

ASKAP: planned are 36 ×12-m dishes

Phase 1 = BETA: 6 ×12-m dishes



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WALLABY – the ASKAP HI All-Sky Survey

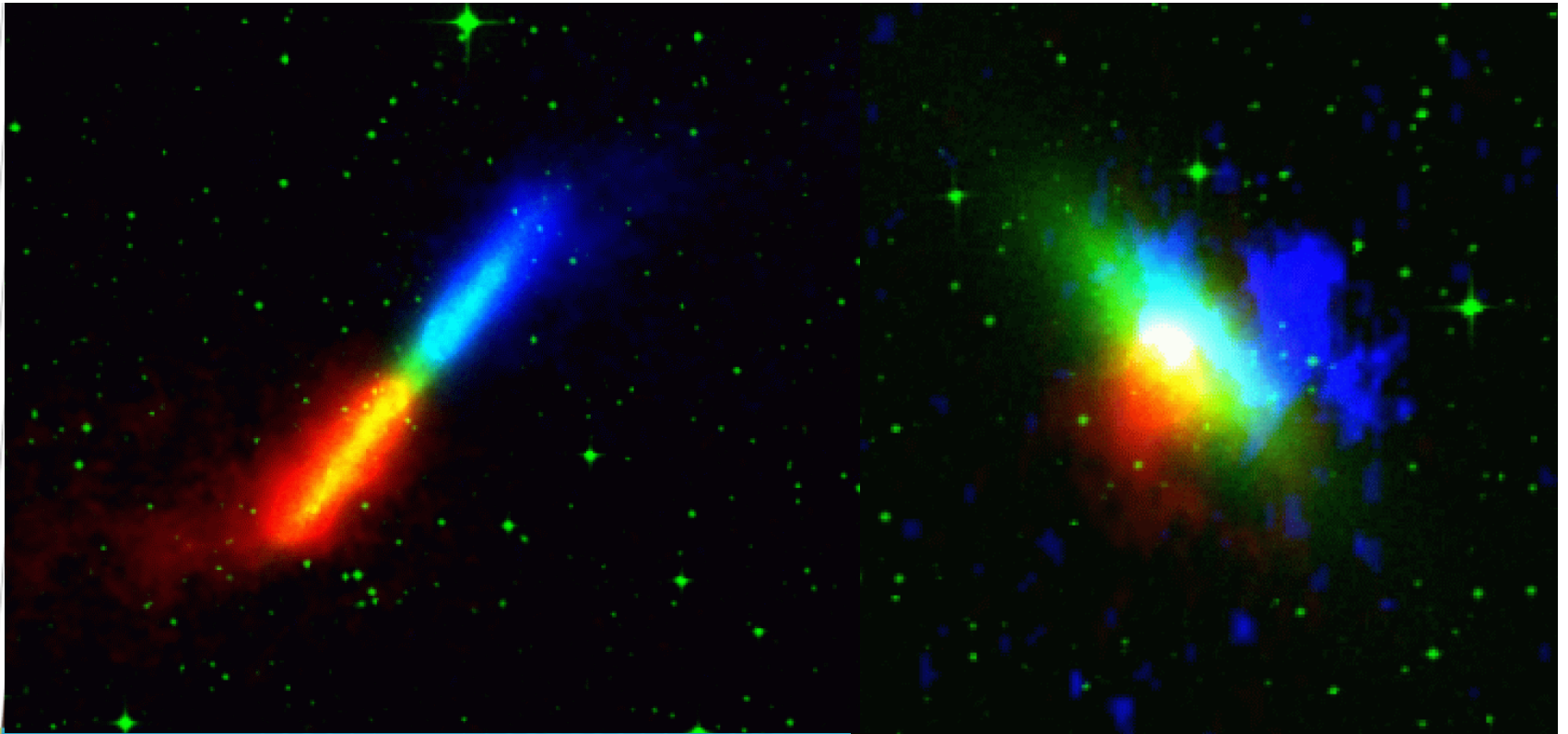
Bärbel Koribalski

CSIRO Astronomy and Space Science

Australia Telescope National Facility

“Gas in Galaxies” – Kloster Seeon – June 2011






www.csiro.au

[www.atnf.csiro.au / research / WALLABY](http://www.atnf.csiro.au/research/WALLABY)

Project leaders:
Bärbel Koribalski &
Lister Staveley-Smith





ASKAP is under construction, 6 antennas assembled,
30 to come. Pictures: Simon Johnston (27 Oct, 2010)

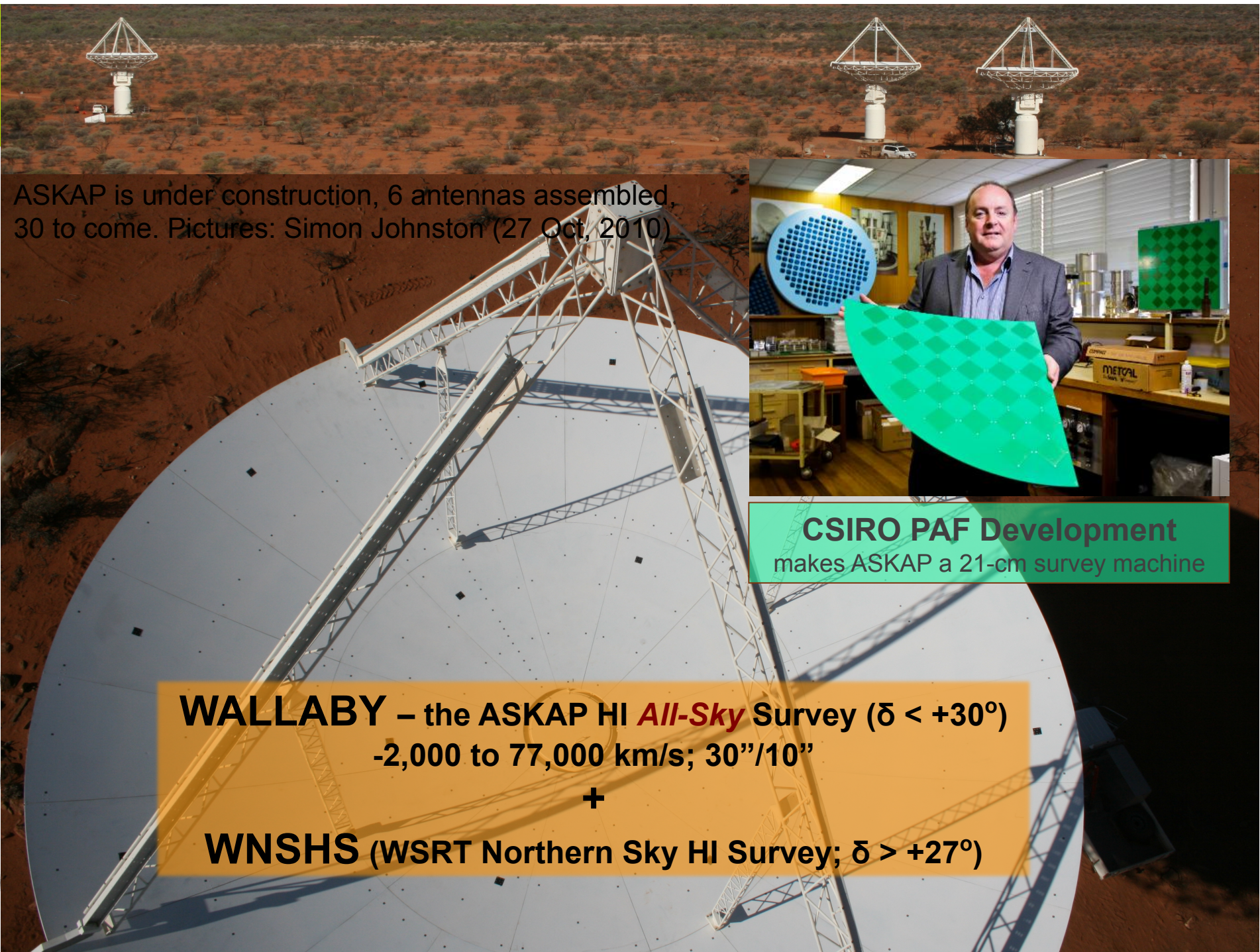
... step by step

in future: **SKA HI Surveys**

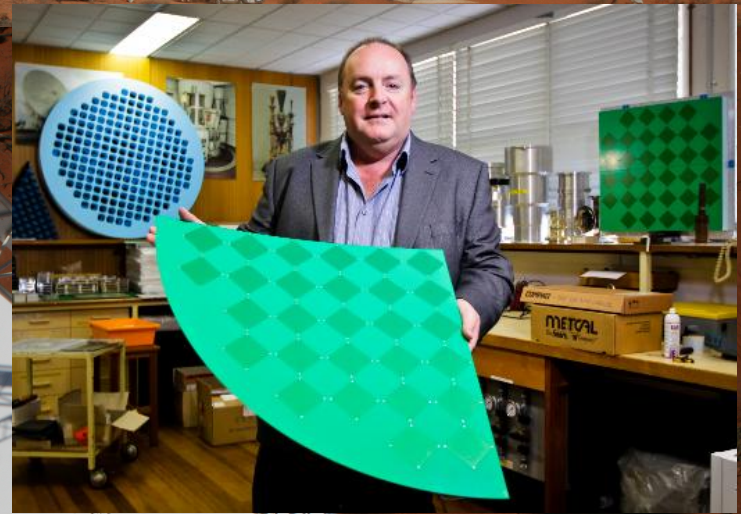
WALLABY – the ASKAP HI All-Sky Survey

LVHIS – the Local Volume HI Survey

HIPASS – the HI Parkes All-Sky Survey



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CSIRO PAF Development
makes ASKAP a 21-cm survey machine

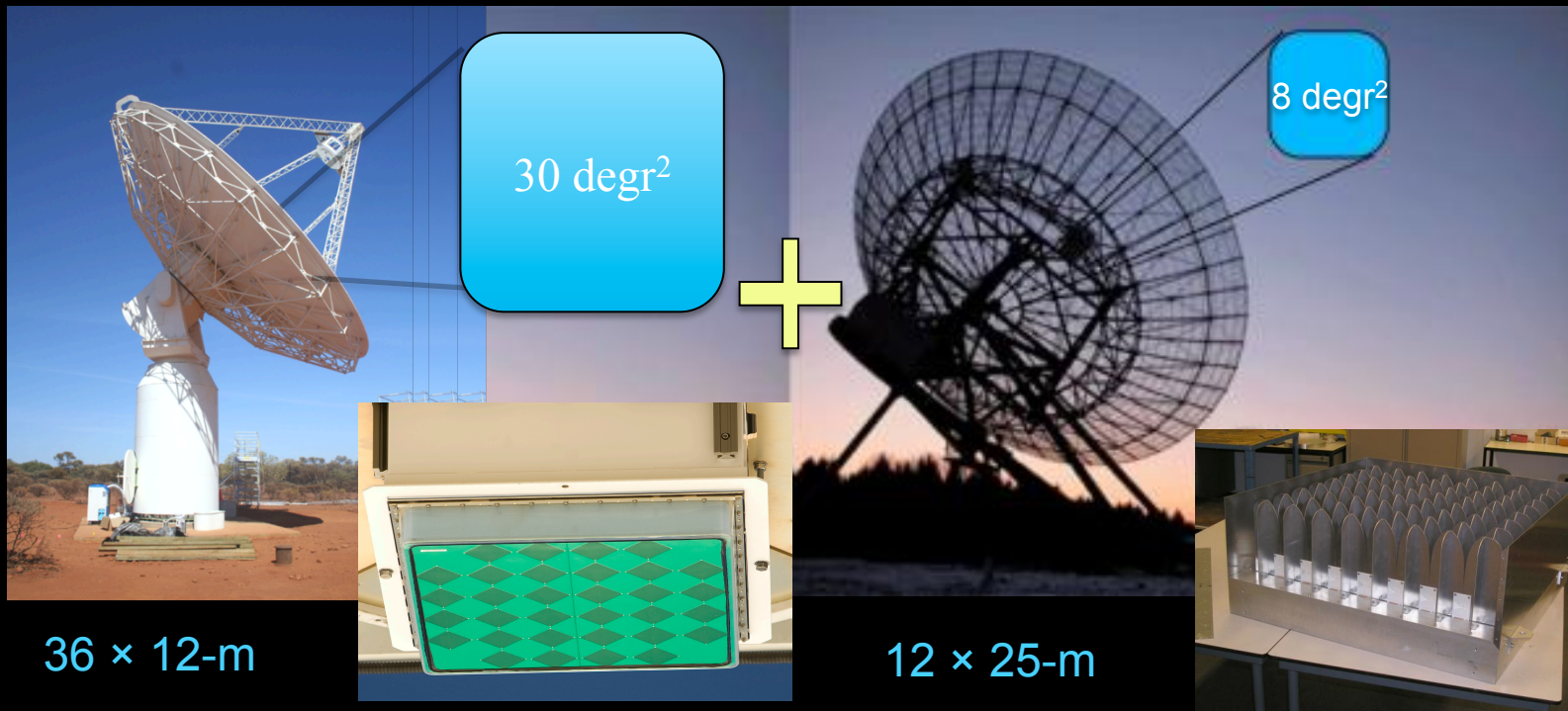
WALLABY – the ASKAP HI *All-Sky* Survey ($\delta < +30^\circ$)
-2,000 to 77,000 km/s; 30"/10"

+

WNSHS (WSRT Northern Sky HI Survey; $\delta > +27^\circ$)

HI (21-cm) All-Sky Survey

ASKAP + WSRT with Apertif

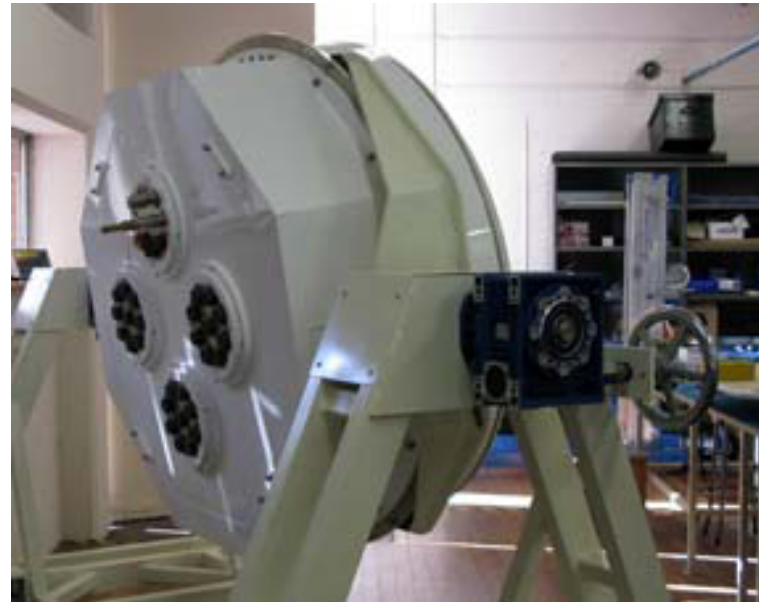
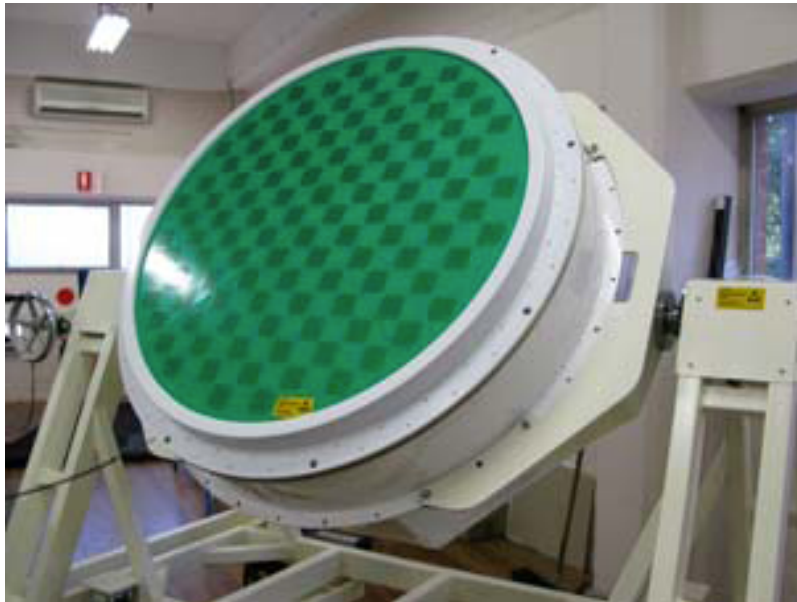


36 × 12-m

12 × 25-m

To achieve all-sky coverage we require ≈ 1200 ASKAP pointings (left), integrate 8h each ($\delta < 30$ degr) + ≈ 1300 WSRT/Apertif pointings (right), 4h each ($\delta > 30$ degr) to achieve the same sensitivity and resolution.

The ASKAP PAF – a new radio camera



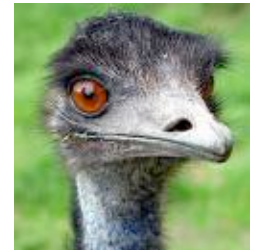
April 2011: Front view & rear view of the ASKAP PAF.

- ◆ ***PAF = Phased Array Feeds (checkerboard array: 188 elements)***
- ◆ ***Beamformer: creates up to 36 beams, each 1.2 degr FWHM***
- ◆ ***resulting field of view is 30 square degrees (5.5 deg × 5.5 deg)***

ASKAP SSPs

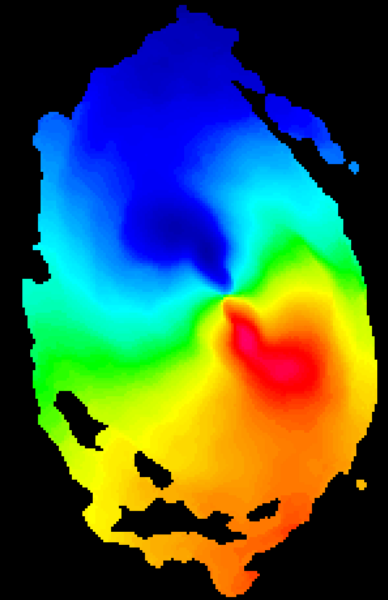
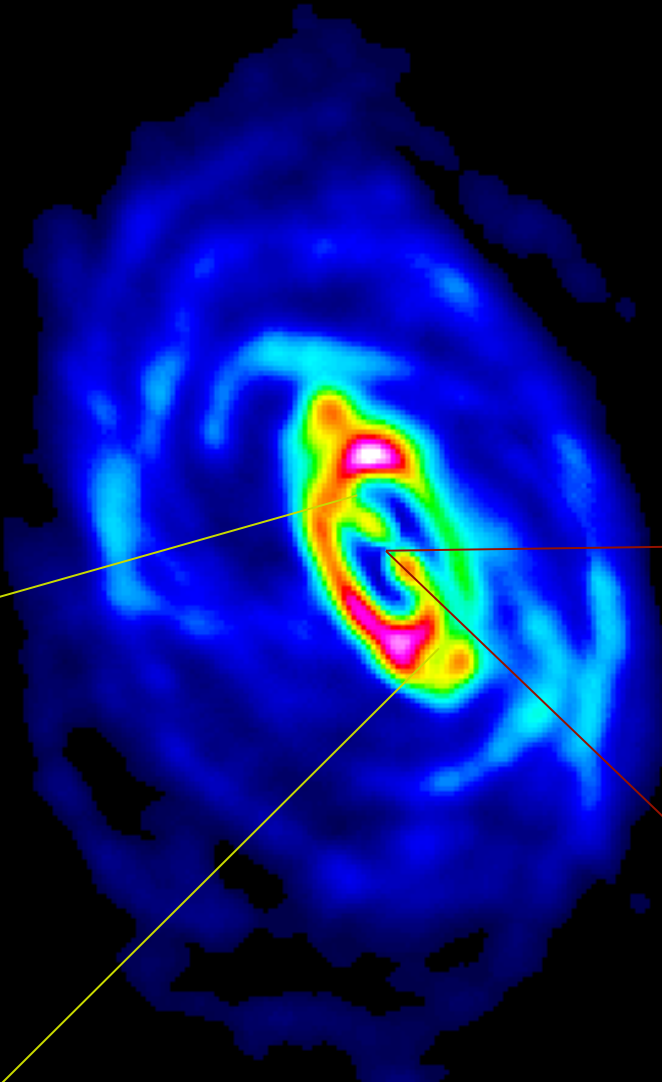
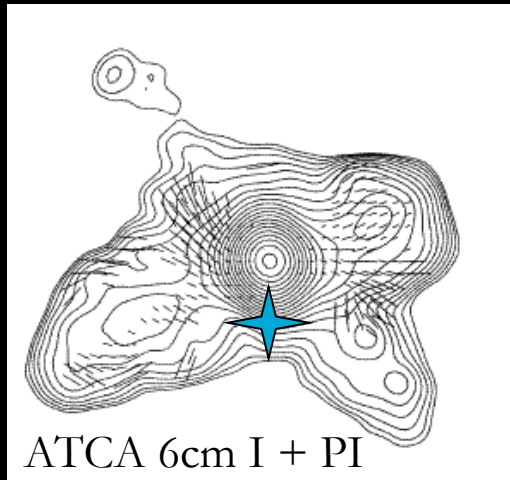


- WALLABY (Koribalski/Staveley-Smith) All sky **H_I** survey to $z \sim 0.2$
- EMU (Norris) All sky continuum to $10 \mu\text{Jy rms}$
- POSSUM (Gaensler/Landecker/Taylor) Polarization / RM grid
- FLASH (Sadler) **H_I** absorption to $z \sim 1$
- VAST (Murphy/Chatterjee) Transients and variables ($>5 \text{ sec}$)
- CRAFT (Dodson/Macquart) Fast transients ($<5 \text{ sec}$)
- GASKAP (Dickey) Galactic and Magellanic **H_I** and OH
- DINGO (Meyer) Deep **H_I** emission survey
- COAST (Stairs) Pulsar timing and searching
- VLBI (Tingay) ASKAP as part of the LBA

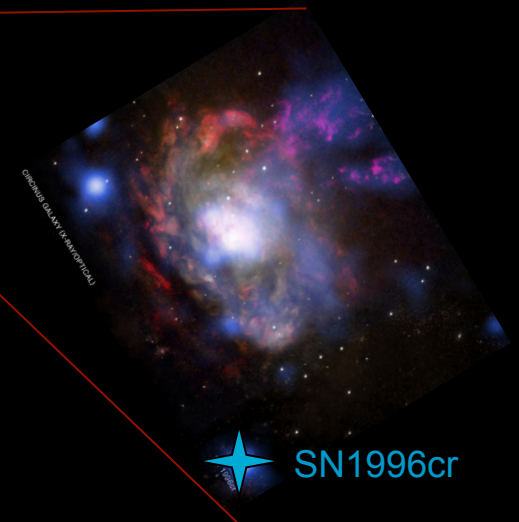


The Circinus Galaxy (HIPASS J1413-65)

= one of the largest nearby galaxies



ATCA HI velocity field



Chandra X-ray + H α

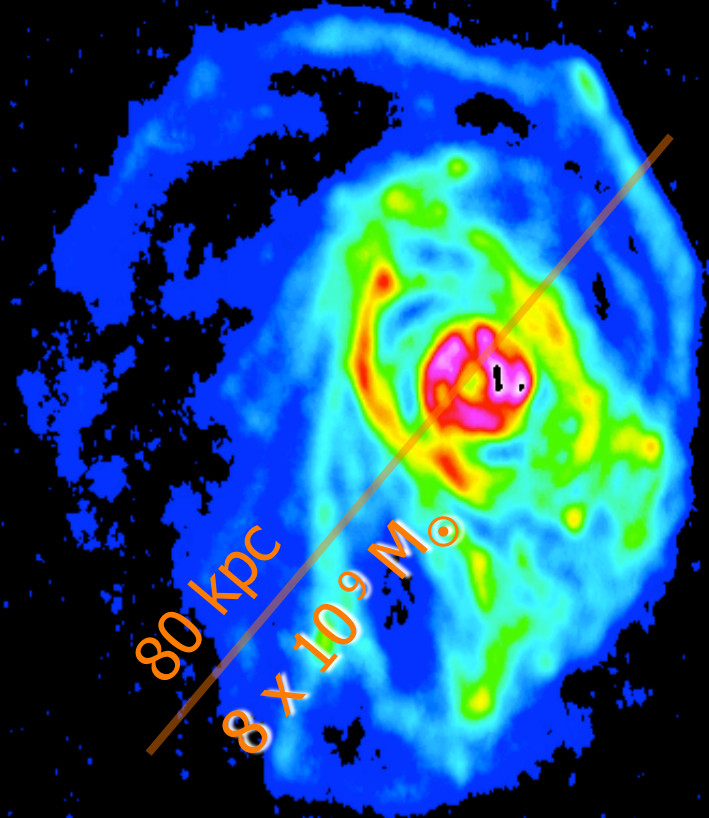
WALLABY – sensitivity & scales

- e.g., 8h integration time
 - ➔ 5σ M_{HI} limit
 - = $5 \times 10^6 M_{\odot}$ (D = 10 Mpc)
 - = $5 \times 10^8 M_{\odot}$ (D = 100 Mpc)
 - = $3 \times 10^{10} M_{\odot}$ (D = 800 Mpc)
- 10" beam
 - = 0.5 kpc (D = 10 Mpc)
 - = 5 kpc (D = 100 Mpc)
 - = 39 kpc (D = 800 Mpc)
- 30" beam
 - = 1.5 kpc (D = 10 Mpc)
 - = 15 kpc (D = 100 Mpc)
 - = 116 kpc (D = 800 Mpc)

M 83

(D = 4.5 Mpc)

UGCA 365



WALLABY will explore

- the *Gaseous* Universe
- the *Dynamic* Universe
- the *3D* Universe
- the *Dark* Universe

and

- the *Unknown* Universe

... probing the Gaseous Universe

WALLABY will discover

- new dwarf galaxies in the *Local Group*
- hundreds of dwarfs in the *Local Volume* ($5 \times 10^6 M_{\odot}$ out to 10 Mpc)
- diffuse HI clouds, tails and filaments connecting galaxies
- $10^8 M_{\odot}$ out to 60 Mpc

M 81 dwarf A

Holmberg I

Holmberg II

IC 2574

VLA HI + Spitzer MIR + Galex UV; Walter et al. (2009)

... probing the Gaseous Universe

M 83 + UGC 365

WALLABY will reveal

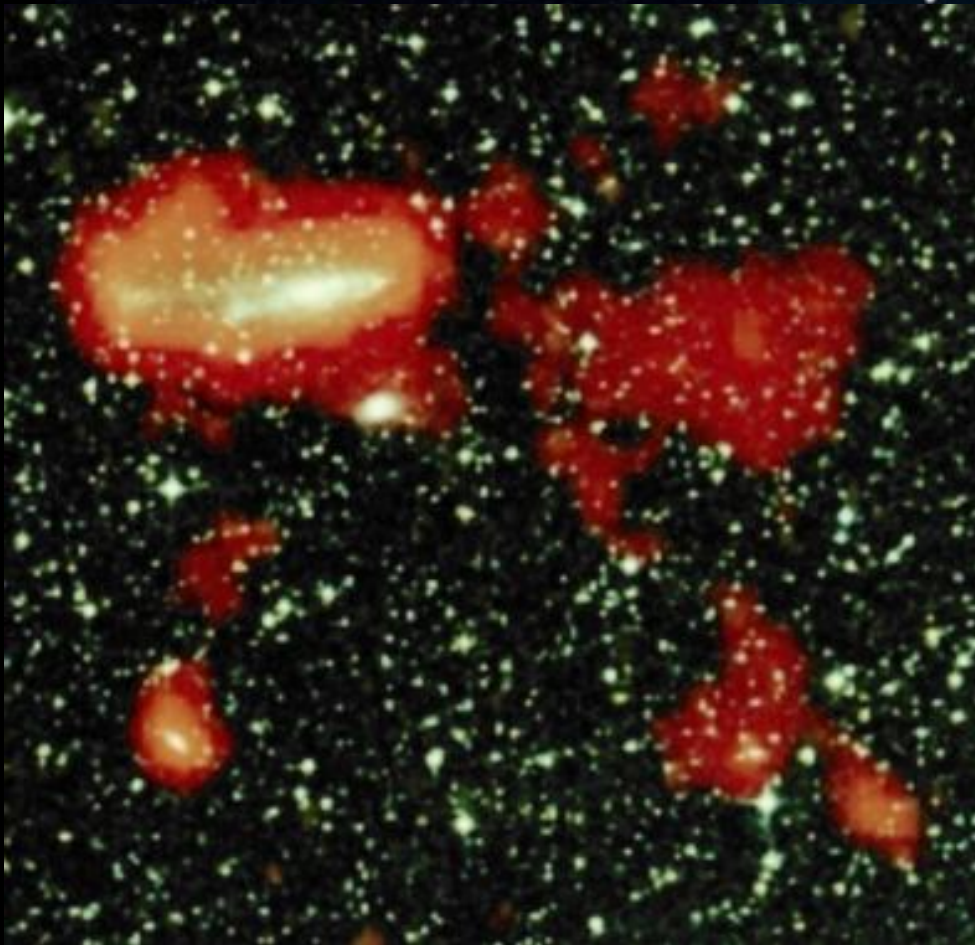
- the large-scale HI disks of spiral galaxies
- HI streams in galaxy haloes resulting from the accretion of neighbouring dwarf galaxies

The Circinus
Galaxy

BK et al. 2011, in prep.

... probing the Gaseous Universe

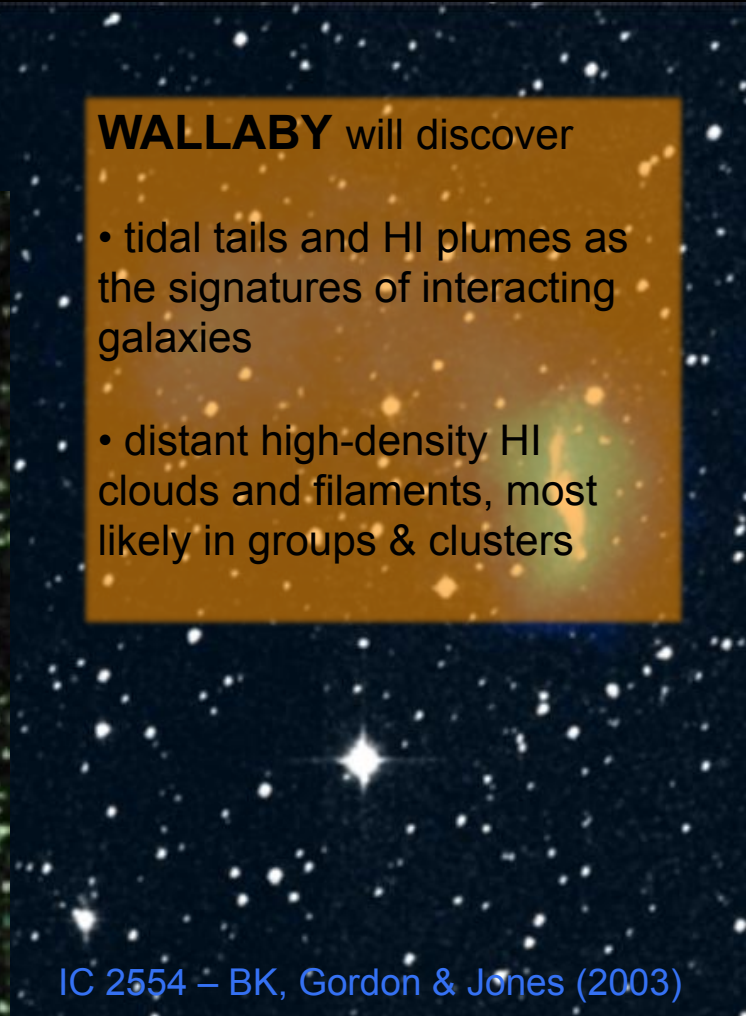
NGC 3263 group – English, BK et al. (2010)



WALLABY will discover

- tidal tails and HI plumes as the signatures of interacting galaxies
- distant high-density HI clouds and filaments, most likely in groups & clusters

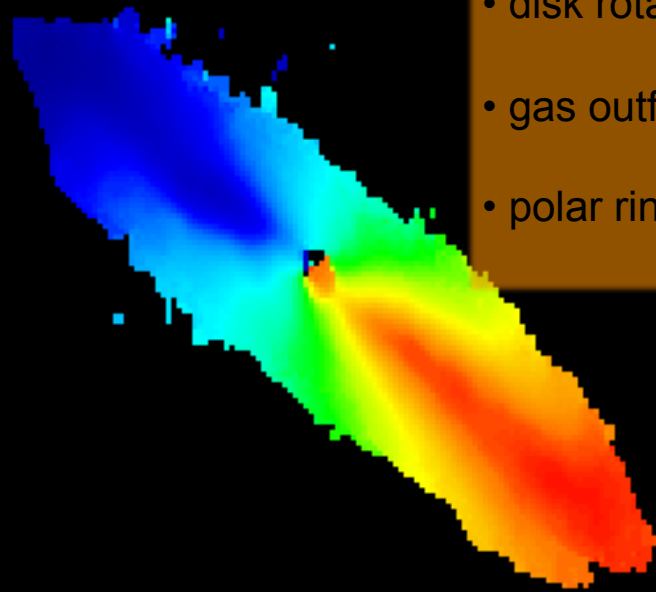
IC 2554 – BK, Gordon & Jones (2003)



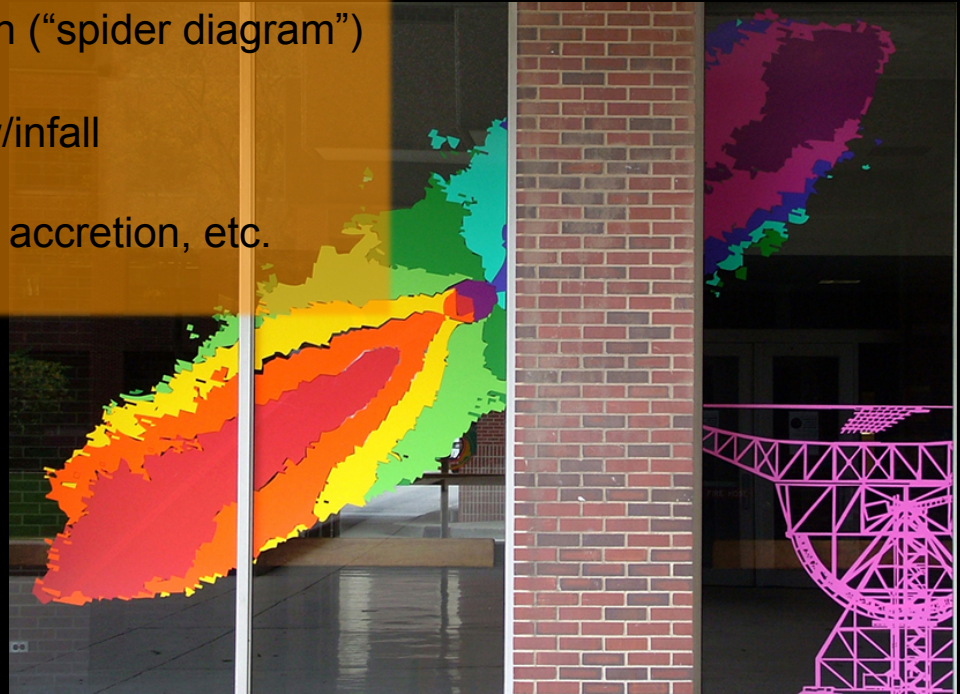
... exploring **the Dynamic Universe**

WALLABY will reveal

- the large-scale HI velocity fields of spiral galaxies
- disk rotation (“spider diagram”)
- gas outflow/infall
- polar rings, accretion, etc.



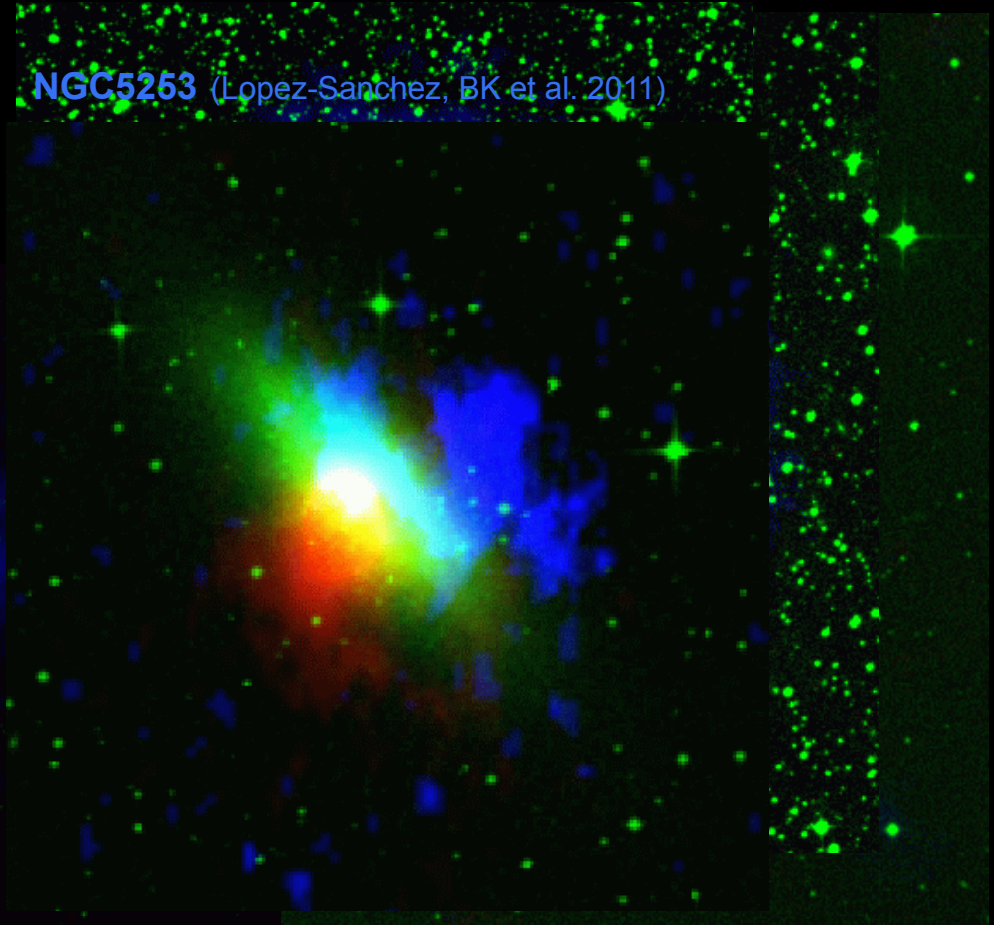
The starburst galaxy NGC 253



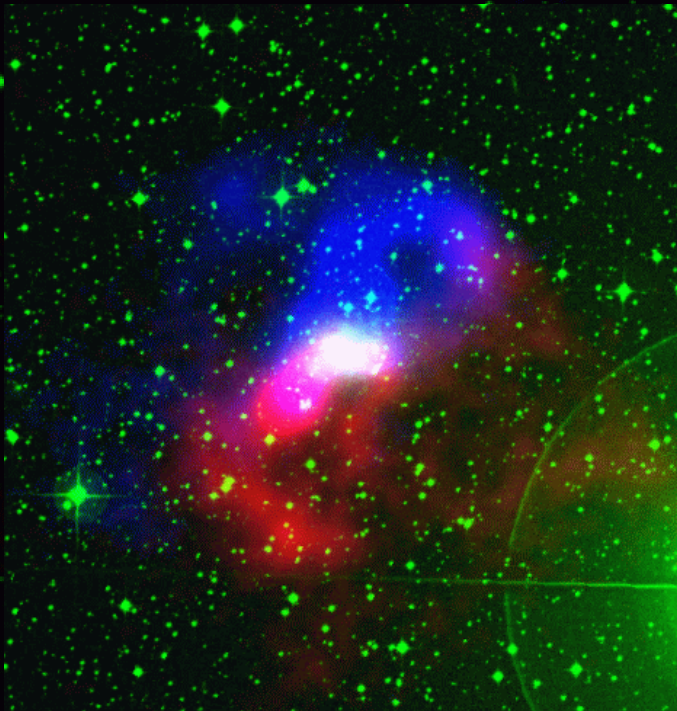
Dennison Mural @ U Michigan, IYA2009:
The Universe – Yours to Discover

... exploring **the Dynamic Universe**

NGC5253 (Lopez-Sanchez, BK et al. 2011)

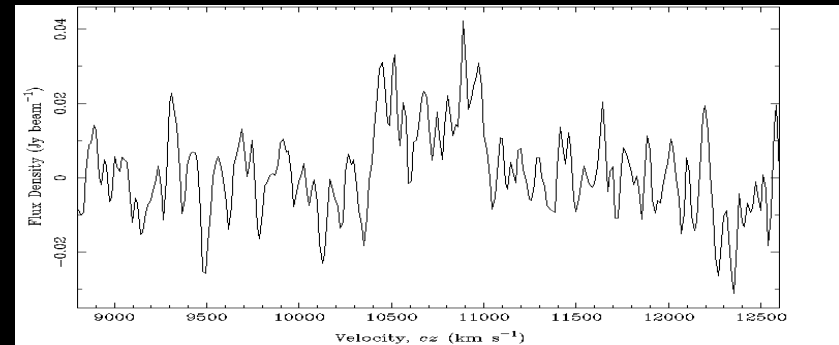
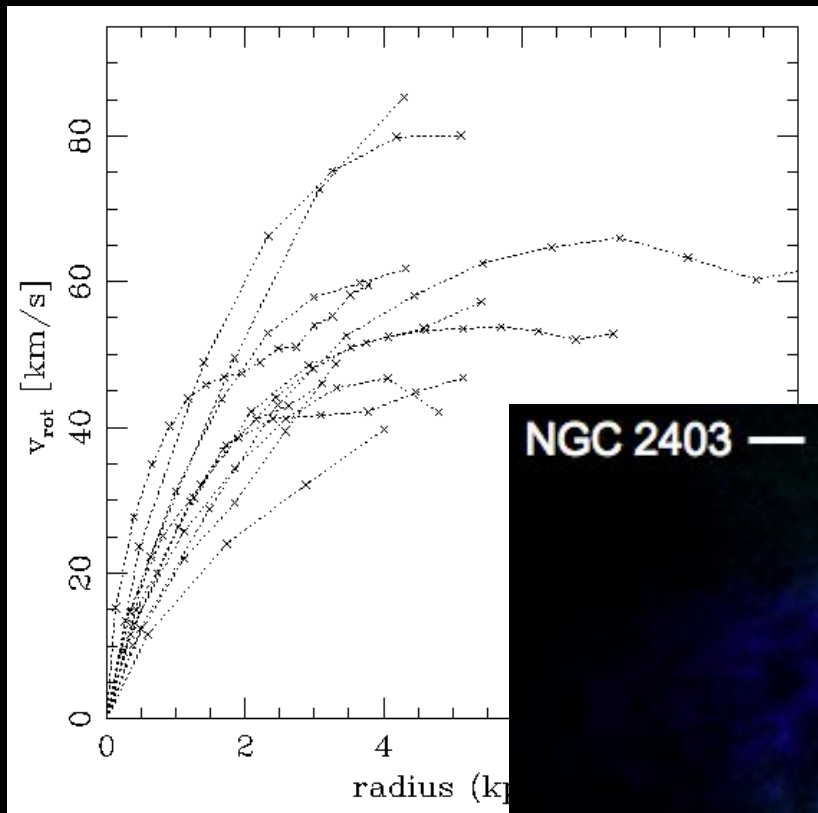


IC 4662 (van Eymeren, BK et al. 2009)

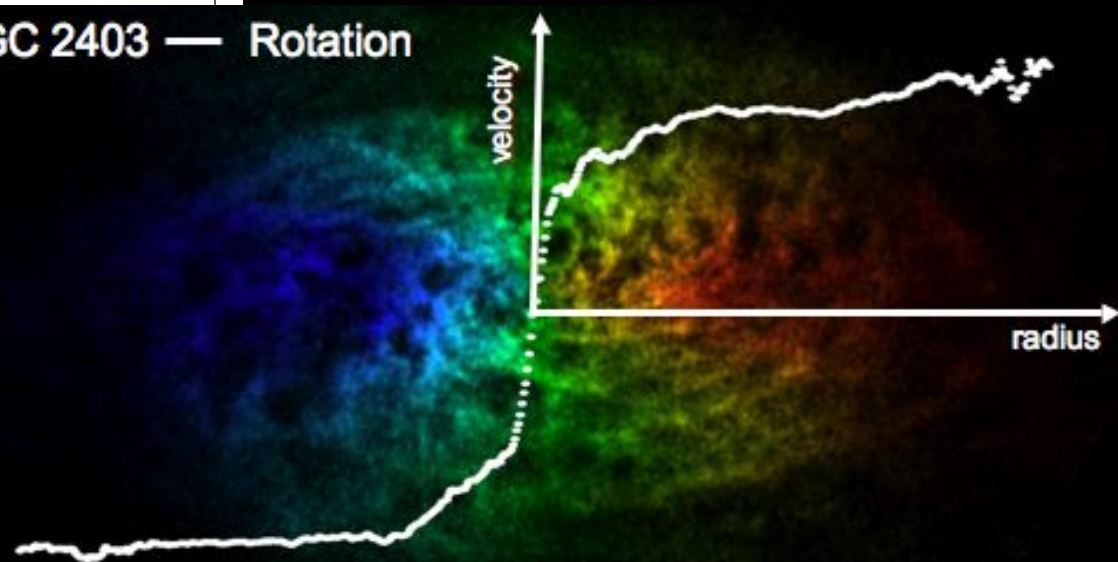


LVHIS galaxies (gas + stars)

... uncover the Dark Universe



NGC 2403 — Rotation

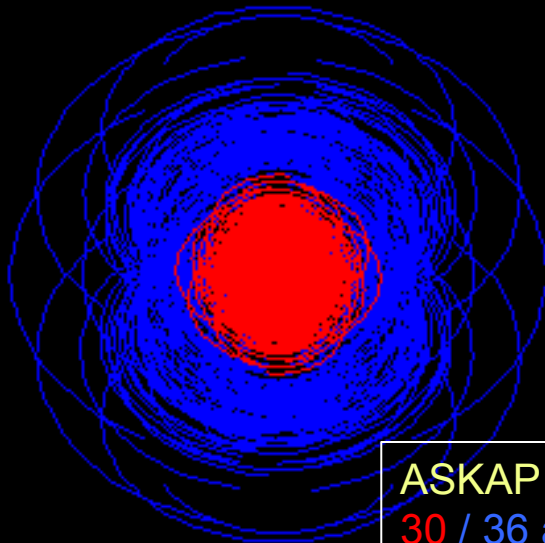


LVHIS: Kirby, BK et al. (2010)

$$M_{\text{dyn}} = 2.31 \times 10^5 R_{\text{kpc}} v_{\text{rot}}^2$$

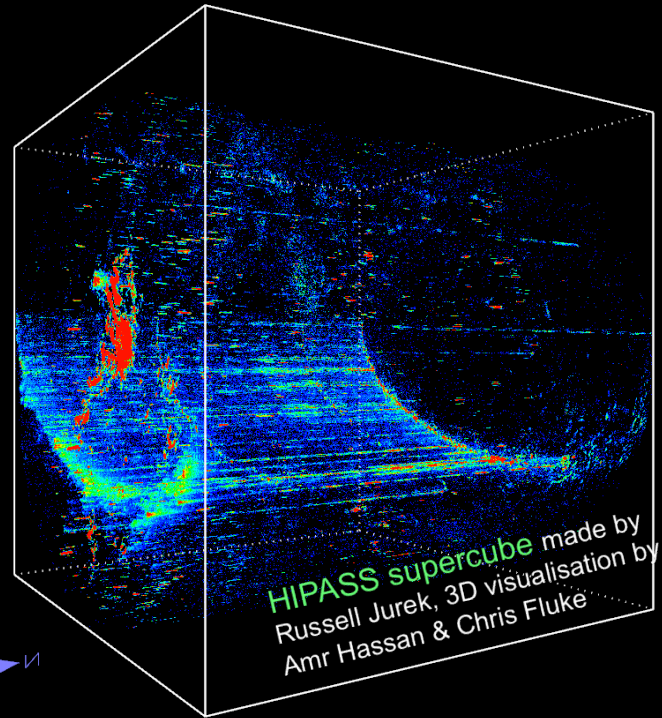
THINGS: Walter et al. (2009)

... exploring the 3D Universe

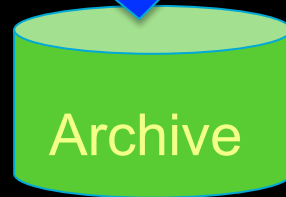


10.0klambda

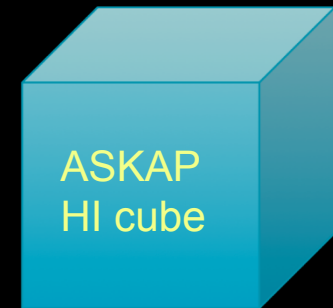
ASKAP uv-coverage:
30 / 36 antennas




HIPASS supercube made by
Russell Jurek, 3D visualisation by
Amr Hassan & Chris Fluke



1200 ×



ASKAP
HI cube



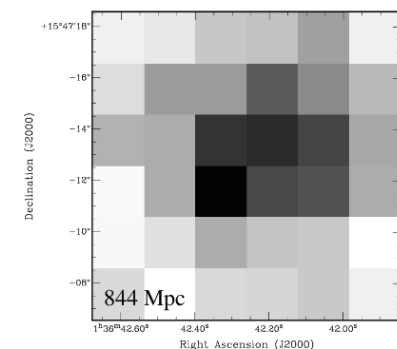
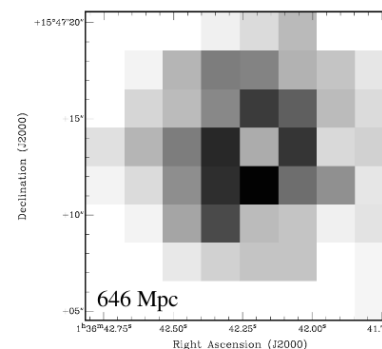
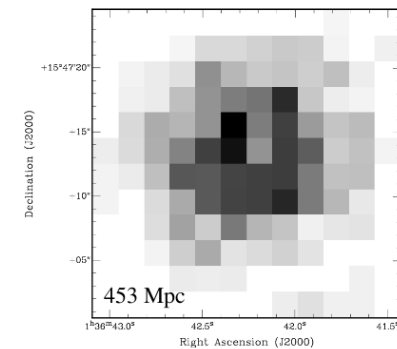
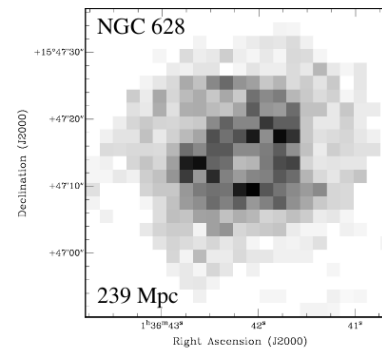
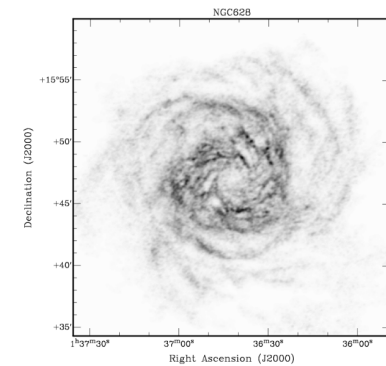
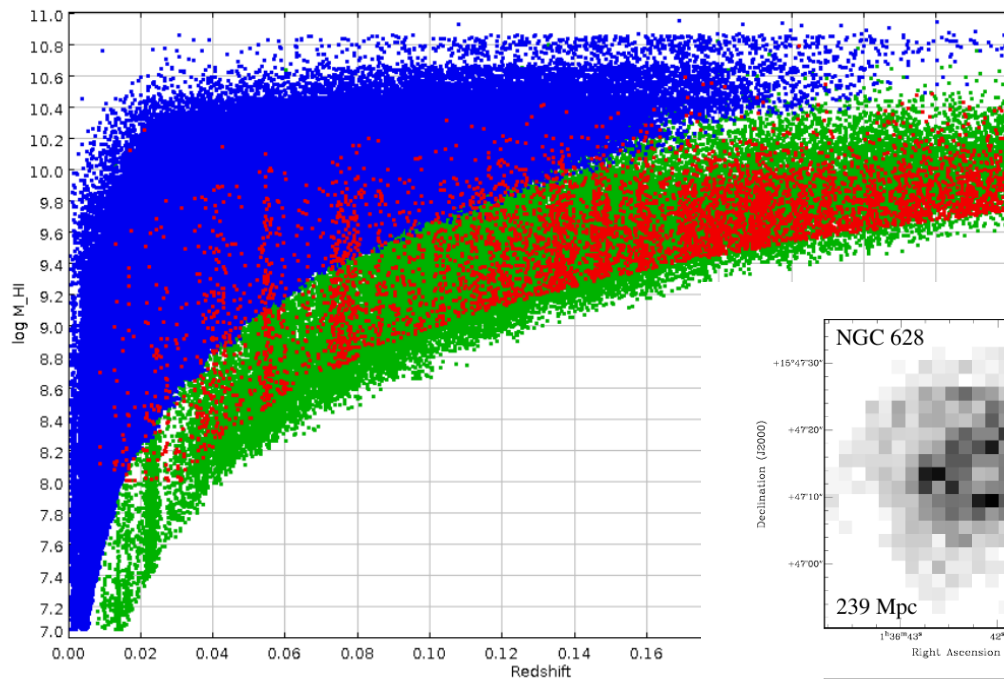
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WALLABY – Technical Working Groups:

- Numerical simulations & Mock catalogs (*Chris Power, Chris Blake, A. Duffy, R. Crain, M. Zwaan, G. Kauffmann, C. Frenk, A. Popping, ...*)
- Source Finding & Parameterization (*Tobias Westmeier, M. Whiting, R. Jurek, P. Serra, B. Winkel, T. Oosterloo, J. Allison, ...*)
- Parameterization of extended galaxies (*Kristine Spekkens, Jozsa Gyula, Se-Heon Oh, Ed Elson, Erwin de Blok, ...*)
- Survey Strategy (*Bradley Warren et al.*)
- Stacking (*Martin Meyer, Sadler, et al.*)
- etc.

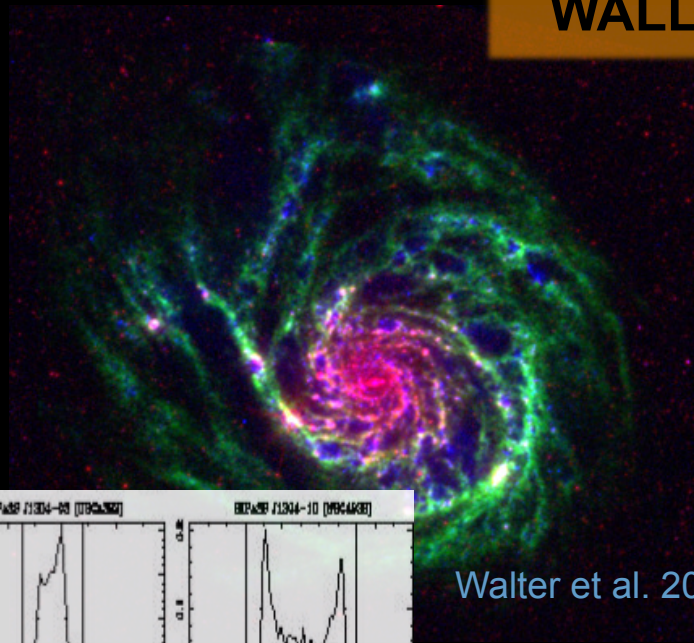
ASKAP simulations – input galaxies

HI mass vs. redshift for **WALLABY**, **DINGO deep**, and **simulation**

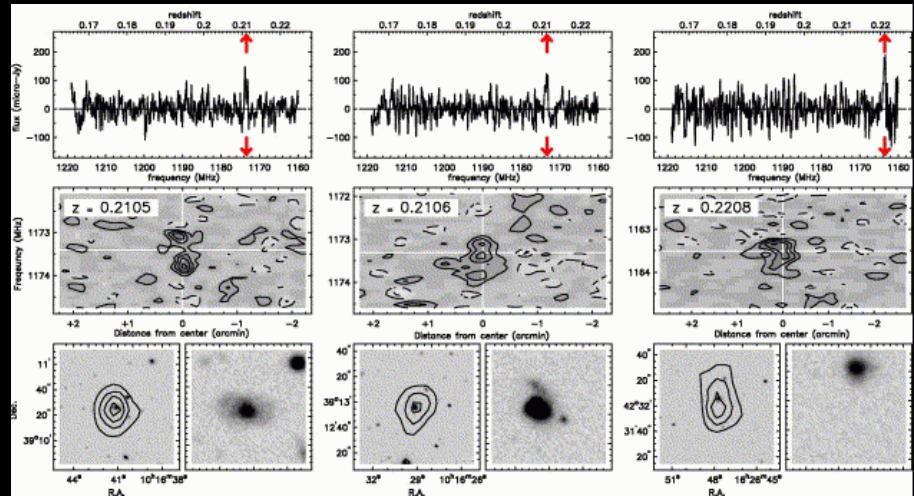


300 HI data sets for nearby galaxies;
red-shifted to several distances and
distributed on cosmic web simulation.

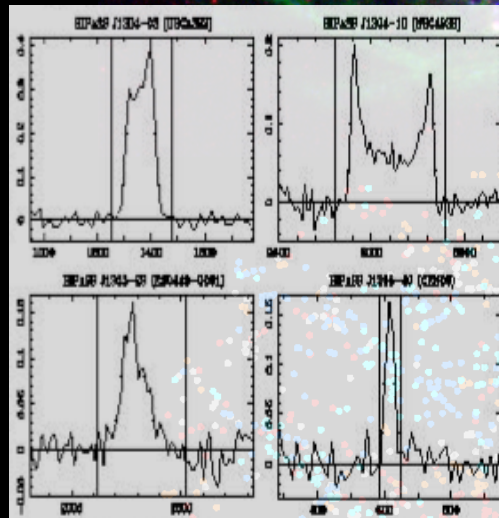
WALLABY in summary



Walter et al. 2008

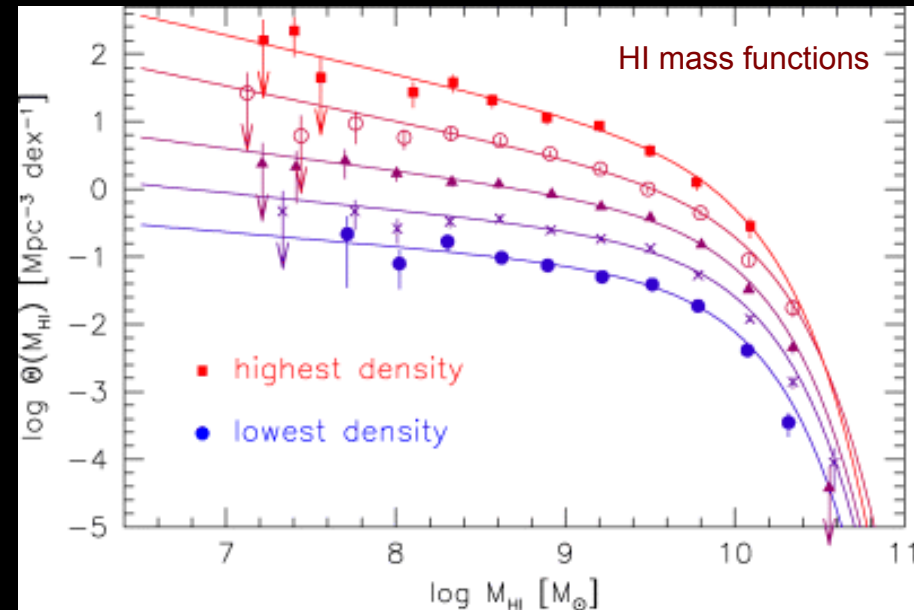


Verheijen et al. 2007



500 000 HI detections,
ie. 500 000 redshifts, HI
& dynamical masses, ...

Koribalski et al. 2004



Zwaan et al. 2005

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Bärbel Koribalski
CSIRO Astronomy and Space Science
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“Gas in Galaxies” – Kloster Seeon – June 2011

