ATCA Legacy Project Expression of Interest: WALLABY@ATCA

Title: **WALLABY@ATCA**

Authors: *Lister Staveley-Smith, Bärbel Koribalski, Paolo Serra, Tobias Westmeier (on behalf of the WALLABY team)*

Point of contact: *Tobias Westmeier*

Scientific Aims

The aims of the Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) are to discover and examine the distribution and neutral hydrogen (HI) properties of up to 500,000[1] galaxies out to a redshift of 0.26 (equivalent to a look-back time of ~ 3 Gyr) in order to study: (1) galaxy formation and the missing satellite problem in the Local Group, (2) evolution and star-formation in galaxies, (3) mergers and interactions in galaxies, (3) the HI mass function and its variation with galaxy density, (4) physical processes governing the distribution and evolution of cool gas at low redshift, (5) cosmological parameters relating to gas-rich galaxies, and (6) the nature of the cosmic web.

WALLABY will provide the largest, most homogeneous HI sample of galaxies. It will have a flux sensitivity some 20 times better than the HI Parkes All-Sky Survey (HIPASS), at a velocity resolution some 4 times better, and will detect 20 times more galaxies than the recently completed ALFALFA survey with six times better spatial resolution. WALLABY will detect dwarf galaxies (M_{HI} = 10^8 $M_\odot$) out to a distance of ~ 60 Mpc, massive galaxies (M_{HI} = 6×10^9 $M_\odot$) to ~ 500 Mpc, and super-HI massive galaxies like Malin 1 (M_{HI} = 5×10^{10} $M_\odot$) to the survey 'edge' of 1 Gpc.

The driving motivation for WALLABY@ATCA is to provide a regular stream of follow-up HI (and continuum) observations of noteworthy WALLABY discoveries. These discoveries will include: (1) the extrema of the galaxy population such as 'dark' galaxies [2] and HI-massive galaxies, which guide our understanding of galaxy formation and evolution; (2) new gas-rich Local Group galaxies [3] whose dynamical characteristics will allow us to better define the sphere of influence of the early ionizing cocoon and hot halo of the Milky Way; (3) new local Volume galaxies [4] which will allow us to measure the faintest end of the HI mass function [5]; (4) new interacting systems in a variety of environments (field, group, cluster), which will allow us to quantify the relative influence of physical effects such as tidal and ram-pressure forces and its variation with density [6][7].

WALLABY@ATCA would only observe a small fraction of 'interesting' WALLABY discoveries. We expect around 1% of WALLABY discoveries to merit follow-up observations; however, the time requested in Table 1 (3000 h) is only sufficient to observe 1 in 2000 discoveries. Nonetheless, this would significantly leverage ASKAP science and give rise to a new stream

1 Based on nominal ASKAP telescope specifications and requested time allocation [1].

of value-added scientific publications in a larger, better managed and coordinated approach than is possible by writing hundreds of disconnected PI-driven proposals. This in turn, would significantly advance the scientific utility of ATCA over other facilities such as the JVLA and MeerKAT, which would otherwise have superior performance.

Since the point-source sensitivities of ASKAP and ATCA are similar at 1.4 GHz, what advantages does WALLABY@ATCA offer over WALLABY itself? Firstly, ASKAP is a survey instrument, and it would be a waste of its survey capability to re-observe a single area of sky for the observation of a single object. Secondly, the ATCA is re-configurable and can offer three times the resolution of ASKAP in its most extended configuration (WALLABY is limited to processing data from the 2-km ASKAP core) or 400 times the column density sensitivity in its least extended configuration.

As shown in Table 1, we do not expect any significant time request until 2017OCTS, or later according to the current ASKAP timeline.

Table 1: Requested ATCA observational parameters for WALLABY@ATCA

Area of sky	Declination < −20°
LST range	0 to 24 h
Frequency	1200 to 1430 MHz
CABB mode	CFB 1M−0.5k, CFB 64M−32k
Array configuration	All (H75 to 6km)
Observing strategy	12-hour synthesis of a single source, or small number of sources, at a time
Sensitivity	Typically 2.7 mJy/beam per 6.6 km/s channel (4 × 12 h), corresponding to 35 K (6-km configuration) or 2.3 mJy/beam per 6.6 km/s channel (1 × 12 h), corresponding to 22 mK (H75 configuration), according to ATCA sensitivity calculator (robust −1)
Observing time	3000 h total at 300 h per semester from 2017OCTS
Resources	The WALLABY team consists of 124 members, including an early-science active core of at least 30 members and students
Team expertise	Good knowledge of spectral-line processing

References

[1] Duffy et al. 2012, MNRAS, 426, 3385
[2] Janowiecki et al. 2015, ApJ, 801, 96
[3] Ryan-Weber et al. 2008, MNRAS, 384, 535
[4] Giovanelli et al. 2013, AJ, 146, 15
[5] Martin et al. 2010, ApJ, 723, 1359
[6] Spekkens et al. 2014, ApJ, 795, L5
[7] Wetzel et al. 2013, MNRAS, 432, 336