Extragalactic H\textsc{i} Science: ongoing activities towards the SKA

Paolo Serra
Where from?
## Wide area single-dish surveys

<table>
<thead>
<tr>
<th></th>
<th><strong>HIPASS</strong></th>
<th><strong>ALFALFA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>area</strong></td>
<td>$3\pi$</td>
<td>$2/3 \pi$</td>
</tr>
<tr>
<td><strong>resolution</strong></td>
<td>15 arcmin, 18 km/s</td>
<td>4 arcmin, 10 km/s</td>
</tr>
<tr>
<td><strong>noise (20 km/s)</strong></td>
<td>13 mJy/beam</td>
<td>1.5 mJy/beam</td>
</tr>
<tr>
<td><strong>nr detections</strong></td>
<td>5,000</td>
<td>30,000</td>
</tr>
<tr>
<td><strong>redshift range</strong></td>
<td>0 - 0.04</td>
<td>0 - 0.06</td>
</tr>
</tbody>
</table>

Barnes et al. (2001)  
Haynes et al. (2018)
Global scaling relations

Hunag et al. (2012)
Pointed interferometric observations

~ 1000 resolved galaxies
detailed morphology
kinematics, rotation curves
\( z \sim 0 \)

Where from?

$\sim 10^4$ unresolved galaxies at $z < 0.05$

$\sim 10^3$ resolved galaxies at $z \sim 0$
Where from?

$\sim 10^4$ unresolved galaxies at $z < 0.05$

$\sim 10^3$ resolved galaxies at $z \sim 0$

Verheijen et al. (2007)
Where from?

$\sim 10^4$ unresolved galaxies at $z < 0.05$
$\sim 10^3$ resolved galaxies at $z \sim 0$

Where to?

$\sim 10^6$ unresolved galaxies at $z < 1.5$
$\sim 10^4$ resolved galaxies at $z < 0.1$
HI surveys wedding cake

- LADUMA (MeerKAT)
- CHILES (VLA)
- MHONGOOSE (MeerKAT)
- FORNAX (MeerKAT)
- MIGHTEE-HI (MeerKAT)
- DINGO (ASKAP)
- APERTIF - M
- MALS (MeerKAT)
- WALLABY (ASKAP)
- APERTIF - S

wider area
more sensitive, higher z
<table>
<thead>
<tr>
<th></th>
<th>WALLABY</th>
<th>ALFALFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>area</td>
<td>$3\pi$</td>
<td>$2/3\pi$</td>
</tr>
<tr>
<td>resolution</td>
<td>0.5 arcmin, 4 km/s</td>
<td>4 arcmin, 10 km/s</td>
</tr>
<tr>
<td>noise (20 km/s)</td>
<td>0.7 mJy/beam</td>
<td>1.5 mJy/beam</td>
</tr>
<tr>
<td>nr detections</td>
<td>500,000</td>
<td>30,000</td>
</tr>
<tr>
<td>redshift range</td>
<td>0 - 0.26</td>
<td>0 - 0.06</td>
</tr>
</tbody>
</table>

P.I.’s Koribalski & Staveley-Smith

ASKAP

other wide-area surveys at low z with APERTIF

see Dane Klenier’s talk
P.I.’s Baker, Blyth, Holwerda
MeerKAT
L-band & UHF

from S. Blyth’s talk at PHISCC 2014
MeerKAT Fornax Survey
P.I. Serra
Area~2×1 Mpc²
N(HI)~10^{19} cm^{-2} @ 1 kpc
N(HI)~10^{18} cm^{-2} @ 10 kpc
M(HI)~5×10^5 M☉

E. de Blok (ASTRON, Kapteyn, UCT)
G. Bryan (Columbia)
R.-J. Dettmar (Bochum)
B. Frank (SARAO)
F. Govoni (INAF - Cagliari)
G. Józsa (SARAO, Rhodes)
D. Kleiner (INAF - Cagliari)
R. Kraan-Korteweg (UCT)
A. Loni (INAF - Cagliari, UniCa)
F. Maccagni (INAF - Cagliari)
D. Molnar (INAF - Cagliari)
M. Murgia (INAF - Cagliari)
T. Oosterloo (ASTRON, Kapteyn)
R. Peletier (Kapteyn)
R. Pizzo (ASTRON)
M. Ramatsoku (INAF - Cagliari)
M. Smith (Cardiff)
S. Trager (Kapteyn)
J. van Gorkom (Columbia)
M. Verheijen (Kapteyn)

see Filippo Maccagni’s talk

Image credit: ESO. Acknowledgement: Aniello Grado and Luca Limatola.
NGC 1427A (ATCA)

Hilker+ 97,05; Chaname+ 00; Gregg+ 03; Mora+ 15
NGC 1427A (ATCA)

Hilker+ 97.05; Chaname+ 00; Gregg+ 03; Mora+ 15

10% of HI in the tail

Lee-Waddell et al. (2018)
NGC 1427A (ATCA)

Hilker+ 97,05; Chaname+ 00; Gregg+ 03; Mora+ 15

Lee-Waddell et al. (2018)

Also using deep FDS VST images by Peletier (Kapteyn) and Iodice (Capodimonte)
Won’t be easy
Huge data volumes

ASKAP won’t store full-resolution visibilities

MeerKAT will but for just ~1 year
Radio Frequency Interference

\[ z = 0.1 - 0.2 \]
Source finding

Image credit: N. Giese
Coordinated effort of the extragalactic HI community
**PHISCC* meetings**

2009 Bunkerbay - *Australia*
2010 Arniston - *South Africa*
2011 Perth - *Australia*
2011 Kloster Seeon - *Germany*
2012 Cape Town - *South Africa*
2013 Sydney - *Australia*
2014 ASTRON - *the Netherlands*
2015 Rutgers University - *U.S.*
2016 Cape Town - *South Africa*
2017 Pune - *India*
2018 Pingtang - *China*
2019 Perth - *Australia*

(*) Pathfinders HI Science Coordination Committee

Sessions at next PHISCC

- Reference Fields (Adams)
- Database & products for public release (Staveley-Smith)
- RFI flagging and mitigation (Moss)
- Data quality assessment (Adams)
- New lessons in high/deep dynamic range imaging (Smirnov)
- Visualisation (Taylor)
- Source finding (Westmeier)
- Source parameterisation (Oh)
- SKA HI-SWG (Verdes-Montenegro)
Tobias Westmeier, Lars Flöer, Nadine Giese, Russell Jurek, Bärbel Koribalski, Martin Meyer, Attila Popping, Paolo Serra, Lister Staveley-Smith, Thijs van der Hulst, Benjamin Winkel

References

https://github.com/SoFiA-Admin/SoFiA

SoFiA completeness and reliability

Integr. SNR

- detections
- non-detections
- completeness

5σ
HI projects on the way to the SKA pathfinders
Quenching galaxies in dense environments

$SFR - M_{\star} - M_{HI}$ scaling

$\log SFR$ vs. $\log M_{HI}$ at fixed $M_{\star}$
~50 HI detections
+ multi-wavelength imaging/spectroscopy to obtain Mstar and SFR
(e.g., Hunt et al. 2019)
GASP - GAs Stripping Phenomena in galaxies

P.I. B. Poggianti (Padova)

Includes several collaborators in Padova and Cagliari

~100 stripped galaxies observed with MUSE

13 papers published in 2017-2018

additional observations with

APEX, ALMA, VLA, UVIT

Poggianti et al. (2017)

Ramatsoku et al. (in prep.)
Empowering the SKA as a Probe of galaxy Evolution with HI
P.I. L. Hunt (Arcetri)

+ 62 coIs: IASF-Milano, OA Brera, OAS Bologna, OA Capodimonte, OA Roma, OA Padova, OA Trieste, 4 universities (Firenze, Milano, Padova, Trieste)

€400k PRIN-SKA 2016

GOAL: Build up all that is needed for an effective scientific exploitation of SKA for our understanding of the role of HI in driving galaxy evolution up to redshift ~ 2

WP1: local HI benchmark

• Global scaling relations
• Resolved studies of environmental effects and feedback (GASP, MAGNUM)

WP2: multi wavelength data for SKA target fields

• High-z surveys including optical, IR, CO, dust (VIPERS, VUDS, VVDS, COSMOS, KiDS, LEGA-C, PEP, H-ATLAS, HerMES, WEAVE-StePS)
• Hydrodynamical simulations
HI content of galaxies in semi-analytic models
Zoldan, De Lucia, Xie, Fontanot, Hirschman (Trieste)

see Anna Zoldan’s talk
WEAVE - APERTIF Survey
P.I. J. Falcon-Barroso (IAC)
includes Cagliari, Arcetri

IFU follow-up of a sample selected based on HI mass and HI morphology from APERTIF
Mapping the Vela supercluster behind the ZoA with MeerKAT
P.I. R. Kraan-Kraan-Korteweg (UCT) – includes Ramatsoku, Serra (Cagliari)
Great improvement in extragalactic HI science with SKA Pathfinders

The extragalactic Italian community interested in HI science is large and is active in projects leading to SKA Pathfinder science

This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement no. 679627; project name FORNAX).