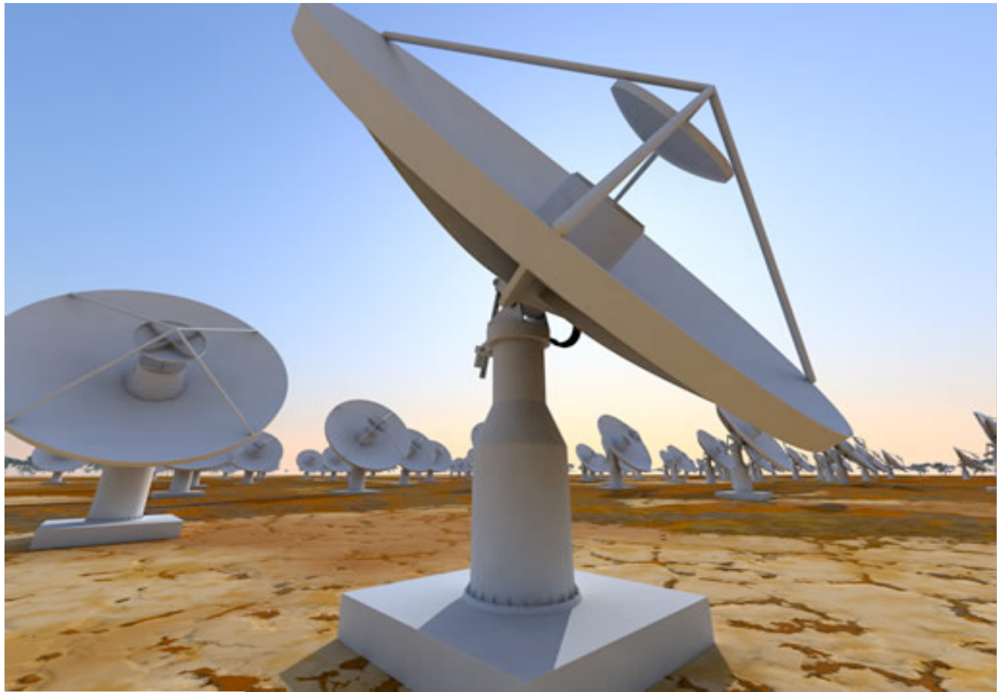
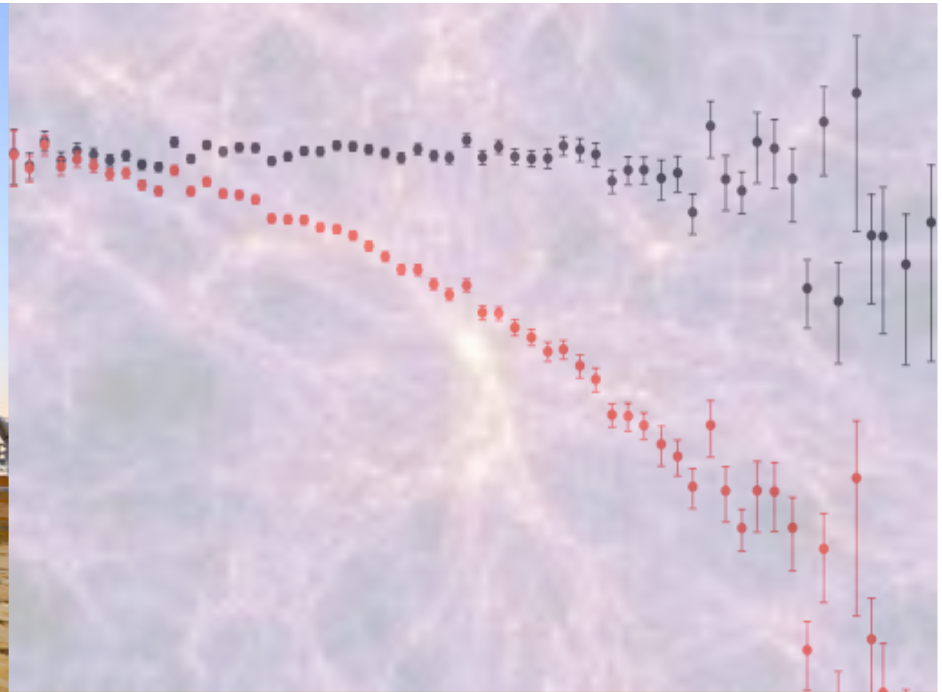




Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY)

Lister Staveley-Smith

International Centre for Radio Astronomy Research, Perth

International Centre for Radio Astronomy Research

UWA node

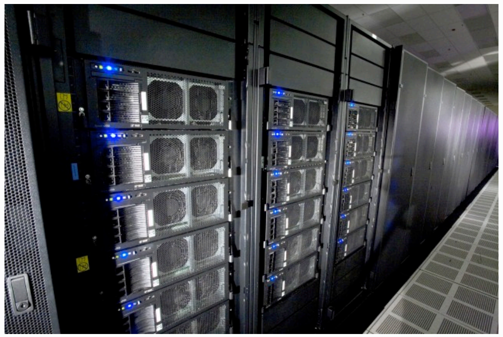
Curtin node

+ =

ICRAR International Centre for Radio Astronomy Research

iVEC + ICRAR + CSIRO =

Australian National SKA Centre, Perth



Outline

ASKAP/WALLABY

- Design

Science Goals

- Galaxy formation
- (Galaxy Evolution)
- Cosmology

Synergies

- Radio
- Optical/IR

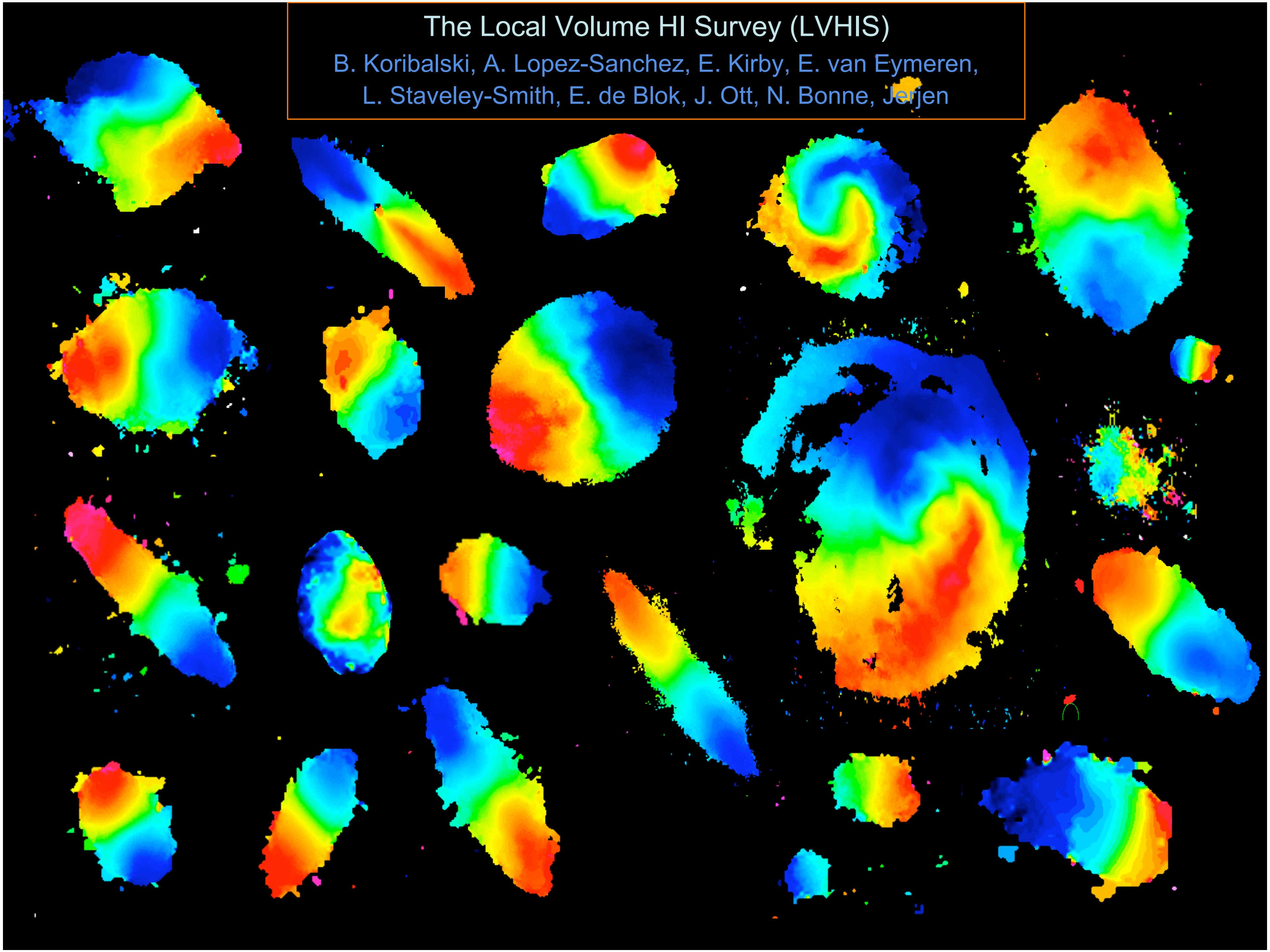
Wallaby team (May 2009)

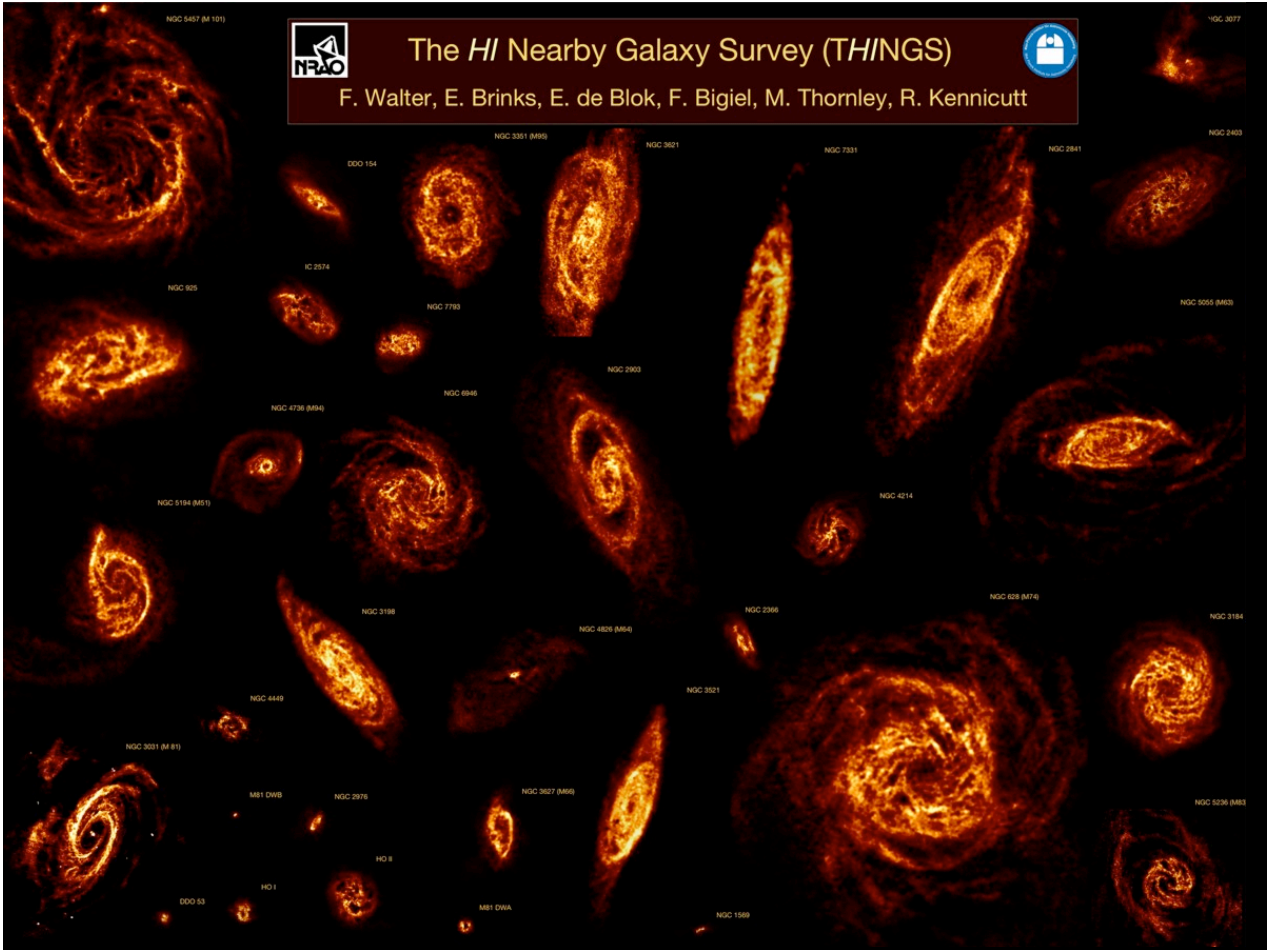
Principal Investigators: B. S. Koribalski (ATNF) & L. Staveley-Smith (ICRAR)

Survey Team: Alexandra Abate (Laboratoire de l'Áccélérateur Linéaire), David Barnes (Swinburne University), Carlton Baugh (Durham University), Kenji Bekki (Uinversity of NSW), Nadya Ben Bekhti (AIfA Bonn), Chris Blake (Swinburne University), Robert Braun (ATNF), Michael Brown (Monash University), Pieter Buyle (xxxx), Matthew Colless (AAO), Erwin de Blok (University of Capetown), John Dickey (University of Tasmania), Simon Driver (St.Andrews), Alan Duffy (UWA), Loretta Dunne (Nottingham University), Steve Eales (Cardiff University), Bjorn Emonts (ATNF), Jayanne English (University of Manitoba), Bryan Gaensler (Sydney), Karl Glazebrook (Swinburne University), Neeraj Gupta (ATNF), Martin Hendry (Glasgow University), Trish Henning (University of New Mexico), Andrew Hopkins (AAO), Tom Jarrett (IPAC), Matt Jarvis (Hertfordshire), Helmut Jerjen (ANU), Heath Jones (AAO), Eva Jütte (University of Bochum), Peter Kalberla (AIfA Bonn), Jürgen Kerp (AIfA Bonn), Virginia Kilborn (Swinburne University), Henry Lee (Gemini), Lerothodi Leeuw (NASA Ames Research Center; SKA South Africa) Ángel López-Sánchez (ATNF), Gerhardt Meurer (John Hopkins University), Martin Meyer (UWA), Raffaella Morganti (ASTRON), Jeremy Mould (Melbourne University), Erik Muller (Nagoya University), Tara Murphy (University of Sydney), Hiroyuki Nakanishi (Kagoshima University), Ray Norris (ATNF) Seheon Oh (ANU), Tom Oosterloo (ASTRON), Attila Popping (Groningen University), Chris Power (Leicester University), Peter Quinn (UWA), Somak Raychaudhury (University of Birmingham), Steve Rawlings (Oxford), George Rhee (Nevada), Emma Ryan-Weber (Swinburne University), Stuart Ryder (AAO), Elaine Sadler (University of Sydney), DJ Saikia (NCRA, India), Paolo Serra (ASTRON), Kristine Spekkens (xxx) Christian Struve (ASTRON), Mark Thompson (Hertfordshire), Bart Wakker (University of Wisconsin), Rachel Webster (Melbourne University), Tobias Westmeier (ATNF), Matthew Whiting (ATNF), Erik Wilcots (Wisconsin), Richard Wilman (Melbourne University), Benjamin Winkel (AIfA Bonn), Ivy Wong (Yale University), Dan Zucker (Macquarie University), and Martin Zwaan (ESO).

Wallaby parameters

	main survey	unit
maximum baseline	2	km
angular resolution (at $z = 0$)	30	arcsec
sky coverage	$-90°$ to $+30°$	
number of ASKAP pointings	1200	
integration time per pointing	8	hours
total observing time	9600	hours
frequency range	1130 – 1430	MHz
redshift range	0 – 0.26	
velocity range	–2,000 to +60,000	km/s
bandwidth	300	MHz
number of channels	16384	
frequency resolution	18.3	kHz
velocity resolution	3.9	km/s
rms sensitivity (for T_{sys} = 50 K, 0.1 MHz)	0.7	mJy
number of cubes per field	1	
image size	2048	pixels
cell size	$10''$	
time resolution	100	seconds
dynamic range (continuum)	10^4	
dynamic range (spectral)	10^5	
correlations	XX,YY	
total storage (Stokes-I cubes)	330	TB


The Local Volume HI Survey (LVHIS)
B. Koribalski, A. Lopez-Sanchez, E. Kirby, E. van Eymeren,
L. Staveley-Smith, E. de Blok, J. Ott, N. Bonne, Jerjen


The HI Nearby Galaxy Survey (THINGS)
F. Walter, E. Brinks, E. de Blok, F. Bigiel, M. Thornley, R. Kennicutt
NRAO
NGC 5457 (M 101)
NGC 3351 (M95)
NGC 3621
NGC 7331
NGC 2841
NGC 2403
DDO 154
IC 2574
NGC 925
NGC 7793
NGC 5055 (M63)
NGC 2903
NGC 6946
NGC 4736 (M94)
NGC 5194 (M51)
NGC 4214
NGC 628 (M74)
NGC 3184
NGC 3198
NGC 2366
NGC 4826 (M64)
NGC 3521
NGC 4449
NGC 3031 (M 81)
M81 DWB
NGC 2976
NGC 3627 (M66)
NGC 5236 (M83)
HO II
HO I
DDO 53
M81 DWA
NGC 1569

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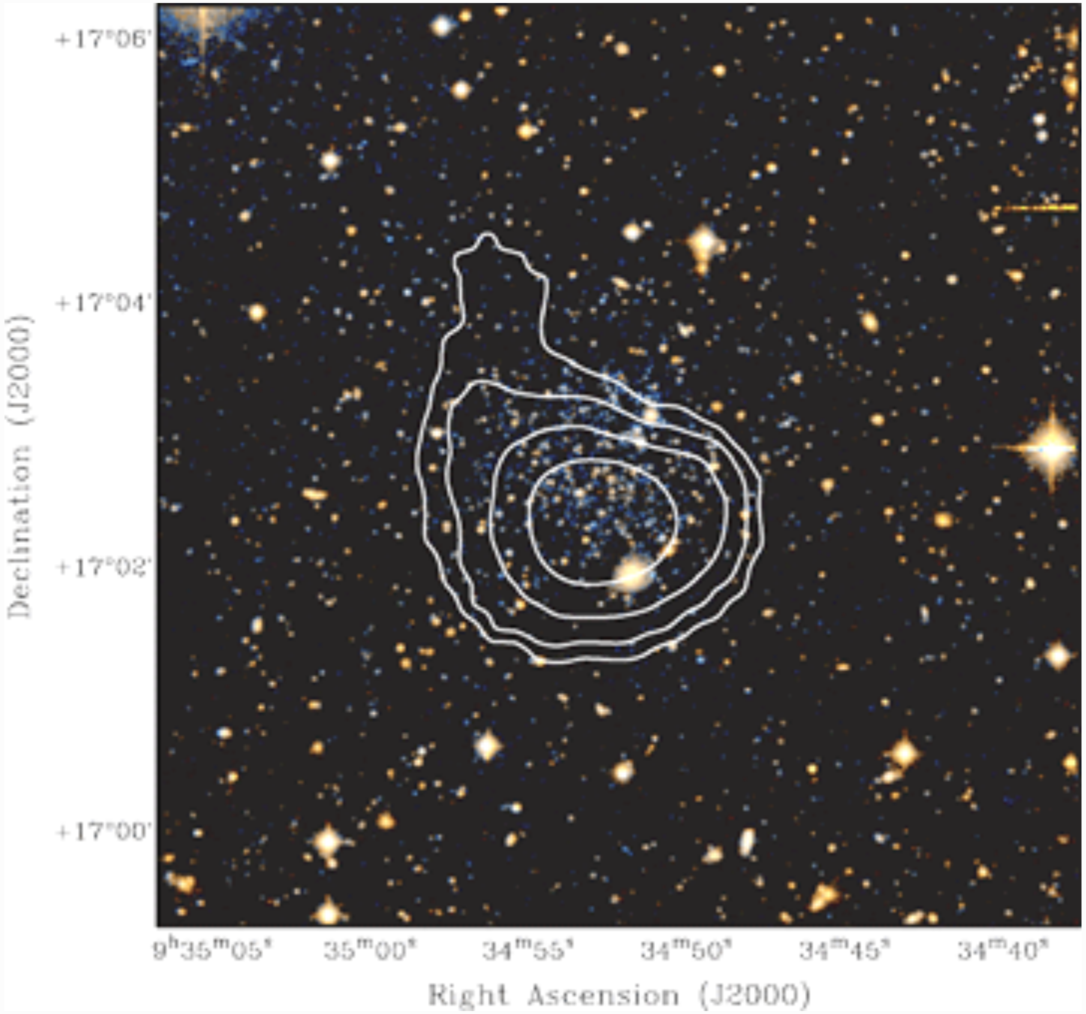
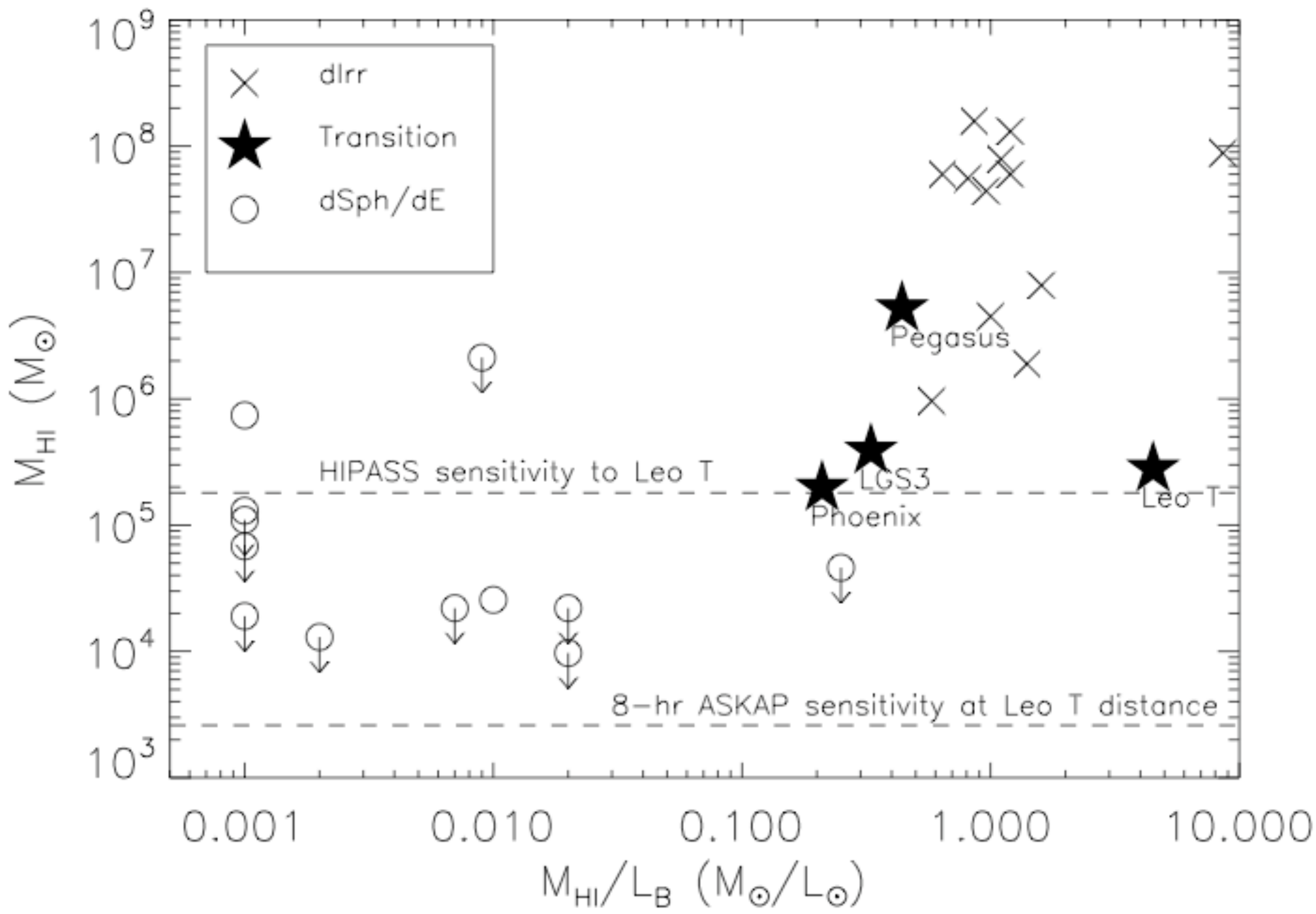
Leo T: a transitional dwarf galaxy in the Local Group
(Irwin et al. 2007; Ryan-Weber et al. 2008)

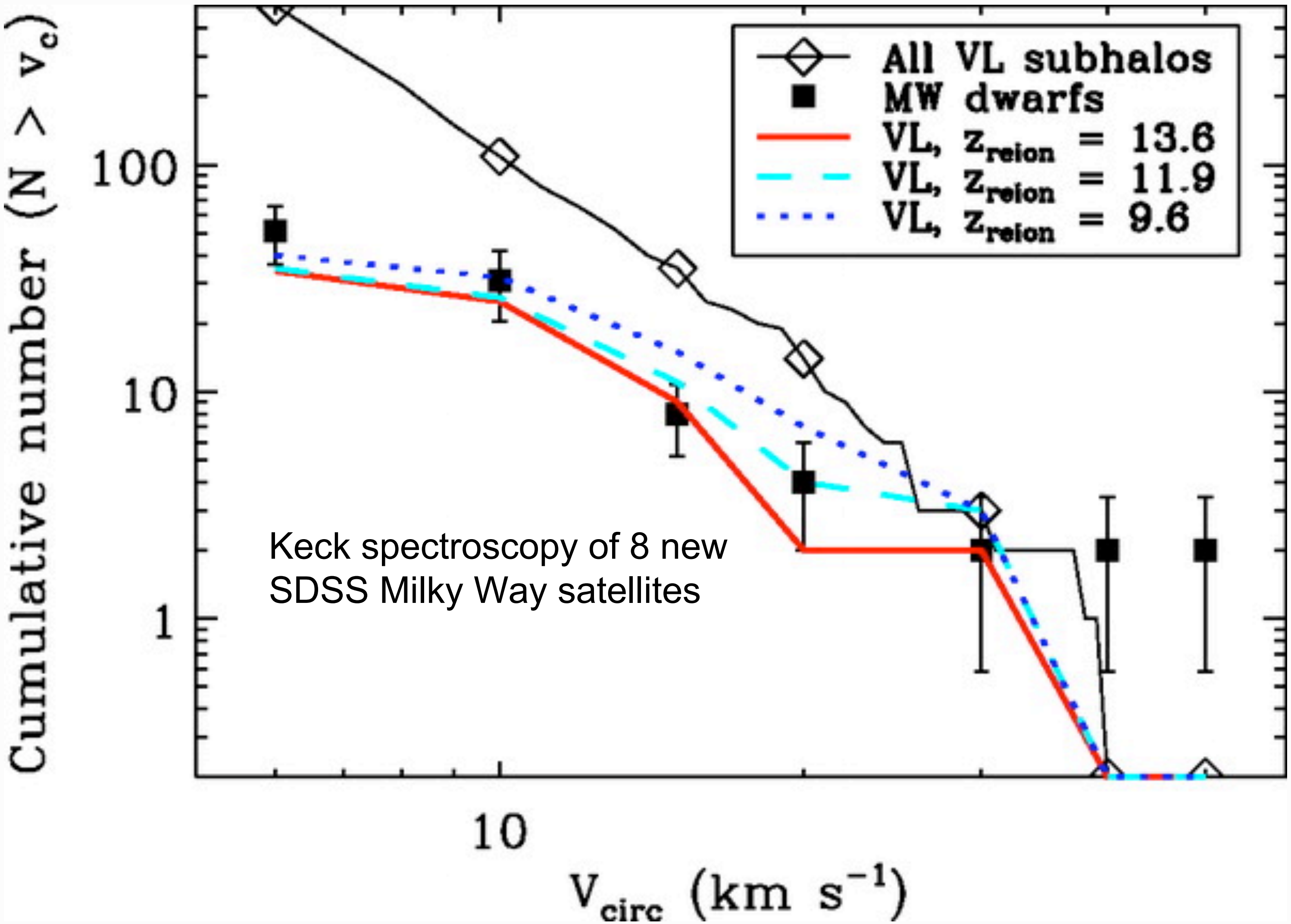


GMRT 30" resolution
(same as WALLABY)

Gas and stellar properties of Local Group dwarfs
(Mateo 1998; Ryan-Weber)



Local Group velocity function: the missing satellite problem (Simon & Geha 2007)



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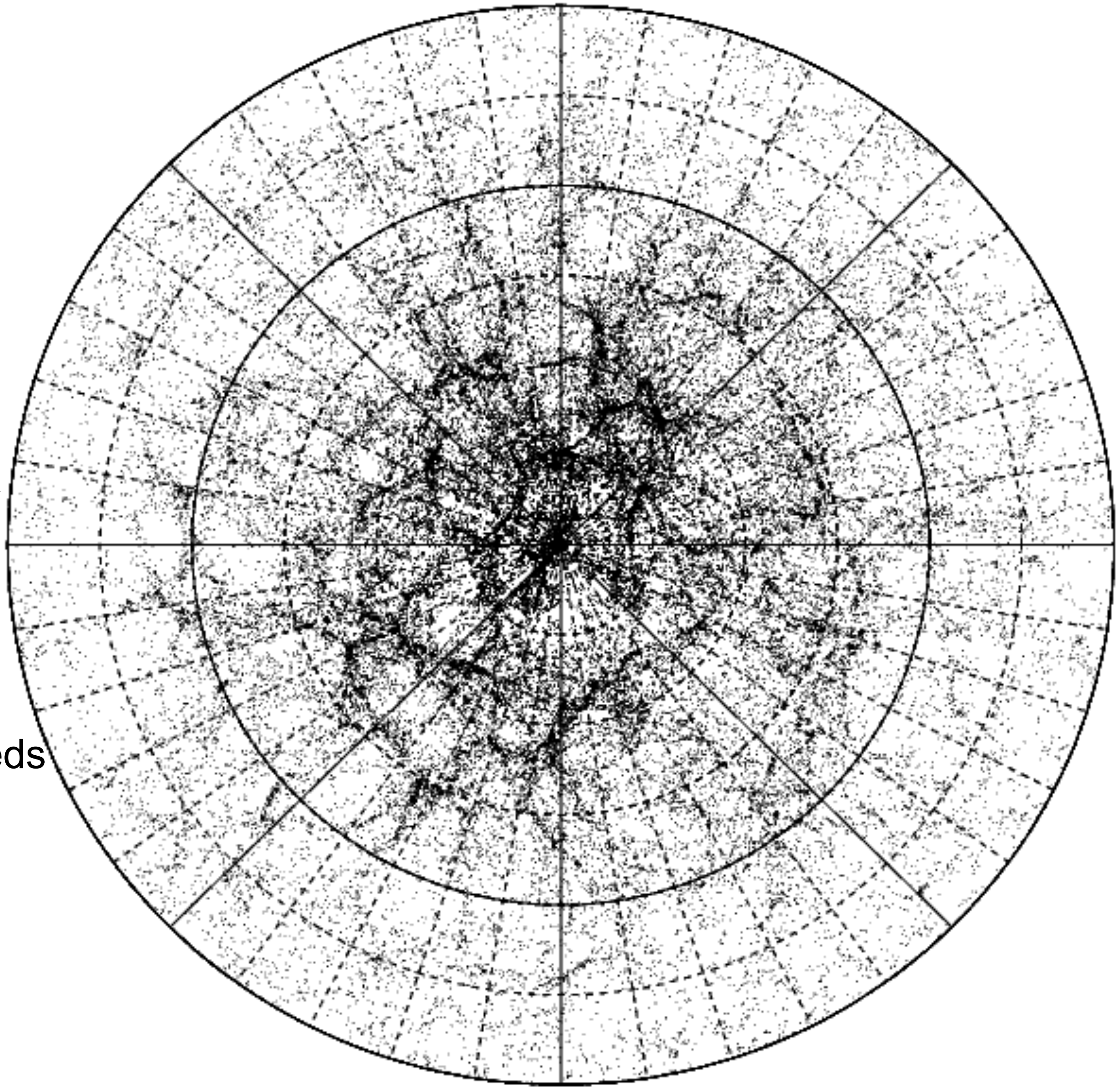
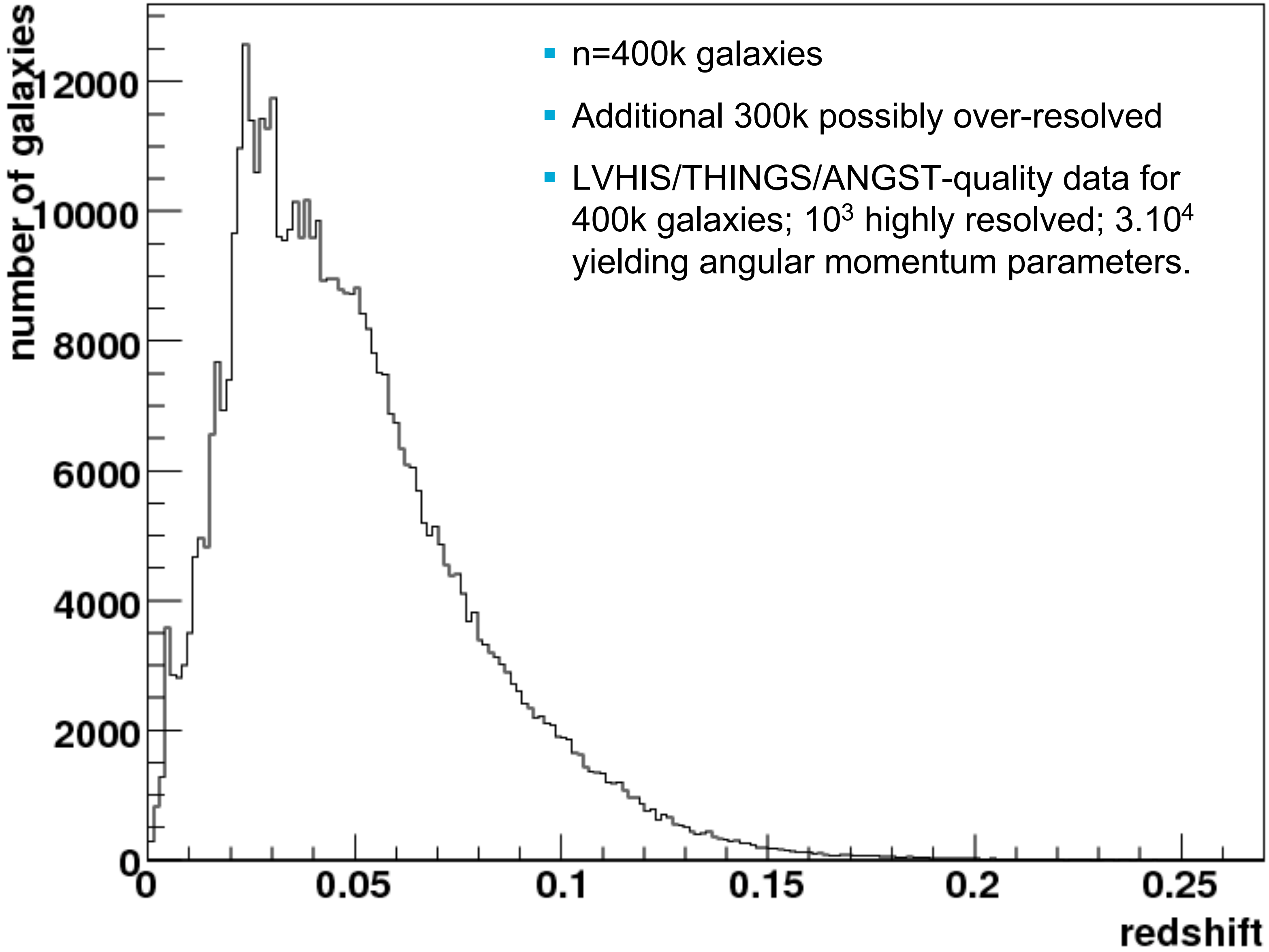
COSMOLOGY WITH WALLABY?
Simulated sky distribution

- Semi-empirical galaxy generator
- 300 Mpc radius, 50 Mpc slice
- 5-σ optimal detection algorithm
- HIPASS 2DSWML mass-velocity function (Zwaan et al. 2005)
- No evolution
- Millennium simulation galaxy seeds (Springel et al. 2005)

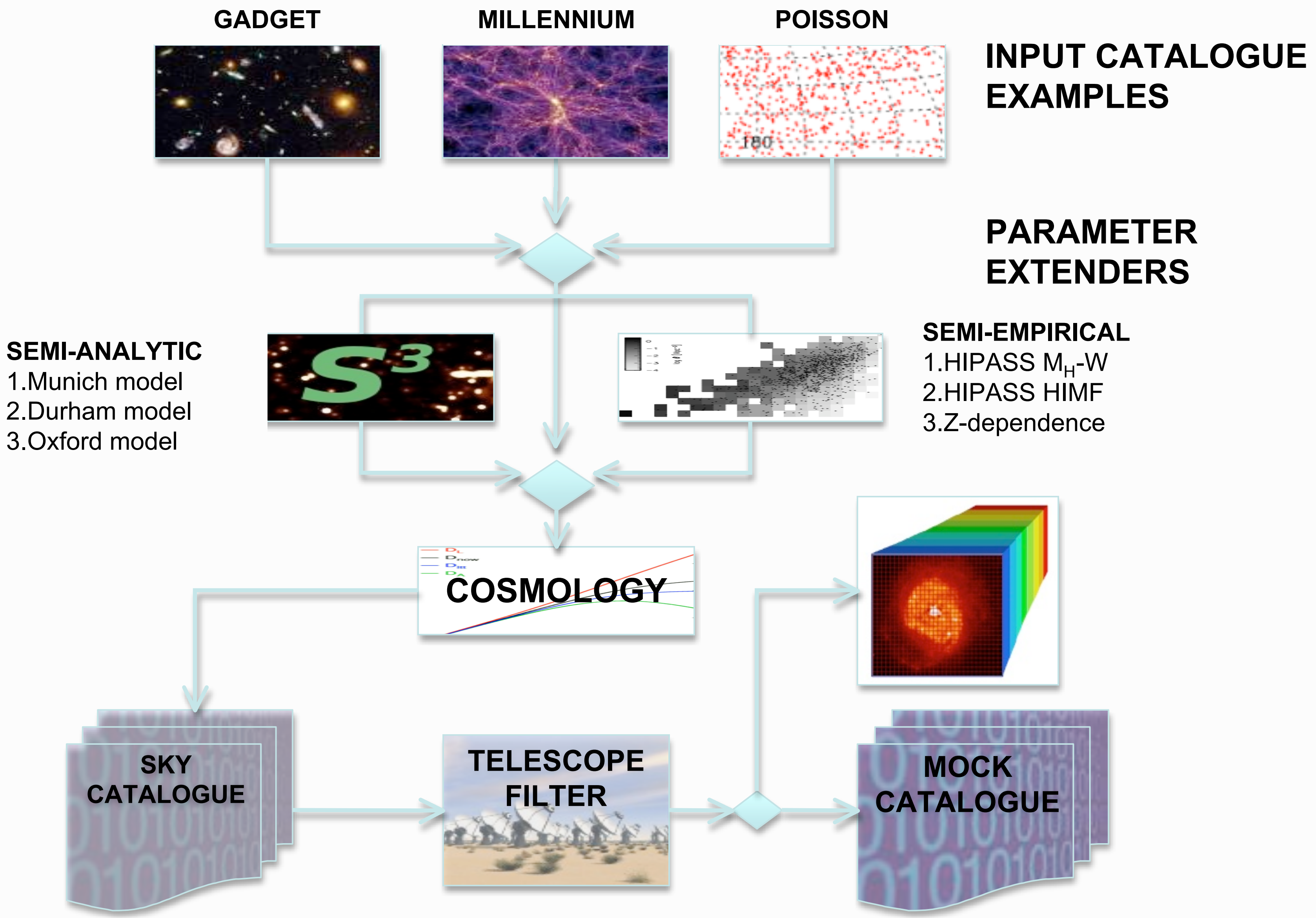


WALLABY: simulated redshift distribution



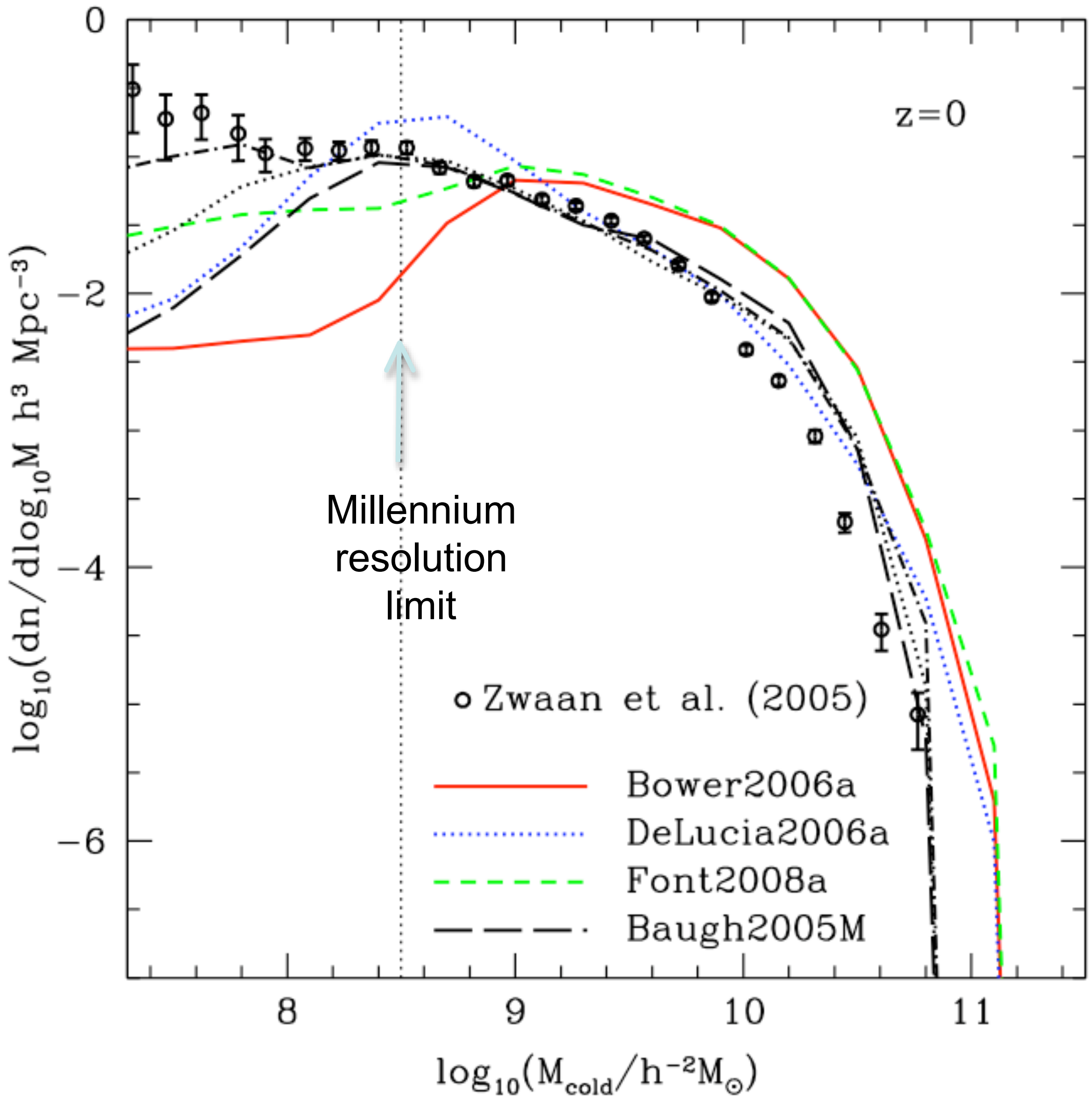
- n=400k galaxies
- Additional 300k possibly over-resolved
- LVHIS/THINGS/ANGST-quality data for 400k galaxies; 10^3 highly resolved; 3.10^4 yielding angular momentum parameters.

Mock catalogues

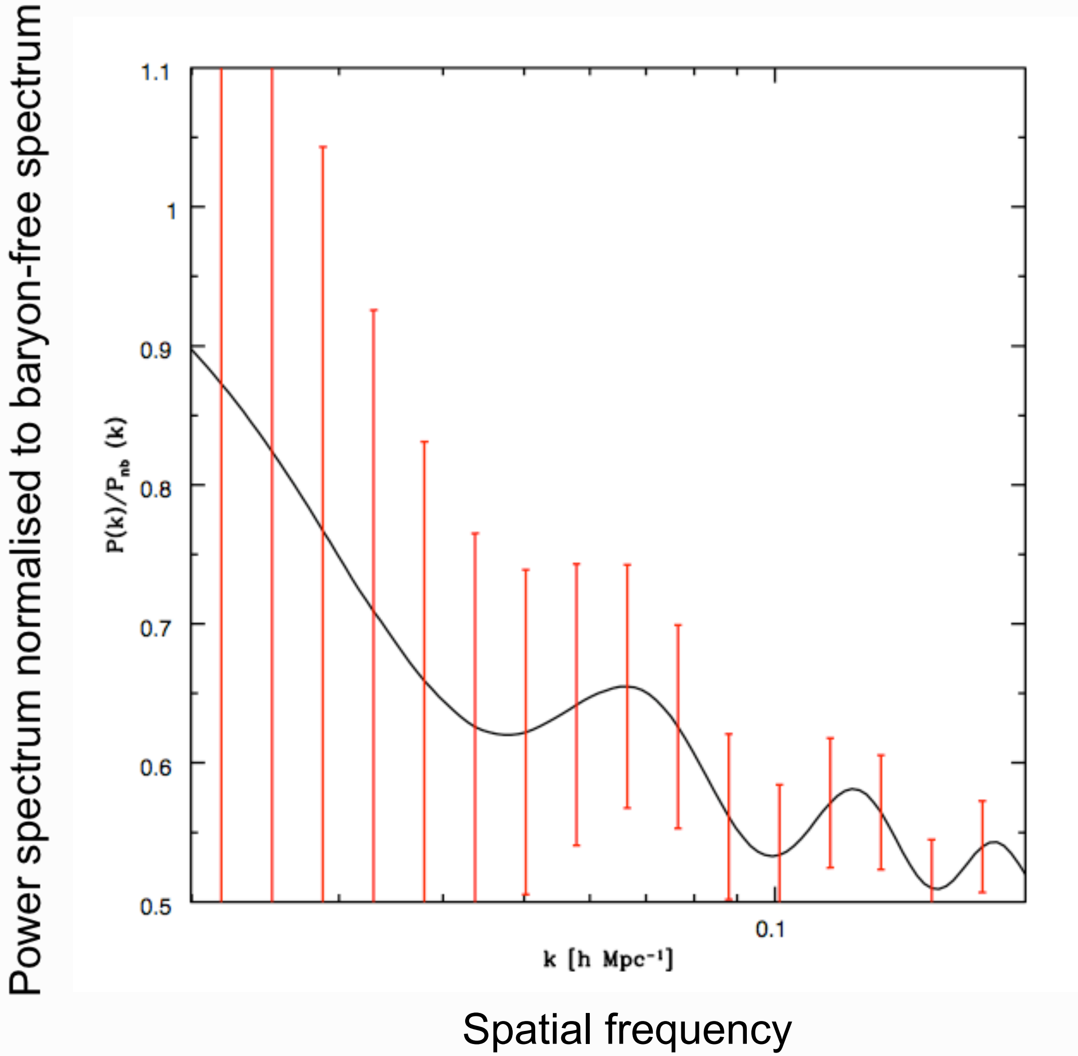


Limitations of (semi-)analytics: HI Mass function

Power & Baugh (2009)



WALLABY matter power spectrum: WMAP5 cosmology (Duffy & Moss)



Cosmology from WALLABY IN THE ERA OF PLANCK?

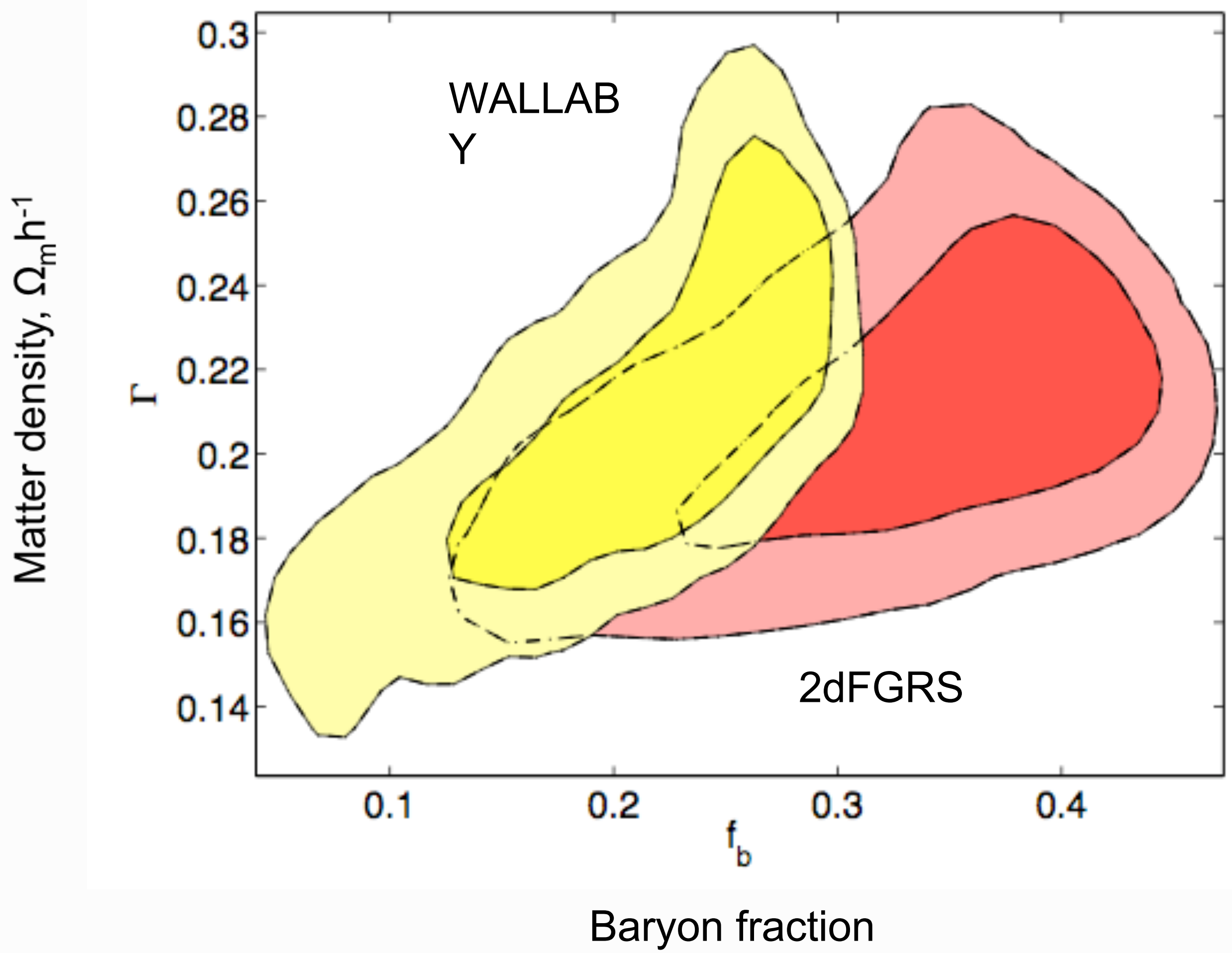
Duffy & Moss

Parameter	Planck + w	Planck + WALLABY + w
$\Omega_b h^2$	0.0227 ± 0.0002	0.0227 ± 0.0002
$\Omega_c h^2$	0.1097 ± 0.0016	0.1099 ± 0.0015
n_s	0.965 ± 0.005	0.963 ± 0.005
$\log(10^{10} A_s)$	3.06 ± 0.01	3.05 ± 0.01
h	0.693 ± 0.108	0.688 ± 0.053
τ	0.091 ± 0.006	0.090 ± 0.004
w	-0.92 ± 0.30	-0.91 ± 0.15

Errors in Hubble Constant and Dark Energy parameter reduced a factor of ~2; no change in accuracy of other parameters

WALLABY cf. 2dFGRS

Duffy & Moss



Wallaby cosmology: an SKA science pathfinder

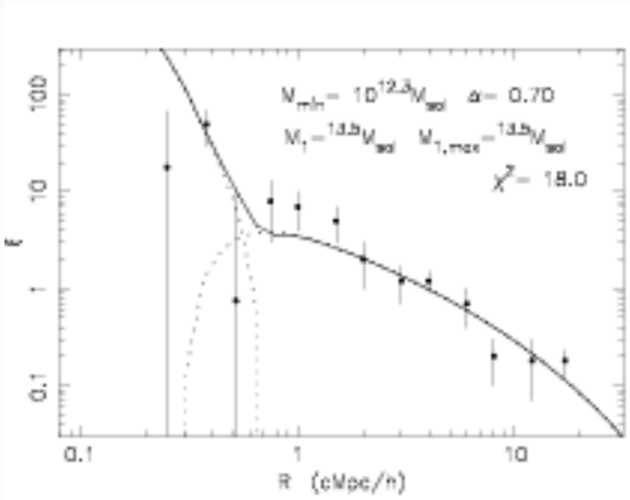
Local density fluctuations (σ_8)

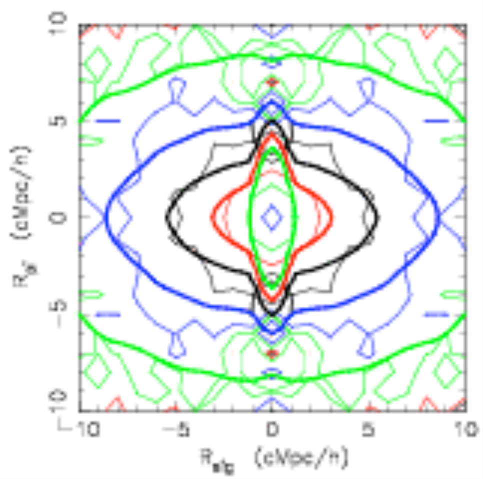
- Tully-Fisher distances will measure local flow field and poorly known rms density fluctuation σ_8 (Abate et al. 2008).

Halo Occupation Distribution

- Description of how gas-rich galaxies populate DM halos.
- Constrains star-formation epoch, growth modes
- HIPASS implies high halo mass cutoff (Wyithe, Brown, Zwaan & Meyer)

Excess galaxy pairs cf random distribution





Projected Distance (Mpc/h) Projected Distance (Mpc/h)

Synergies

HI Synergies

- APERTIF (Dec > +25 deg?)
- MeerKAT (deep follow-up & deep pencil-beam)
- eVLA (deep follow-up)

Radio Synergies

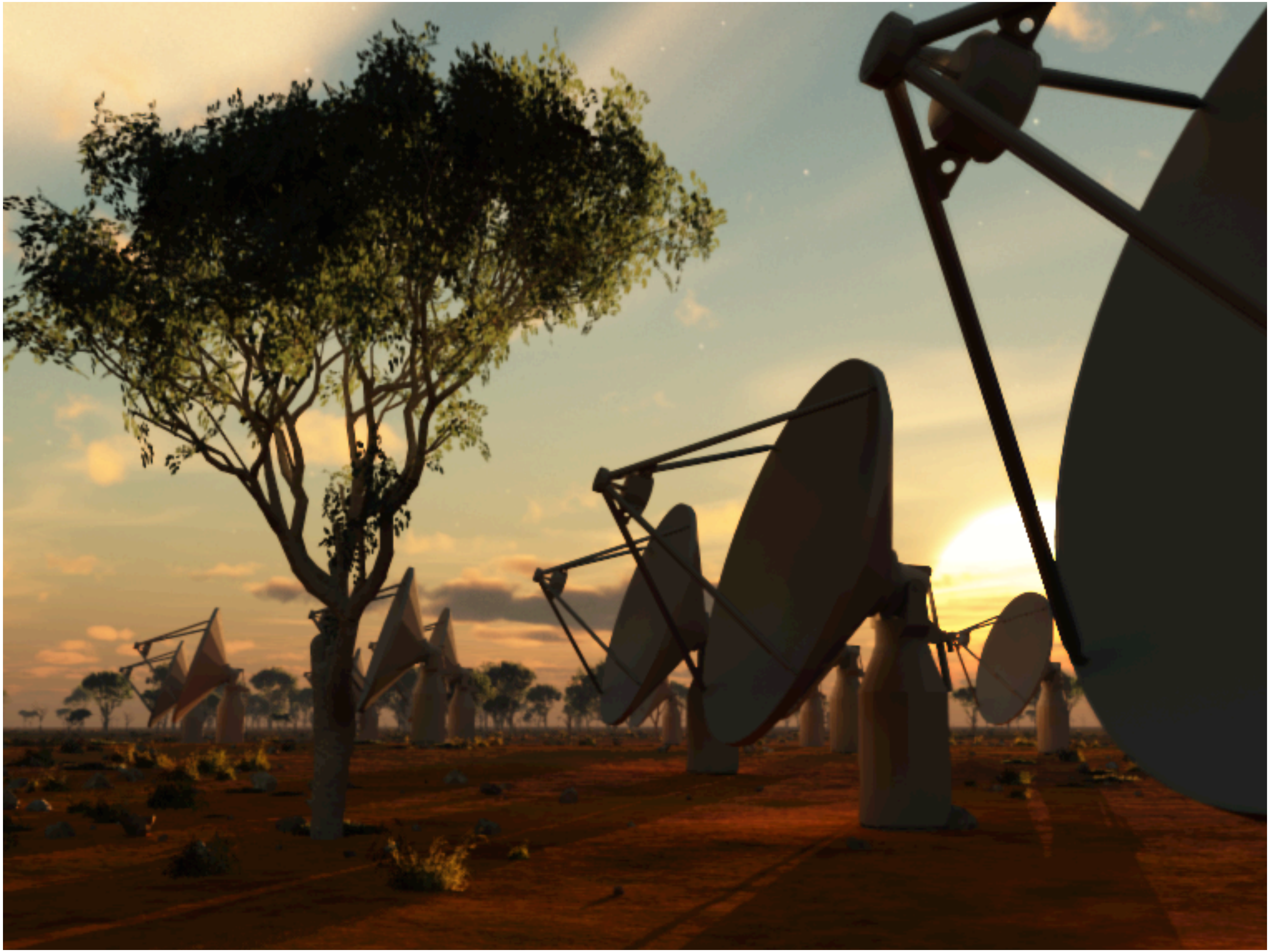
- EMU continuum survey (star formation rates)
- ALMA (molecular content)

Optical/IR Synergies

- VISTA Hemispheric Survey (*ZYJHK*); VST ATLAS (*ugriz*)
- SkyMapper
- Super-6dFGS

Summary

- **Wallaby will provide a public database of HI data for ~0.5M galaxies (if SSP proceeds!)**
- **DR1 ‘instantly’ available following QC**
- **Fields probably observed at the rate of 2-3 per day.**
- **World-class science relating to galaxy formation; galaxy evolution; cosmology (the latter mainly as an ‘SKA’ pathfinder)**
- **Best science will come after combination with other radio and optical/IR surveys.**



Using distance-velocity data to measure z=0 power spectrum amplitude σ_8 (Abate et al. 2008)

- Hubble and non-Hubble velocities will allow a better measure of σ_8 (sensitive to dark energy, neutrino mass etc.)

Table 1. Some recent 68 per cent confidence limits for σ_8 using various cosmological probes: cosmic microwave background (CMB), weak lensing (WL), Lyα forest (Lyα), cluster measurements (CL) and supernovae (SN). This shows that σ_8 could reasonably lie anywhere in the range 0.5–1.

Authors	Probe	σ_8 result	Reference
*WMAP*3 (ΛCDM)	CMB	0.76 ± 0.05	1
*WMAP*3 (Λ CDM $+ m_\nu$)	CMB	0.56 ± 0.10	2
Rozo et al. (2007)	CL	0.92 ± 0.10	3
Benjamin[a] et al. 2007	WL	0.78 ± 0.05	4
Massey[a] et al. 2007	WL	$0.91^{+0.09}_{-0.07}$	5
Gladders et al. (2007)	CL	$0.67^{+0.18}_{-0.13}$	6
Seljak, Slosar & McDonald (2006)	Lyα + CMB + CL + SN	0.85 ± 0.02	7

[a]Assuming $\Omega_m = 0.27$.

References. 1, 2: Spergel et al. (2007); 3: Rozo et al. (2007); 4: Benjamin et al. (2007); 5: Massey et al. (2007); 6: Gladders et al. (2007); 7: Seljak et al. (2006).