WALLABY Overview

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Image credit: CSIRO/Alex Cherney

WALLABY survey details and major goals

Table 1 Survey parameters for HIPASS and WALLABY; updated table from Koribalski (2012a). — Note: An angular resolution of 10 arcsec can be achieved for WALLABY once computing resources allow the processing of all ASKAP baselines (up to 6 km), either for a sample of pre-determined galaxies ('postage stamps') or for the full survey.

	HIPASS	WALLABY
telescope	Parkes	ASKAP
	64-m dish	$36\times12\text{-m}$ dishes
baselines		22 m to \sim 2 km
receiver	21-cm multibeam	Phased Array Feed (Chequerboard)
beams	13	36
field-of-view	$\sim 1 \text{ sq deg}$	$\sim 30 \text{ sq deg}$
$T_{ m sys}/\eta$	$\sim 25 \text{ K}$	$\sim 70 \ { m K}$
observing mode	scanning	dithering/mosaicking
angular resolution	~ 15.5 arcmin	~ 30 arcsec
sky coverage	$\delta < +25^\circ$	$\delta < +30^{\circ}$
	29 343 sq deg	$30 940 \mathrm{sq} \mathrm{deg}$
cubes/fields	$538~(8^{\circ} \times 8^{\circ})$	1120 $(5.5^{\circ} \times 5.5^{\circ})$
frequency coverage	$1362.5 - 1426.5 \ \mathrm{MHz}$	$1130-1430~\mathrm{MHz}$
velocity range (cz)	$-1280 ext{ to } +12 ext{ } 700 ext{ km s}^{-1}$	-2000 to $+77000{\rm kms^{-1}}$
	$z \lesssim 0.04$	$z \lesssim 0.26$
bandwidth	$64 \mathrm{MHz}$	300 MHz
no. of channels	1 024	16 200
channel width	$13.2{ m kms^{-1}}$	$\sim 4{\rm kms^{-1}}$
velocity resolution	$18.0{\rm kms^{-1}}$	${\sim}4{\rm kms^{-1}}$
rms per channel	${\sim}13~{ m mJybeam^{-1}}$	$\sim 1.6 \text{ mJy beam}^{-1}$
rms per 0.1 MHz	$\sim 10 \text{ mJy beam}^{-1}$	$\sim 0.7 \mathrm{~mJy beam^{-1}}$
H _I detections	${\sim}5500$	~ 500000
mean redshift (z)	~ 0.01	~ 0.05

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

Entire Southern Sky! (Potentially)

~200,000 or more detections!

1000's resolved! (All HIPASS sources + others)

Some science goals:

- (a) measurements of the velocity fields and rotation curves of galaxies
- (b) Effects of Environment
- (c) accurate HI mass function
- (d) refinement of cosmological params
- (e) dynamics of high-velocity clouds near the Milky Way
- (f) a census of gas-rich galaxies in the vicinity of the Local Group

Koribalski et al. 2020

Phase 1 Pilot Survey



• Three pilot fields observed:

- Norma cluster
- Hydra cluster
- NGC4636 group
- Testing the processing pipeline; resulting noise stats, validation and image quality in the final cubes etc
- Phase I Pilot survey processing, data archiving complete. Individual un-mosaicked footprint data available in CASDA for all three fields.
- 100s of HI detections in each field!
- Source catalogues, moment maps, cubelets, kinematics models are currently available to internal WALLABY team



Phase 2 Pilot Survey Updates

Phase 2 target fields

- NGC 5044 (4 tiles; tile 4 quality gate; tile 3 commensal with EMU & POSSUM)
- Virgo South (1 tile, quality gate)
- NGC 4808 (1 tile)
- Vela (1 tile, commensal with GASKAP)





Credit: Karen Lee-Waddell

Aims:

- Test processing parameters to deal with bright cont. sources
- Commensality with other ASKAP surveys

NGC 5044 quality gate field

- NGC 5044 quality gate field (tile 4A and 4B) fully processed and mosaics uploaded on to CASDA
- 7 antennas flagged/not used, affecting rms (~1.9 mJy/chan instead of 1.6 mJy/chan)
- No major issues from the processing side
- Preliminary run of SoFiA on the field -> 500 600 genuine HI detections

Moment 0 map of NGC 5044 field from SoFiA



NGC 5044 field Galactic data

- WALLABY Milky Way/Galactic field (MW) data to be processed into separate cubes
- MW data from the current quality gate field has been processed and uploaded to CASDA
- Data quality excellent
- Initial run of SoFiA on the Galactic field (vel. range 100 km/s < cz < 1000 km/s) -> 2 Dwarf galaxies and 2 IVCs/HVCs

Moment 0 map of Gal. field from NGC 5044 data



- 6km visibility data of select sources in the NGC5044 (tile4) field split-out for 10arcsec Postage stamps. Currently working on implementing a processing pipeline for postage stamps. Different weighting schemes etc being tested.
- Virgo South quality gate field observed. Processed using the default parameters & using new set of revised parameters for better cleaning of artefacts associated with bright cont. sources in the field. Validation tests currently underway.
- NGC5044_3A (EMU-POSSUM-WALLABY commensal field) has been observed and processed. Validation tests currently underway
- Vela (WALLABY-GASKAP commensal field) has been observed, waiting to be processed.
- Current aim to finish processing, validating all Pilot Phase 2 fields by early next year.
 Develop 10" postage stamp pipeline

10 arcsec postage stamps





HIPASS J1325-21

In three resolutions, 30, 20 and 10 arcsec

Goals:

- Produce 10" images for select subsample
- Deliver kinematic models and rotation curves
- Enable science -> kinematic studies, star formation studies, effects of environment etc

WALLABY Postage stamp tests

- Using NGC 5044 quality gate data for the tests
- Identified 3 HIPASS sources for imaging tests
- Steps: Split-out calibrated 6 km visibilities -> imaging -> imcontsub -> Primary beam correction
 -> mosaicking two footprint data
- Mosaicking one beam from each footprint
- Different weighting and resolution (10 and 20 arcsec) schemes -> noise in image cubes? Integrated flux of sources?
- 10 arcsec data may be relevant to the Hector team. Potential science includes
 - Comparing/combining rotation curves
 - Kinematic studies
 - Angular momentum studies and more



Tapering = 15 arcsec Robust = 0.5 Beam = 20 arcsec 10 kpc 10 kpc Tapering = 15 arcsec Beam = 20 arcsec 10 kpc 10 kpc \bullet Robust = 0.5 Beam = 20 arcsec 10 kpc \bullet 10 kpc



Tapering = 15 arcsec Robust = 0.5 HIPASS J1325-21 Beam = 20 arcsec 10 kpc \bullet Tapering = 15 arcsec Beam = 20 arcsec 10 kpc \bullet Robust = 0.5 Beam = 20 arcsec

10 kpc

10 kpc

10 kpc

10 kpc



HIPASS J1335-24

Tapering = 15 arcsec Robust = 0.5 Beam = 20 arcsec



Tapering = 15 arcsec Beam = 20 arcsec



Robust = 0.5 Beam = 20 arcsec











 σ_{res} (km/s)



HIPASS J1324-24

Taper = 10 arcsec; Beam = 12 arcsec Mask -> SMOOTH Variables -> VROT, PA, INC

HIPASS J1324-24

Taper = 15 arcsec; Beam = 20 arcsec Mask -> SMOOTH Variables -> VROT, PA, INC



HIPASS J1335-24

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Radius (arcsec)

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80

20

40

Radius (arcsec)

60

80

km/s)

80

Taper = 10 arcsec; Beam = 12 arcsec Mask -> SMOOTH Variables -> VROT, PA, INC

HIPASS J1335-24

Taper = 15 arcsec; Beam = 20 arcsec Mask -> SMOOTH Variables -> VROT, PA, INC

WALLABY plans for 2022

- Review of ASKAP Survey Science Proposals (RASSP) outcome in Jan 2022 > determines how much sky coverage WALLABY will be allocated
- Start full survey observations in ~ March 2022

Data release plan:

- Level 7 (science ready) data products: Source catalogues, moment maps, HI spectra, image cubes/cubelets for all detections, kinematic models for well resolved galaxies (> 4 beams)
- Releases to occur annually -> potentially end of first quarter of each year

Access to data:

Level 5/6 data products -> CSIRO ASKAP Science Data Archive (CASDA)

Level 7 data products:

- Internal WALLABY team data access -> Australian SKA Region Centre (AusSRC)
- Kinematic models -> Canadian Initiative for Radio Astronomy Data Analysis (CIRADA)
- Multi-wavelength cutouts -> Spanish Prototype of an SKA Regional Centre (SPSRC)
- Public data access -> CIRADA and Canadian Astronomy Data Centre (CADC)

What may be relevant for Hector:

- Image cubes, moment maps, kinematic models
- 10 arcsec high-res data (as Hector diameter ~ 15 28 arcsec on each galaxy?)

Points of contact in the WALLABY team:

- Lister Staveley-Smith (PI)
- Tobias Westmeier (Project Manager)
- Karen Lee-Waddell (Project Scientist)
- Chandra Murugeshan (Deputy Project Scientist)
- Luca Cortese and Li Shao (Multi-wavelength and ASKAP survey synergies)