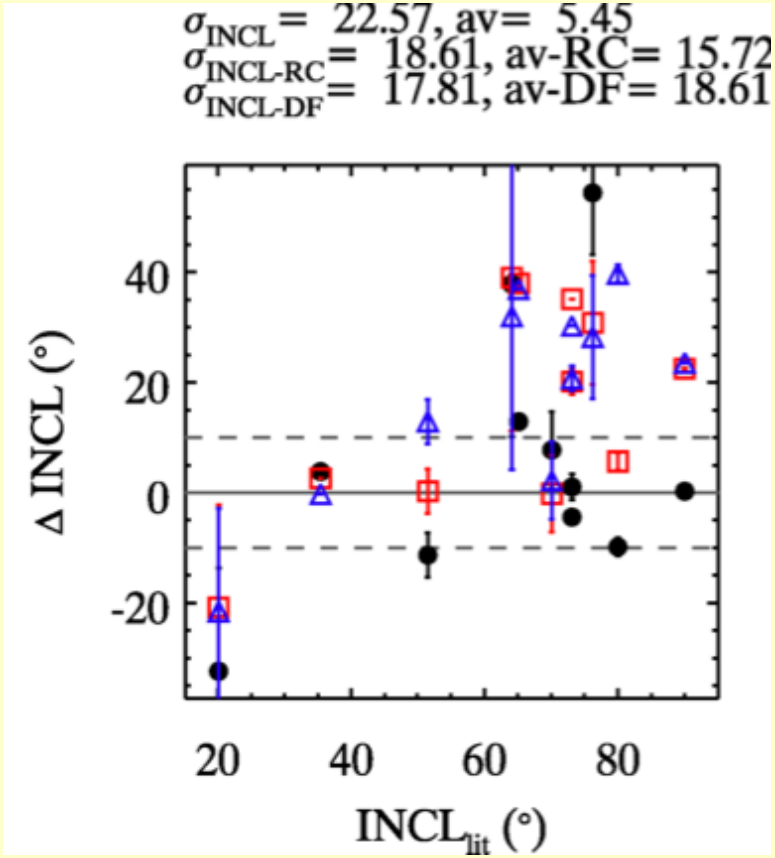
(WALLABY : 0.7 mJy over 0.1 MHz @ 30'' resolution)

Preparing

• 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)





TiRiFiC

Preparing

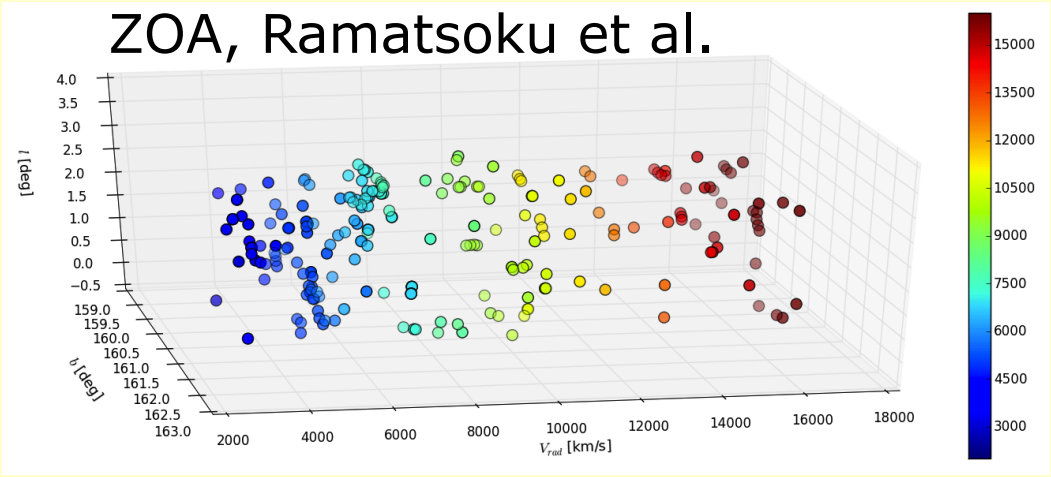
• WSRT projects initiated or conducted to ensure Apertif scientific and technical preparation (pipelining, source finding, source characterisation), e.g.:

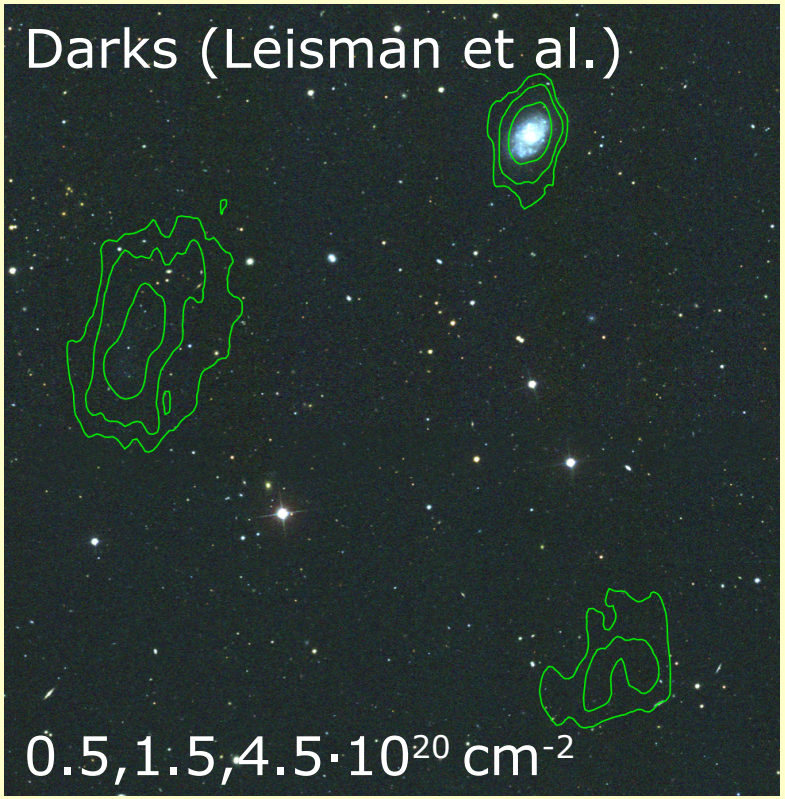
- **ZOA** (Kraan-Korteweg et al., see Ramatsoku et al., galaxy cluster in PP supercluster filament)

- **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)

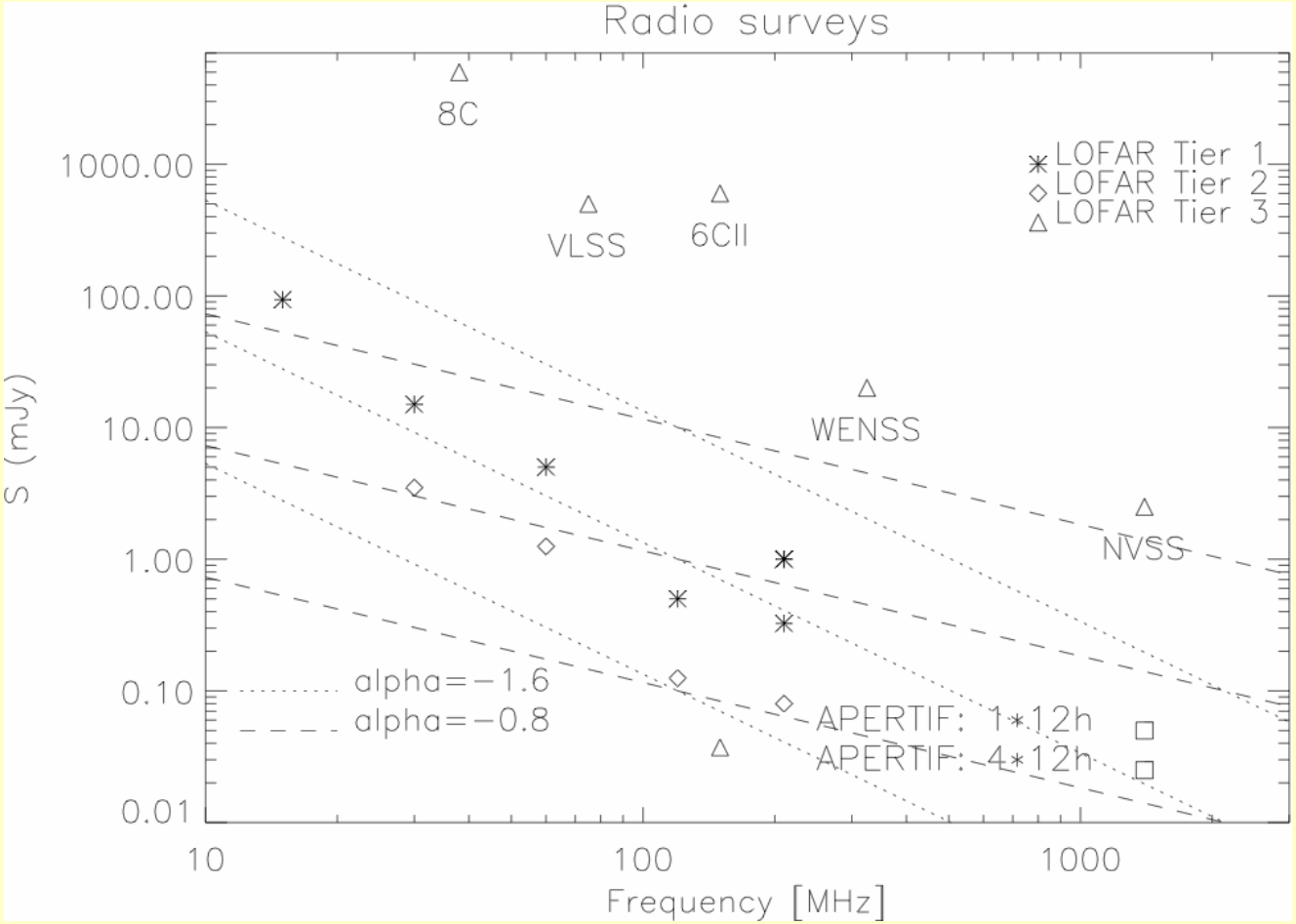




Commensal Apertif surveys

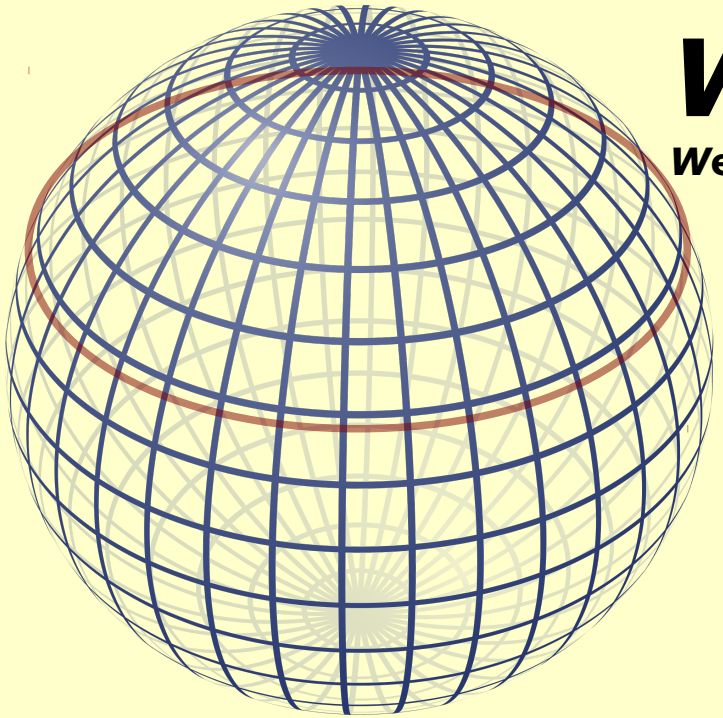
WNSHS
***W**esterbork **N**orthern **S**ky **HI S**urvey*

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



Summary

APERTIF
APERture Tile In Focus



WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*

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

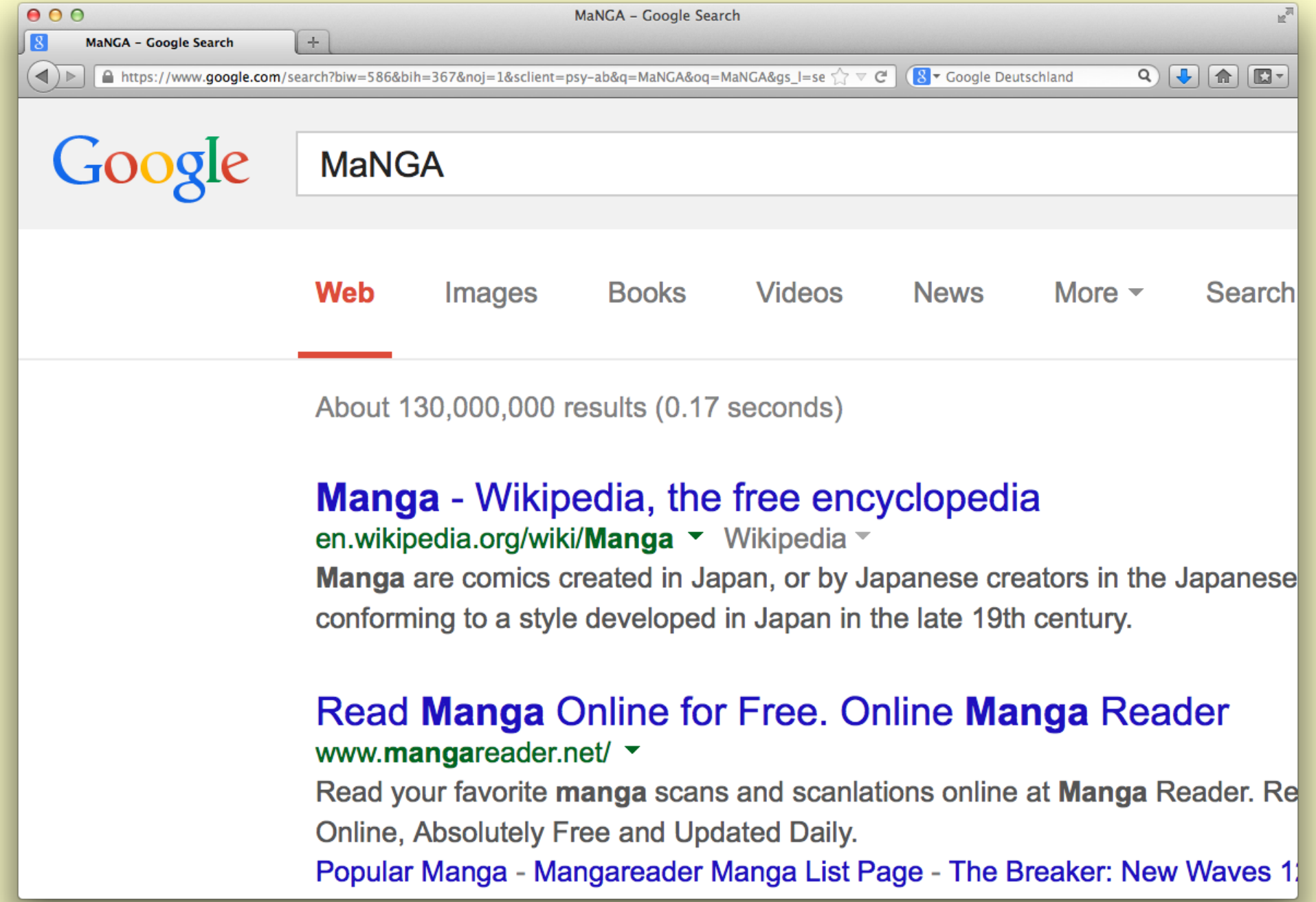
- Preparation using (also) WSRT observations is ongoing

- 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/

Naming


MaNGA – Google Search
MaNGA – Google Search
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conforming to a style developed in Japan in the late 19th century.
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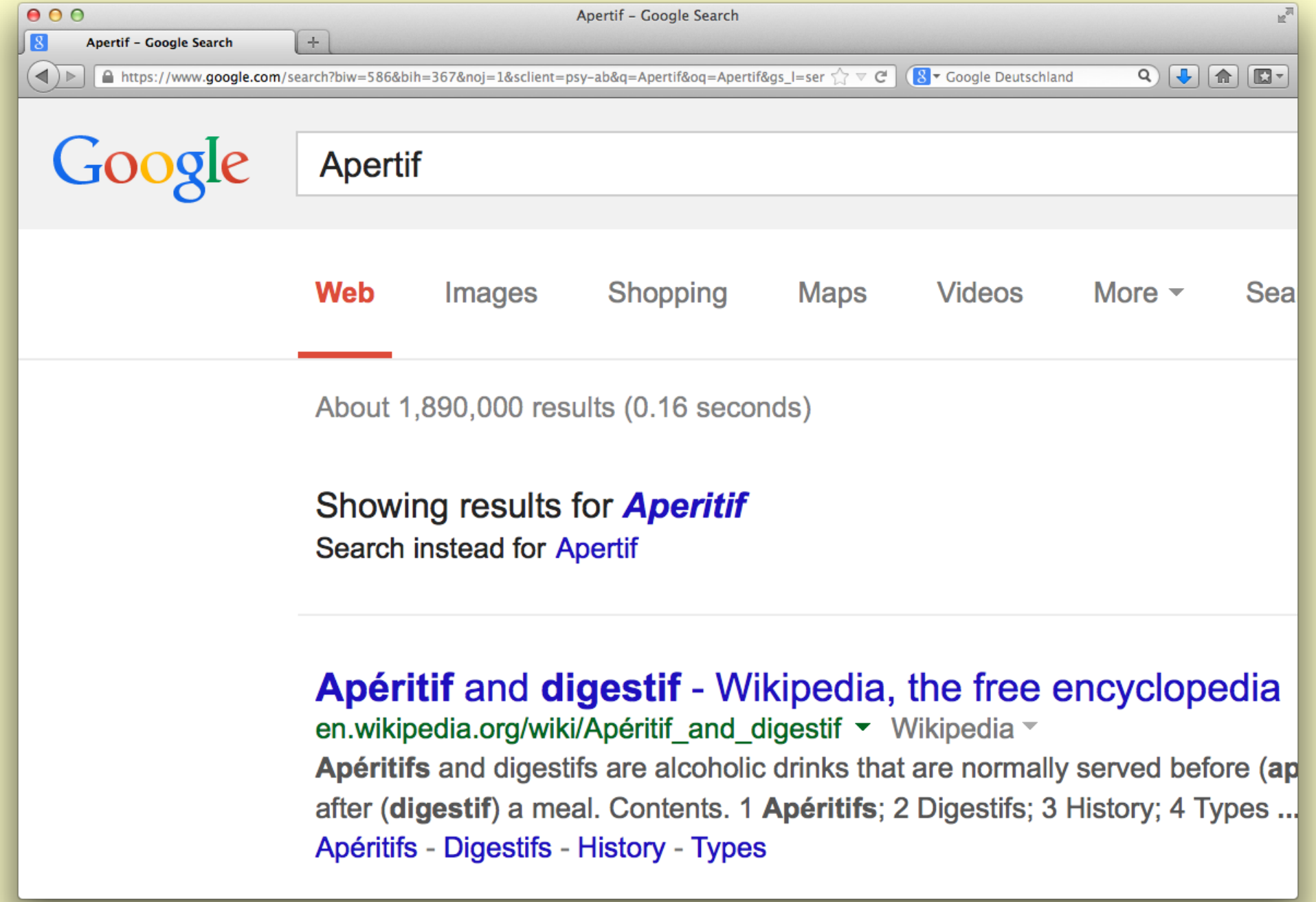
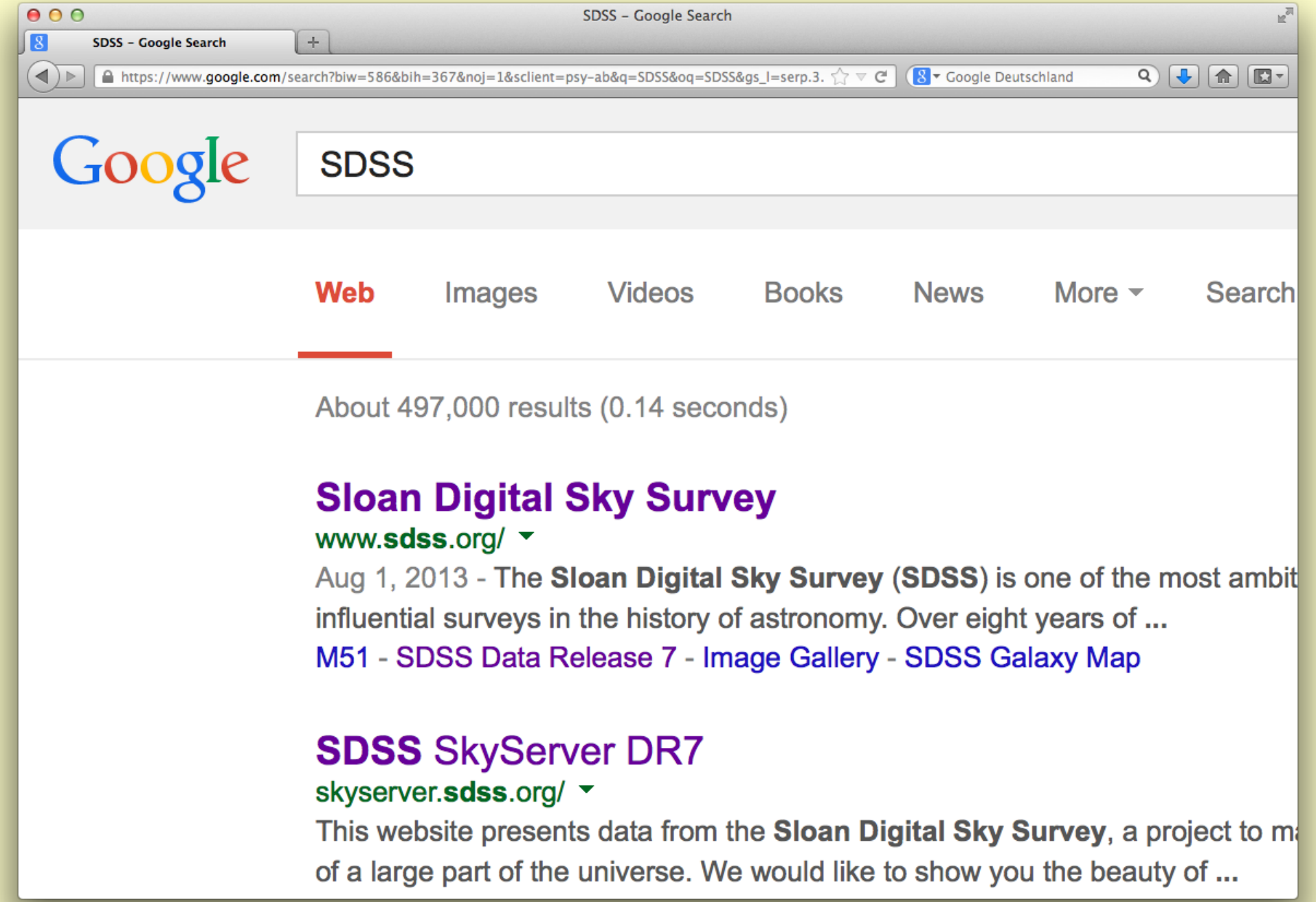
Popular Manga - Mangareader Manga List Page - The Breaker: New Waves 1

Naming

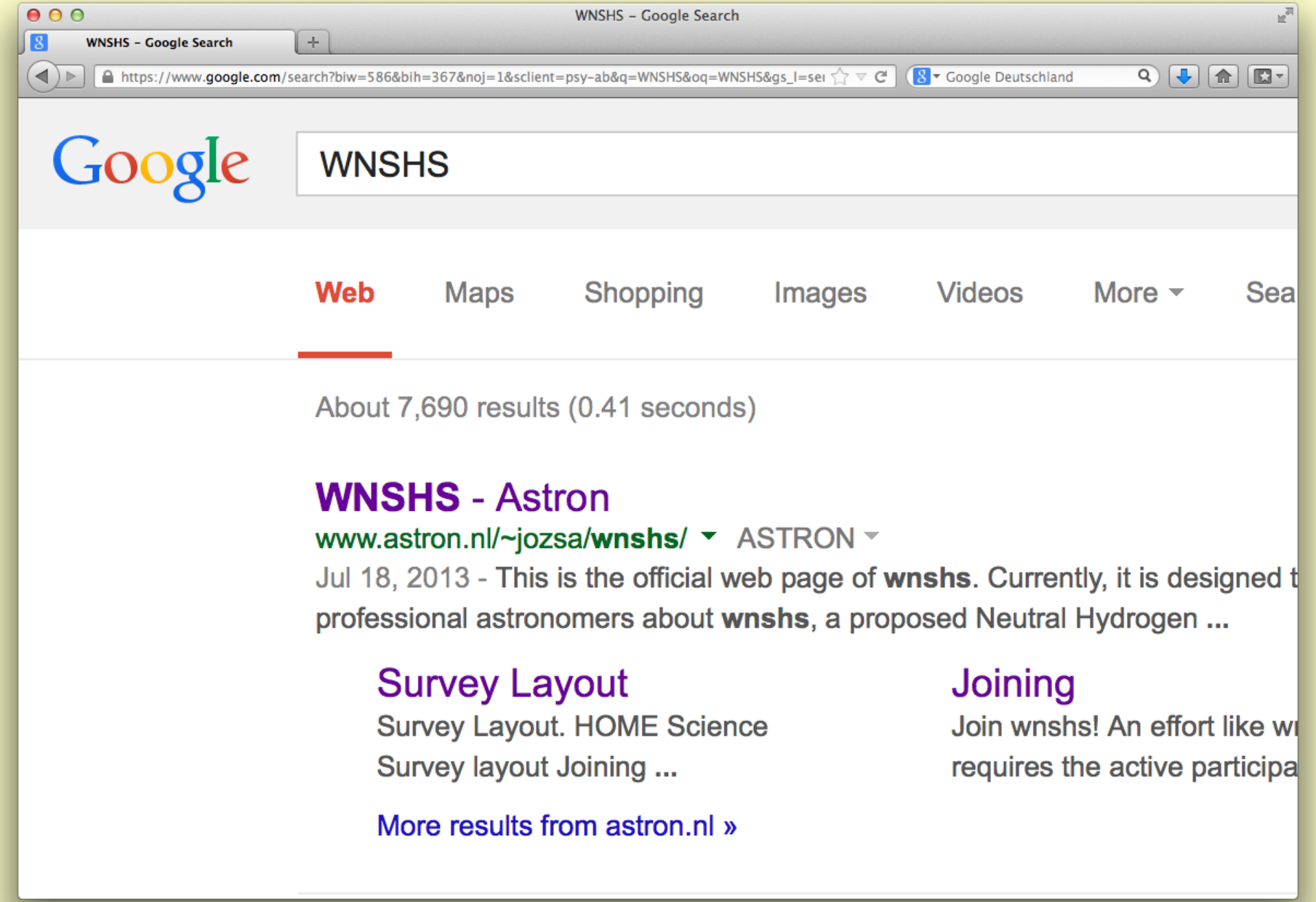

Apertif – Google Search
Apertif – Google Search
https://www.google.com/search?biw=586&bih=367&noj=1&sclient=psy-ab&q=Apertif&oq=Apertif&gs_l=ser
Google Deutschland
Google
Apertif
Web
Images
Shopping
Maps
Videos
More
Sea
About 1,890,000 results (0.16 seconds)
Showing results for Aperitif
Search instead for Apertif
Apéritif and digestif - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Apéritif_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

Naming


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.
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 ambit
influential 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 m
of a large part of the universe. We would like to show you the beauty of ...

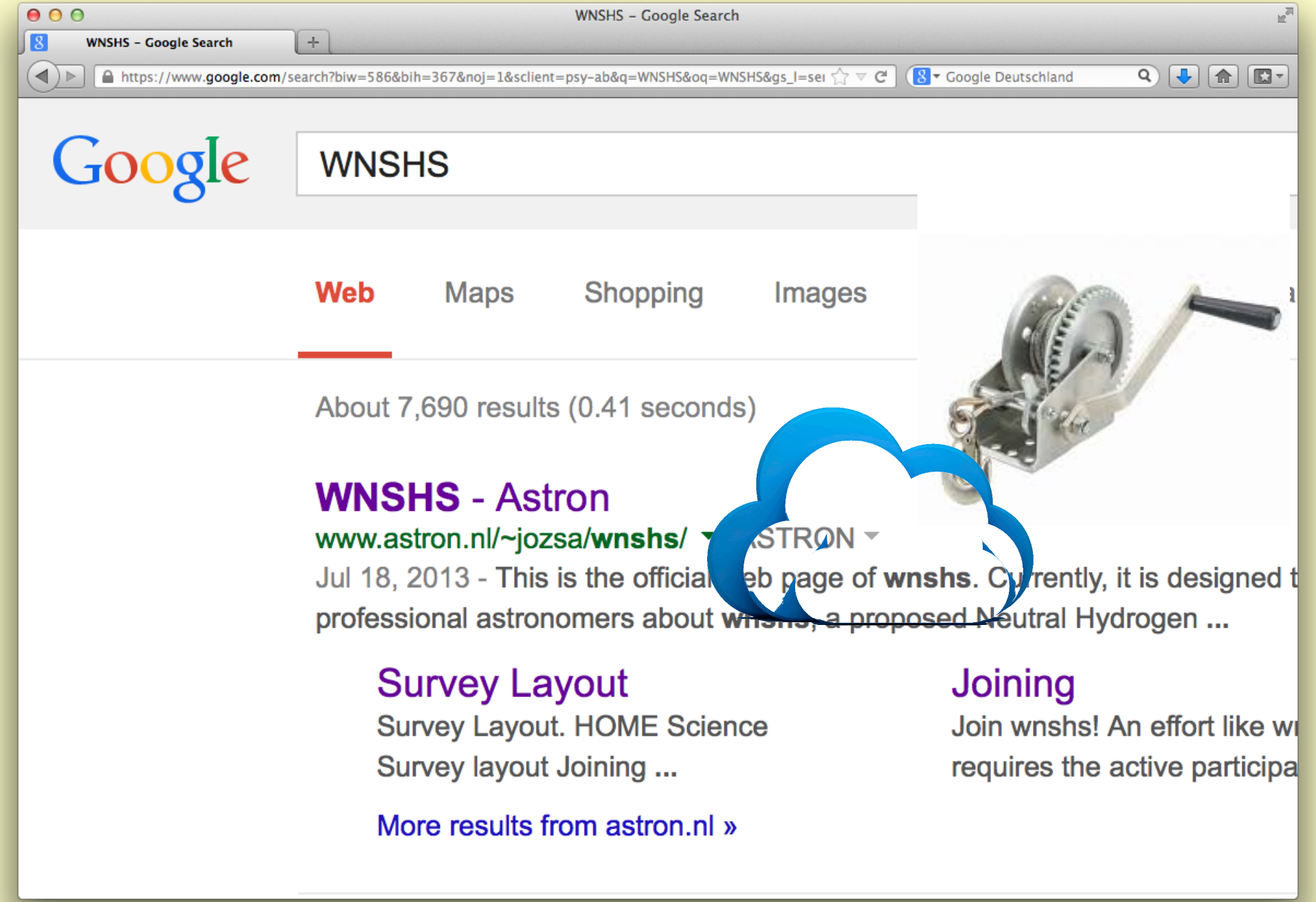
Naming

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*



Naming

WNSHS
***W**esterbork **N**orthern **S**ky **HI** **S**urvey*



Naming

WNSHS

***W**esterbork **N**orthern **S**ky **HI** **S**urvey*