Canadian Prospects in HI:
Extragalactic

Kristine Spekkens
Royal Military College of Canada
Canadian Radio Astronomy, Sept 2017
Canadian Prospects in HI: Extragalactic

- Canada and the current state of the art
- Prospects through 2025: SKA pathfinders
- Prospects through 2035: SKA1

Kristine Spekkens
Canadian Radio Astronomy, Sept 2017
Atomic Gas in Galaxy Disks

State of the art: dozens of well-resolved HI disks from the biggest interferometers

Walter+08
Atomic Gas in Galaxy Disks

Σ

Walter+08
Atomic Gas in Galaxy Disks

Walter+08

Arecibo

SRI, USRA, UMET

HI Flux

Doppler Vel
Atomic Gas in Galaxy Disks

State of the art: tens of thousands of HI profiles from the biggest single dishes

e.g. Barnes+ 02; Haynes+ 11
Arecibo
Atomic Gas in Galaxy Disks

State of the art: tens of thousands of HI profiles from the biggest single dishes

e.g. Barnes+ 02; Haynes+ 11

Arecibo

Extensive use
Atomic Gas in Galaxy Disks

State of the art: dozens of well-resolved disks from the biggest interferometers

Walter+08
Atomic Gas in Galaxy Disks

State of the art: dozens of well-resolved disks from the biggest interferometers

Wiegert+ 2014

Expertise
Atomic Gas in Galaxy Disks

State of the art: dozens of well-resolved disks from the biggest interferometers

Expertise

Lee-Waddell+ 2016

Wiegert+ 2014

Walter+08
Atomic Gas in Galaxy Disks

State of the art: dozens of well-resolved disks from the biggest interferometers

Expertise

Wiegert+ 2014

Lee-Waddell+ 2014

Mok+ 2017

Walter+08
Prospects through 2025: SKA Pathfinders

HI surveys (among others) from 2018-2023

Exgal HI Science Goals

Unresolved detections at high $z$ ($z \sim 0.5$)

Statistics of resolved detections in local universe
HI emission line surveys: 2018 - 2025

- SDSS
- UKIDSS
- WiggleZ
- VST-KIDS/VISTA VIKING
- 2dFGRS
- SAMI
- CALIFA/MaNGA

Bryant+ 2015
HI emission line surveys: 2018 - 2025

~35,000 deg²
res = 30”, 5 km/s
Detect $M_{\text{HI}} = 10^7$ Mo out to Virgo

Bryant+ 2015
HI emission line surveys: 2018 - 2025

- WALLABY + WNSHS
  - ~35,000 deg²
  - res = 30”, 5 km/s
  - Detect $M_{\text{HI}} = 10^7$ Mo out to Virgo

- MALS + MDS
  - ~1,500 deg²
  - res = 12”, 5 km/s
  - Detect $M_{\text{HI}} = 10^{6.8}$ Mo out to Virgo

- 2MASS
- SDSS
- UKIDSS
- WiggleZ
- VST-KIDS/VISTA VIKING
- 2dFGRS
- SAMI
- CALIFA/MaNGA
- Wallaby
- WNSHS
- MDS
- MALS

Bryant+ 2015
HI emission line surveys: 2018 - 2025

WALLABY + WNSHS

~35,000 deg$^2$
res = 30", 5 km/s
Detect $M_{HI} = 10^7$ Mo out to Virgo

MALS + MDS

~1,500 deg$^2$
res = 12", 5 km/s
Detect $M_{HI} = 10^{6.8}$ Mo out to Virgo

MIGHTEE + Fornax + MHONGOOSE

~60 deg$^2$
res = 7 - 90", 5 km/s
Detect $M_{HI} = 10^{5.8}$ Mo out to Virgo

Bryant+ 2015
HI emission line surveys: 2018 - 2025

**WALLABY + WNSHS**
- $\sim 35,000 \text{ deg}^2$
- $\text{res} = 30''$, 5 km/s
- Detect $M_{\text{HI}} = 10^7 \text{ Mo}$ out to Virgo

**MALS + MDS**
- $\sim 1,500 \text{ deg}^2$
- $\text{res} = 12''$, 5 km/s
- Detect $M_{\text{HI}} = 10^{6.8} \text{ Mo}$ out to Virgo

**LADUMA + DINGO + CHILES**
- $\sim 60 \text{ deg}^2$
- $\text{res} = 6-30''$, 5 km/s
- Detect $M_{\text{HI}} = 10^5 \text{ Mo}$ out to Virgo

**MIGHTEE + Fornax + MHONGOOSE**
- $\sim 60 \text{ deg}^2$
- $\text{res} = 7-90''$, 5 km/s
- Detect $M_{\text{HI}} = 10^{5.8} \text{ Mo}$ out to Virgo
Prospects through 2025: SKA Pathfinders

**Exgal HI Science Goals**

- **Unresolved detections at high z** \((z \sim 0.5)\)
- **Statistics of resolved detections in local universe**

**HI surveys (among others) from 2018-2023**

- **ASKAP**
- **WSRT + Apertif**
- **MeerKAT**
Prospects through 2025: SKA Pathfinders

**ASKAP**

**WSRT + Apertif**

**MeerKAT**

HI surveys (among others) from 2018-2023

**Exgal HI Science Goals**

Unresolved detections at high z ($z \sim 0.5$)

Statistics of resolved detections in local universe
2018-2025: ASKAP Wallaby

- Southern sky ($\delta<30^\circ$) HI survey at 30″/13″, 5km/s resolution
2018-2025: ASKAP Wallaby

- Southern sky ($\delta < 30^\circ$) HI survey at 30″/13″, 5km/s resolution

Duffy +12 semi-analytic simulations (present day)

Wallaby will resolve the structure of $\sim 10,000$ HI disks
2018-2025: ASKAP Wallaby

- Southern sky (δ<30°) HI survey at 30”/13”, 5km/s resolution

Wallaby will resolve the structure of ~10,000 HI disks
2018-2025: ASKAP Wallaby

- Southern sky ($\delta<30^\circ$) HI survey at 30″/13″, 5km/s resolution

Wallaby will resolve the structure of $\sim$10,000 HI disks
Conceptual Pipeline

Kinematics group:

KS+ 2012
Conceptual Pipeline

Kinematics group:

2D pipeline
Oh, Spekkens
Oh+ 17

3D pipeline
Kamphuis, Jozsa
Kamphuis+ 15

Pipeline elements are in place; pipeline under construction

KS+ 2012
Extragalactic HI Science, 2025-2035: SKA1
1. Resolved HI kinematics and morphologies of massive galaxies as a function of $z$
2. High spatial resolution studies of the ISM in the nearby universe
Resolved HI Disks and SKA1

Resolved HI disks: SKA pathfinders

Obreschkow+ 09
Resolved HI Disks and SKA1

Resolved HI disks: SKA pathfinders

Resolved HI disks, SKA1

SKA1 will resolve disks out to $z \sim 0.8$, probing the angular momentum assembly of galaxies
ISM in Nearby Galaxies

Arp 220, ALMA

CO J=6–5 Intensity Map

Rangwala+ 15

THINGS, Walter+ 08
ISM in Nearby Galaxies

Arp 220, ALMA

THINGS, Walter+ 08

THINGS ~6” BEAM ($n_{HI} > 10^{20}$ cm$^{-2}$)
ISM in Nearby Galaxies

Arp 220, ALMA

THINGS ~6” BEAM
\( n_{HI} > 10^{20} \text{ cm}^{-2} \)

SKA1: Deep, high-resolution maps of ~30 nearby galaxies + PI project opportunities

Canadian flag
Summary

• Canadian expertise lies in exploiting resolved HI maps to constrain galaxy structure and evolution

• Through 2025, SKA precursors will deliver statistical samples of resolved galaxies in the local universe; Canada leads pipeline development

• Through 2035, SKA1 science priorities are to resolve HI in galaxies to $z \sim 0.8$ and deliver $1''$ resolution ISM maps in the local universe. These mesh well with Canadian strengths.