The 7th Survey Science Group Workshop, 2018 January 15-17

BUDHIES & CHILES

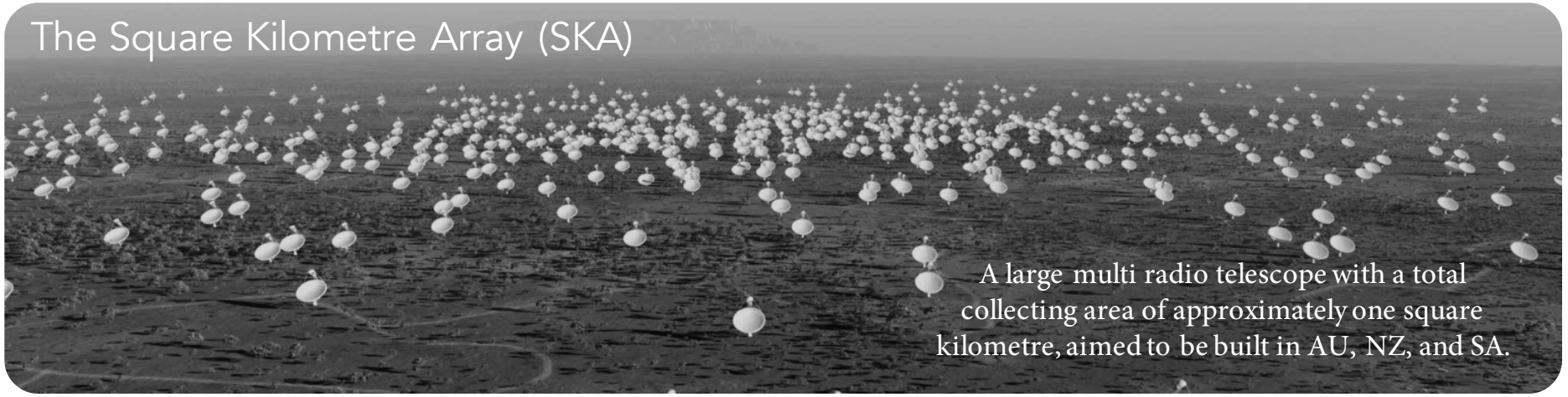
Extragalactic HI Surveys beyond z=0 using SKA pathfinders

On behalf of BUDHIES team and CHILES team

AEREE CHUNG - Yonsei University

Square Kilometer Array & Pathfinders

The Square Kilometre Array (SKA)



A large multi radio telescope with a total collecting area of approximately one square kilometre, aimed to be built in AU, NZ, and SA.

SKA prototype

ASKAP, MWA in Australia

MeerKAT, HERA in South America

SKA pathfinder

Existing telescopes + SKA related technology (e.g. wide band coverage simultaneously with narrow channel width)

→ HI survey of a large volume, e.g.
BUDHIES using WSRT
CHILES using JVLA

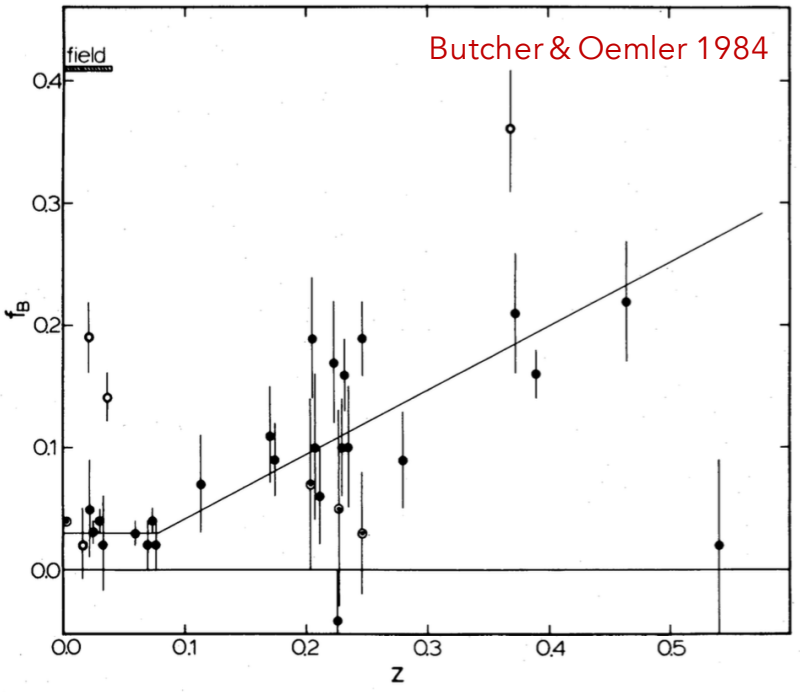
BUDHIES: Blind Ultra Deep HI Environmental Survey

http://www.astro.rug.nl/~budhies/

PI: Marc Verheijen (University of Groningen/Kapteyn Astronomical Institute)

Boris Deshev, Yara Jaffe, Jacqueline van Gorkom, Ximena Fernandez, Bianca Poggianti, Min Yun, Ryan Cybulski, Aeree Chung, Hyein Yoon, K.S. Dwarakanath, Maria Montero-Castano, Glenn Morrison, David Schminovich, Arpad Szomoru

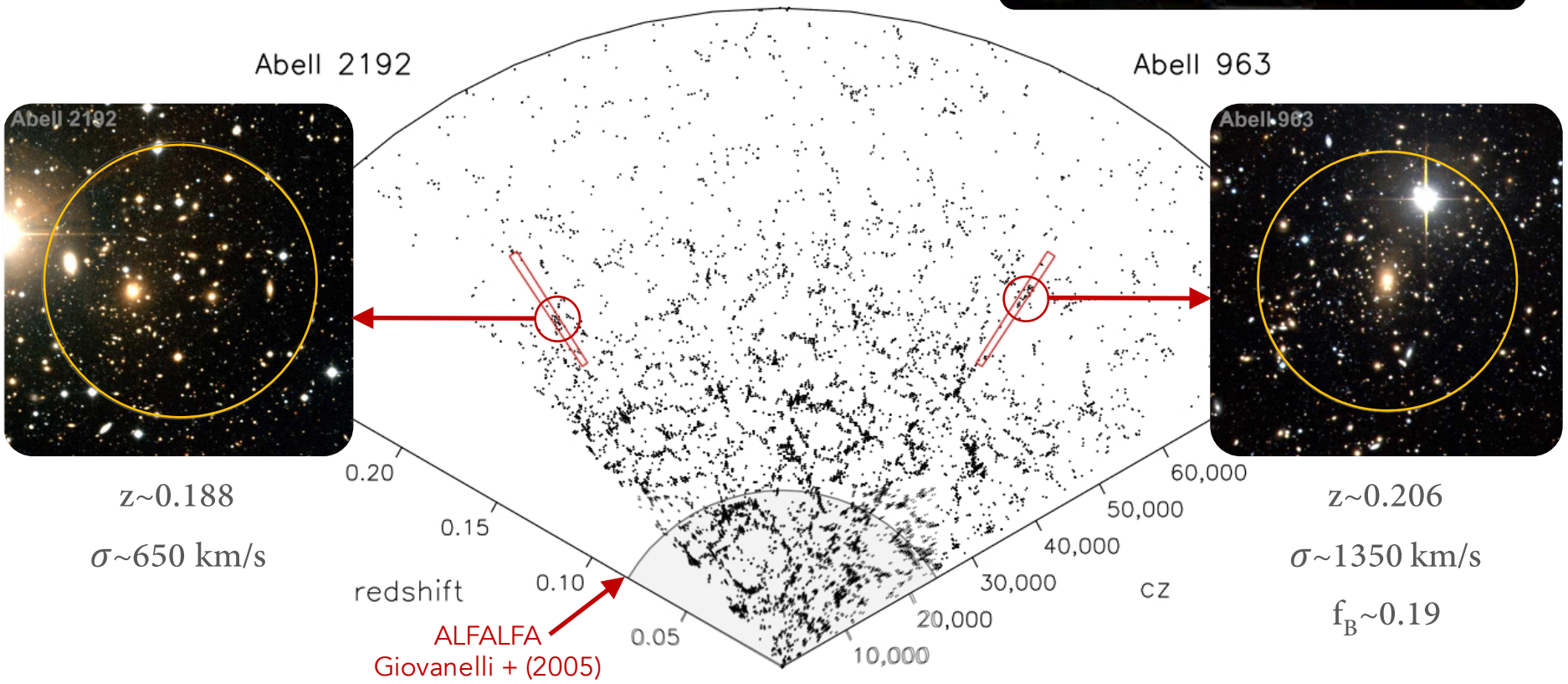
- A deep HI survey of galaxies in two clusters at $0.16 < z < 0.22$ + the large volume where they embedded (z~0.2, potentially an important epoch in the cluster evolution) → Where, how, and why star-forming spiral galaxies get transformed into passive early-type galaxies?



Fraction of blue galaxies in the inner part of each cluster vs. redshift →

BUDHIES: Blind Ultra Deep HI Environmental Survey

- Using Westerbork Synthesis Radio Telescope, ~1000 hrs spent per cluster, covering 60 MHz.
- 49,426 < cz < 67,300 km/s covered simultaneously
- FWQM of the primary beam ~ 61.7 arcmin or 11.9 Mpc
- The effective survey volume ~ 73,000 Mpc^3



z~0.188

σ~650 km/s

z~0.206

σ~1350 km/s

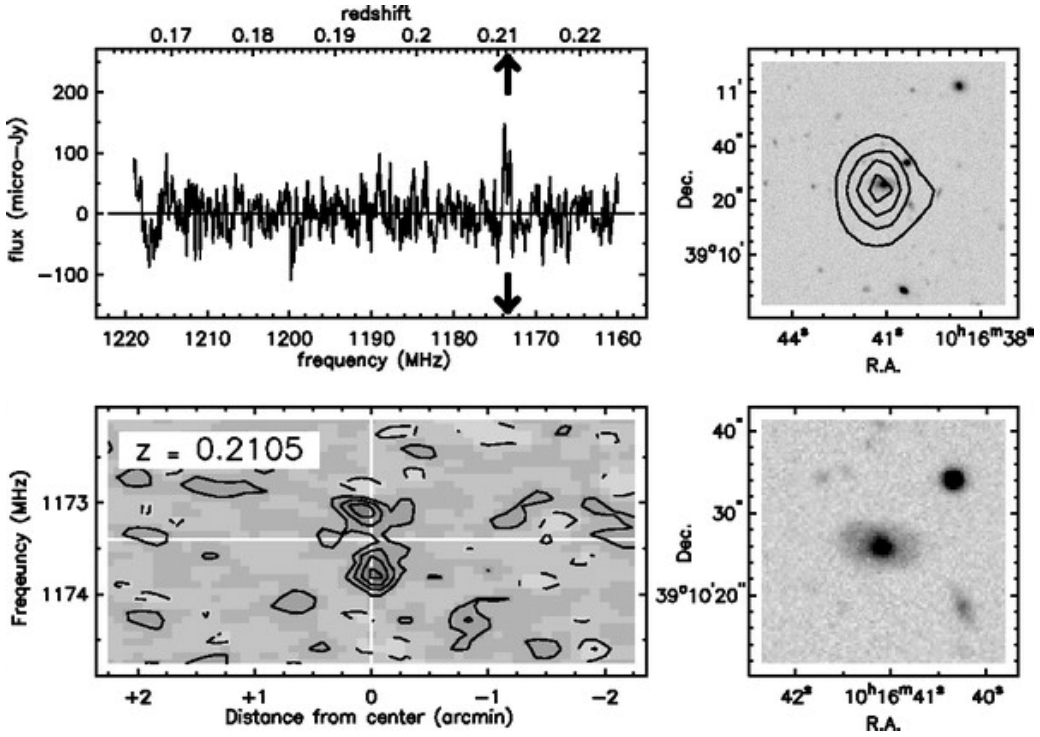
f_B~0.19

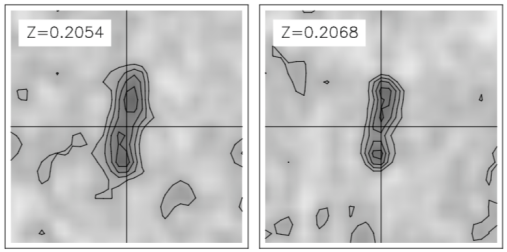
BUDHIES: Blind Ultra Deep HI Environmental Survey

http://www.astro.rug.nl/~budhies/

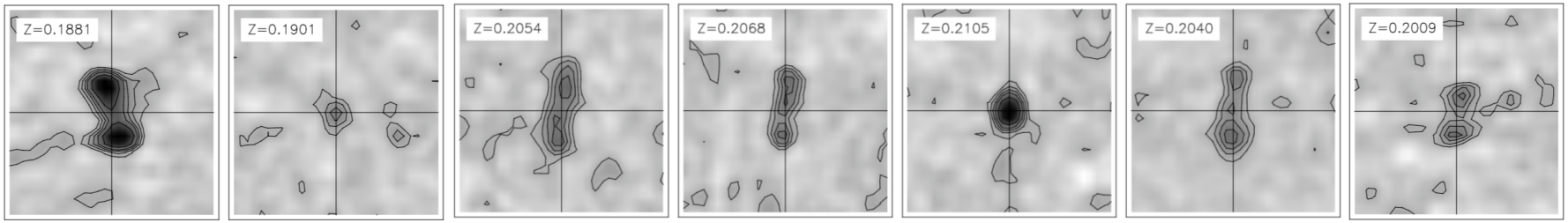
Examples of HI detection

- Synthesize beam size: 23 x 37 kpc^2
- Velocity resolution: ~9 ~ 10 km/s
- Effective resolution is sufficient to study extents, asymmetry and kinematics





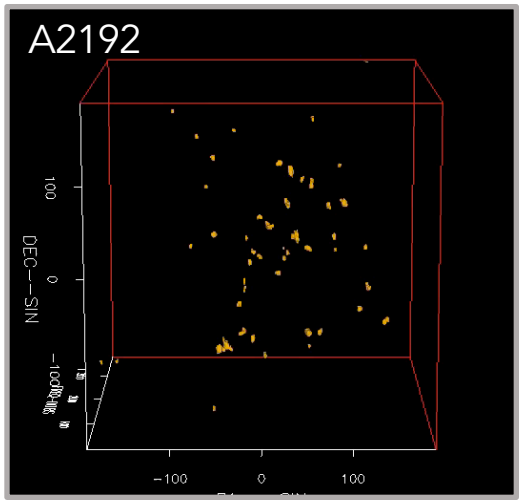
Velocity

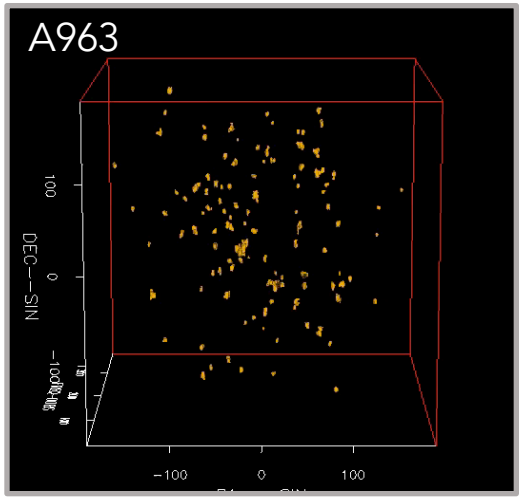


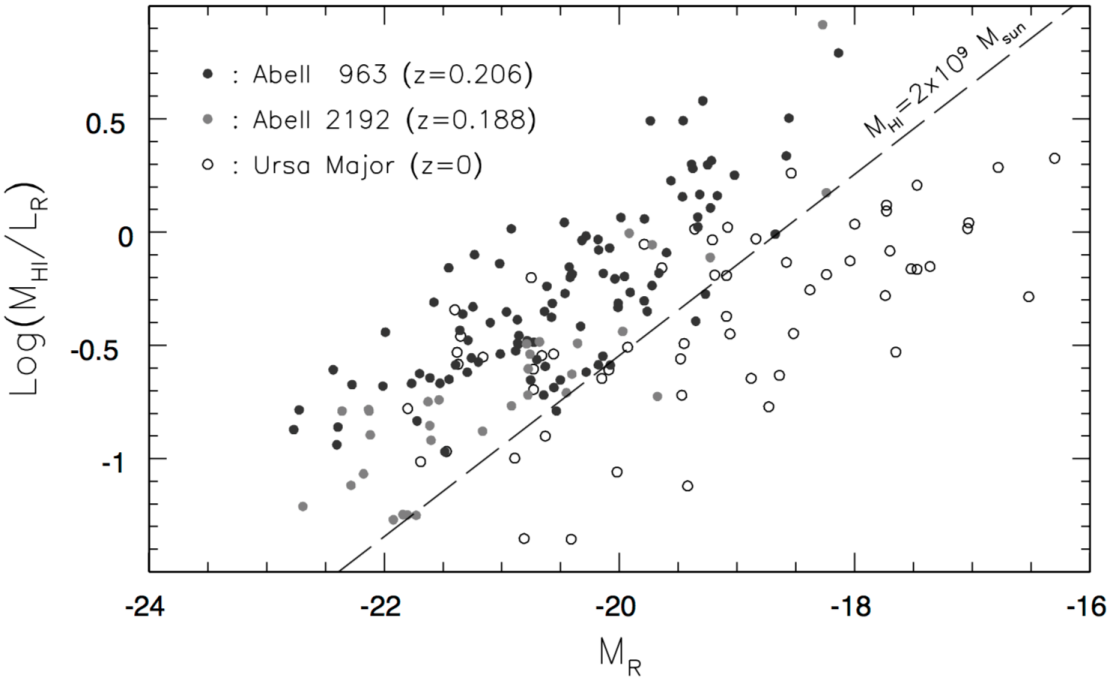
Position

BUDHIES: Blind Ultra Deep HI Environmental Survey

- Detection mass limit ~ a few 1e9 solar (42 and 116 detected in A2192 and A963 respectively)







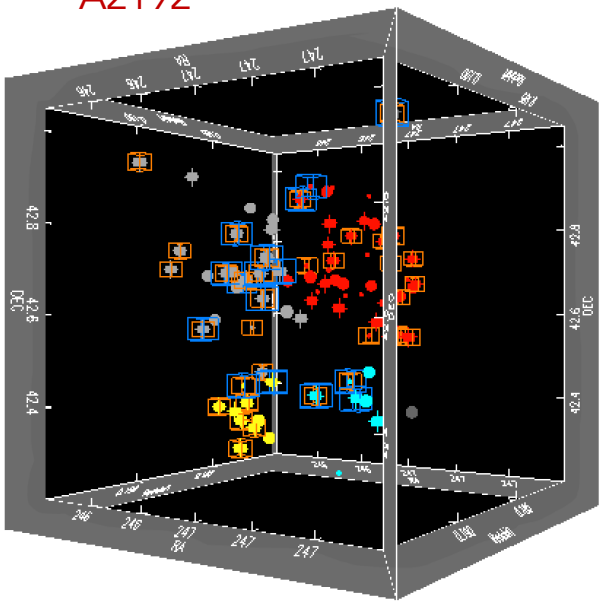
- Compared to the Ursa Major galaxies (a Local HI-rich environment), z~0.2 is observed to be richer in HI-rich galaxies → Gas accretion? → Important population to be probed in order to understand the origin of massive galaxies in the current epoch

BUDHIES: Blind Ultra Deep HI Environmental Survey

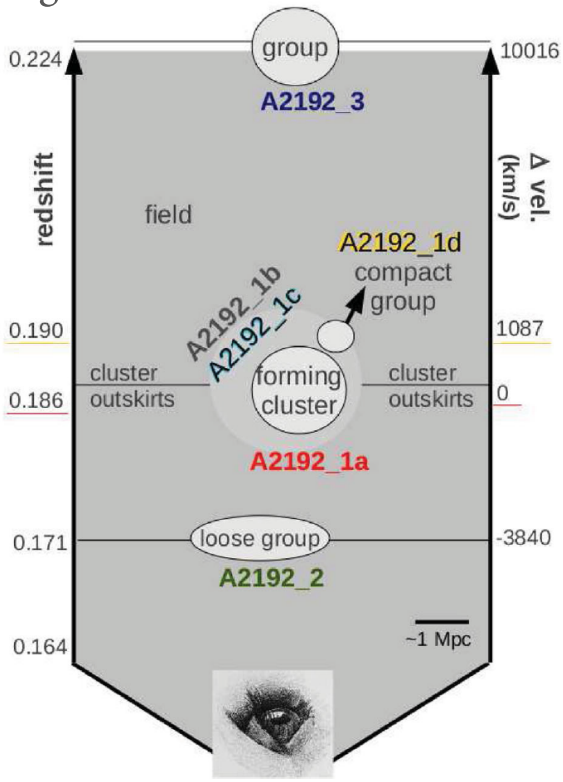
Science Highlights

- Characterizing the environments in and around two clusters (Jaffe et al. 2013)
  - Optical photometry (INT) and spectroscopy (WHT) follow-up
  - Color, redshift, emission line strength

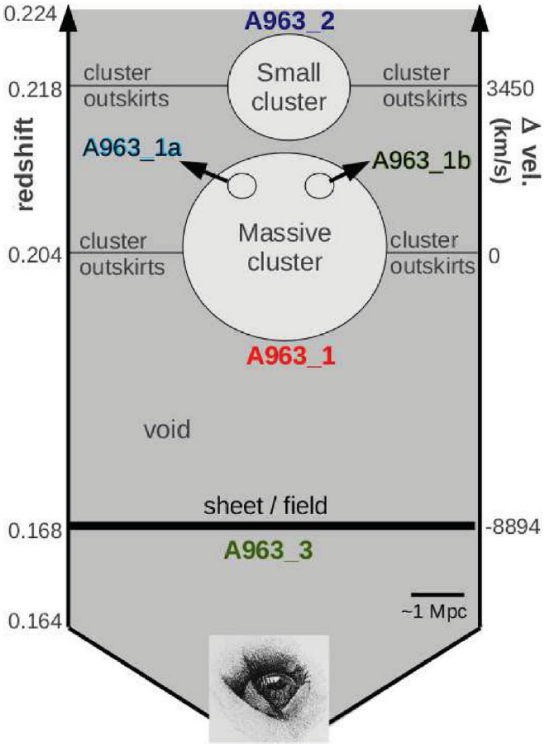
A2192



A2192



A963

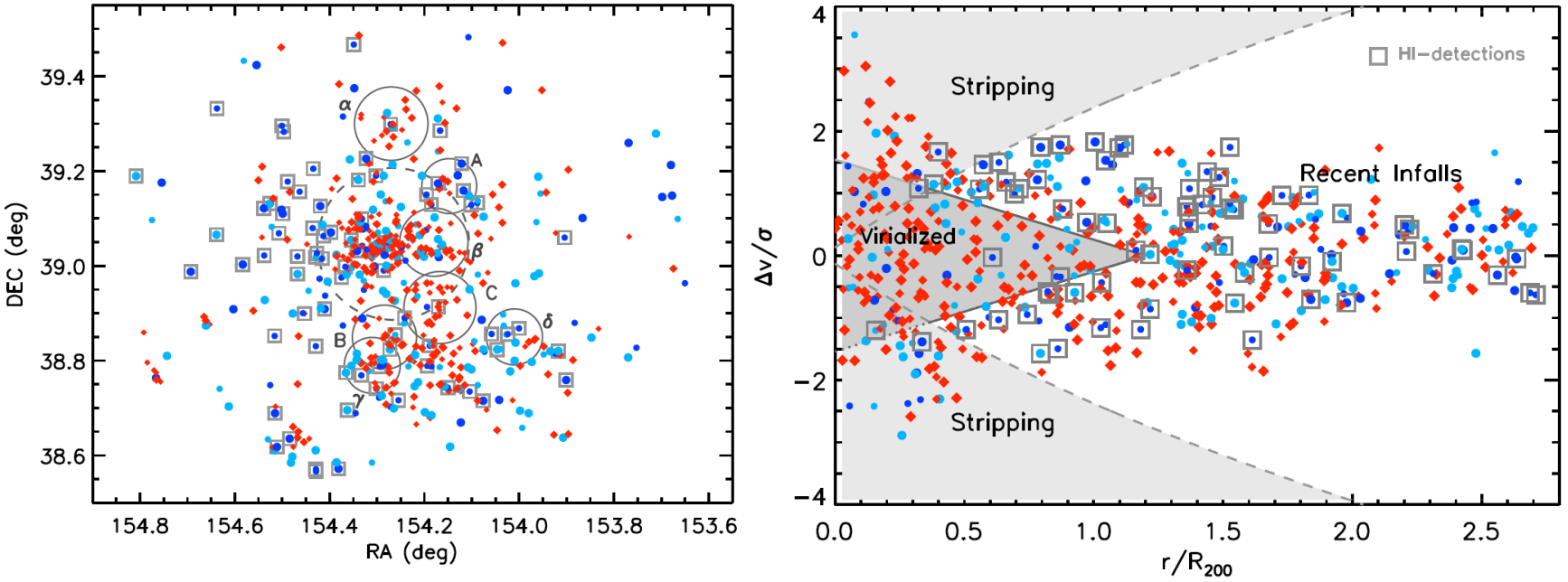


- Gas stripping/SF suppression proceed already in infalling groups

BUDHIES: Blind Ultra Deep HI Environmental Survey

Science Highlights

- Phase-space analysis (Jaffe et al. 2015, 2016)



- Almost all HI detections avoid the virialized region: galaxies lose their gas as they radially fall into the cluster (ram pressure stripping?) → Further confirmed by Yoon et al. (2017)
- Additionally, CO follow-up study to study cold gas contents of BUDHIES galaxies by Cybulski et al. (2016) using the Large Millimeter Telescope

CHILES: Cosmos HI Large Extragalactic Survey

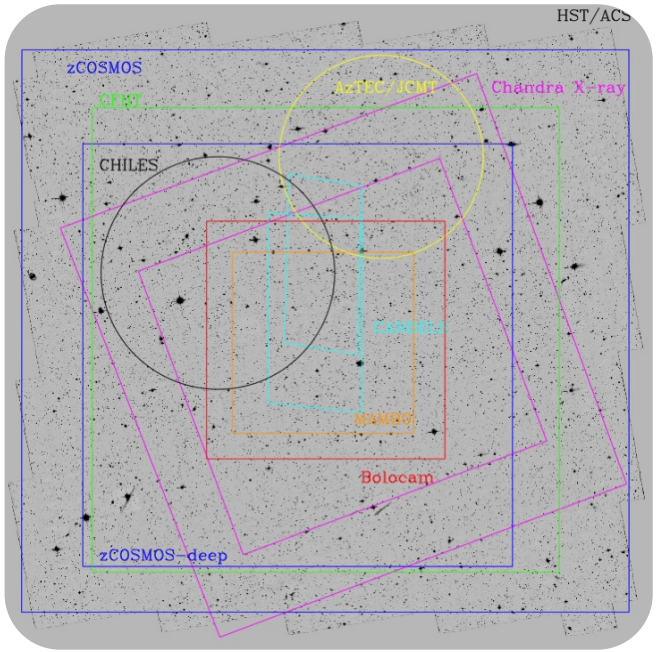
http://chiles.astro.columbia.edu/

PI: Jacqueline van Gorkom (Columbia University)

Ximena Fernandez, Kelley Hess, Emmanuel Momjian, DJ Pisano, Lucas Hunt, Hansung Gim, Julia Gross, Martin Meyer, Attila Popping, Richard Dodson, Danielle Lucero, Marc Verheijen, Tom Oosterloo, Aeree Chung, Trish Henning, John Hibbard, Jennifer Donovan Meyer, Eric Wilcots, Min Yun, et al.

+ CHILES CON POL (led by Chris Hales) & CHILES VERDES (led by Laura Chomiuk)

- The first HI deep extragalactic survey, covering $0 < z < 0.45$, toward the COSMOS field for which plenty of ancillary data are already available (2 square degree field; accessible with most of space-based and a number of powerful ground-based telescopes) → HI properties as function of redshift, galaxy mass, color and location in the large scale structure
- CHILES field avoids strong radio continuum sources



CHILES: Cosmos HI Large Extragalactic Survey

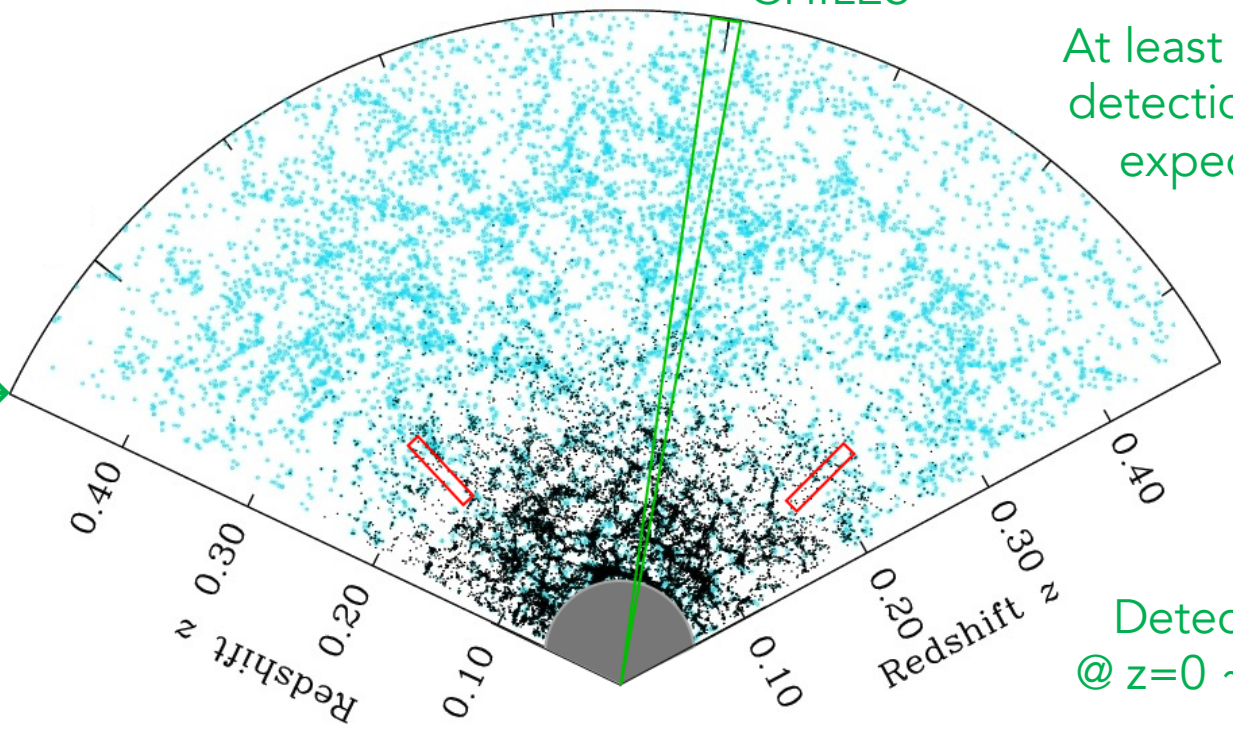
- Using Jansky Very Large Array, ~1000 hrs in B configuration (synthesized beam ~ 5” in L-band)

	OLD	PILOT	CURRENT
Bandwidth (MHz)	6.25	240	480
Channels	31	16384	30720
Velocity resolution (km/s)	40	3.5	3.5
Instantaneous z coverage	0<z<0.004	0<z<0.193	0<z<0.5

CHILES

At least 300 HI detections are expected

Detection limit ~ 3e10 solar →



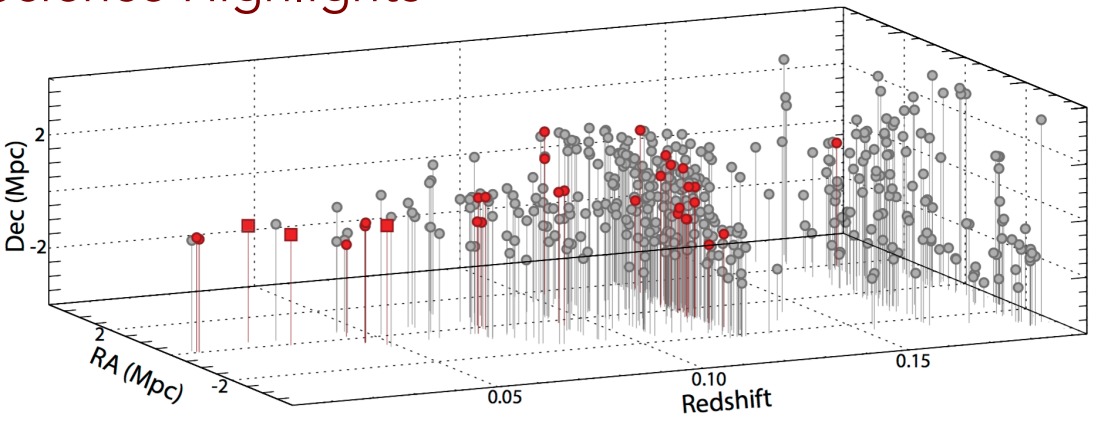
Detection limit @ z=0 ~ 1e7 solar

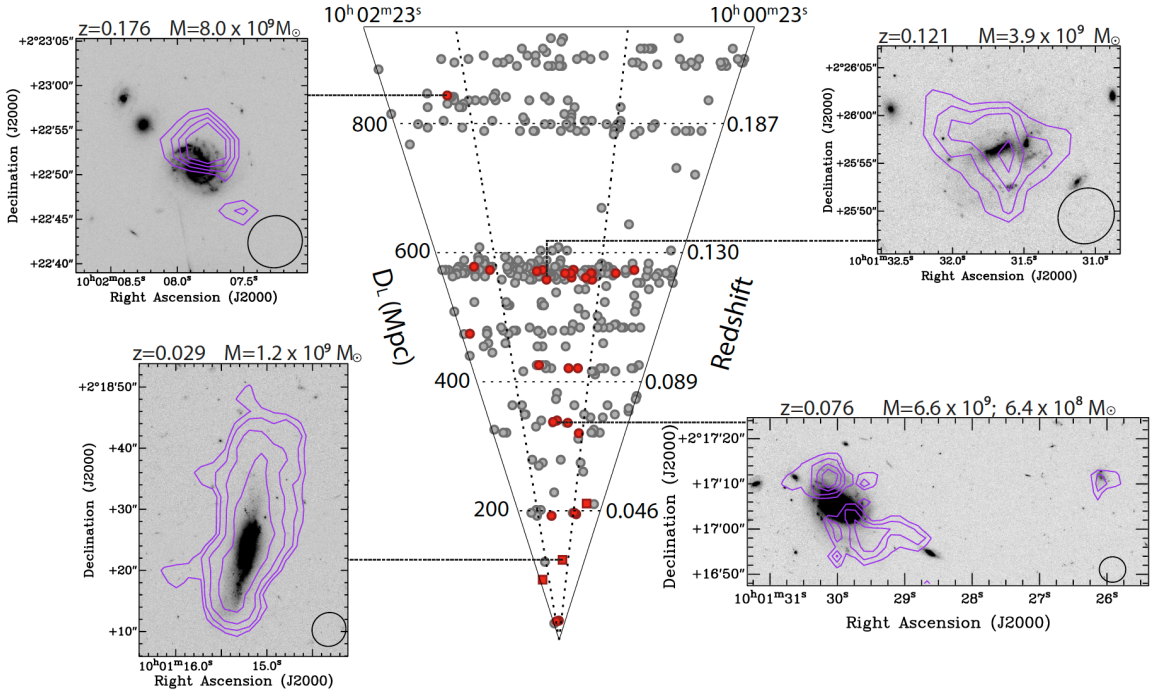
CHILES: Cosmos HI Large Extragalactic Survey

Science Highlights

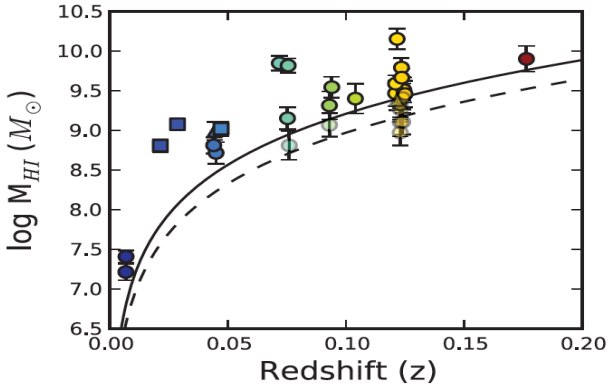
A pilot study (Fernandez et al. 2013)

- The first 50 hours in a volume containing 413 galaxies with optical spectroscopic redshift





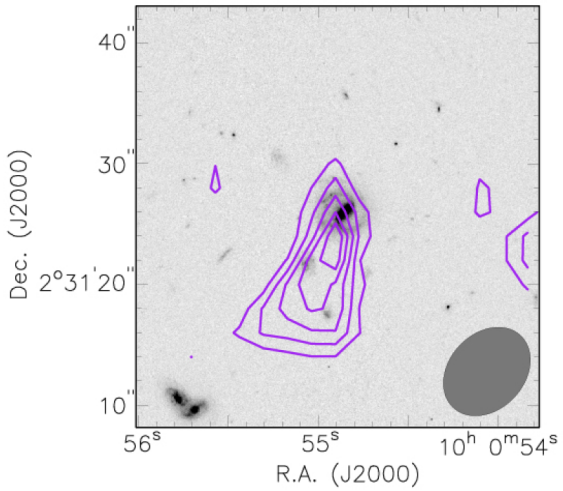
- 33 galaxies detected in HI
- HI mass function (solid – in 150 km/s, dashed in 50 km/s)

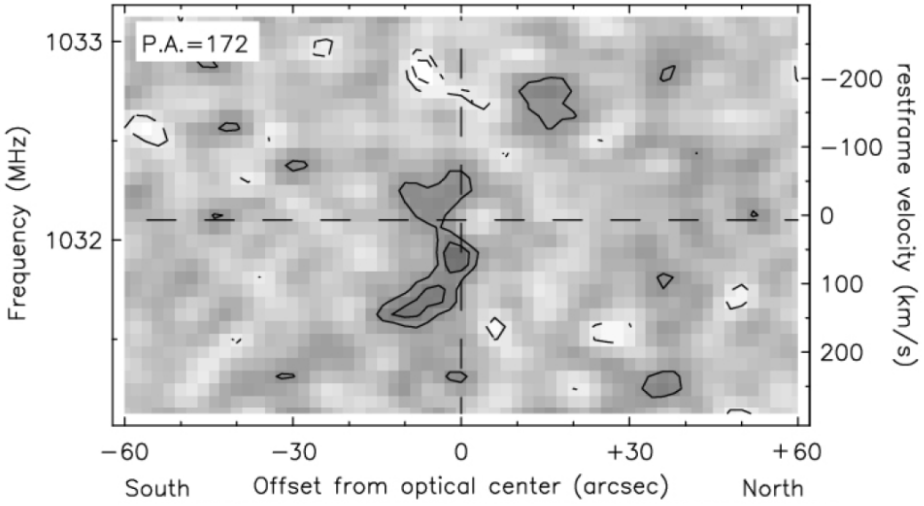


CHILES: Cosmos HI Large Extragalactic Survey

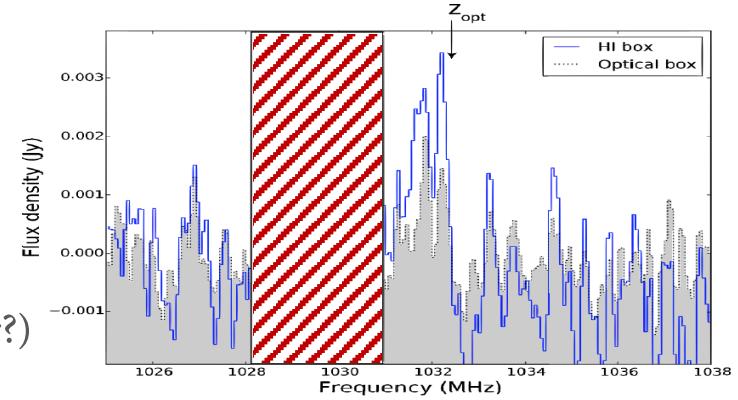
Science Highlights

- The most distant object detected in HI (Fernandez et al. 2016)
  - LIRG at z=0.376 from 178 hrs of observation with M(HI) ~ 3e10 solar





  - RFI to be further studied for the SKA era
  - Besides, other issues, such as,
  - Data handling & source finding, etc.



- ~400 hrs to go (complete by 2019 summer?)

SUMMARY

- The SKA pathfinders can be used as a wide field imaging spectrometer for extragalactic HI science beyond z=0
- We are entering the SKA era!
- Do we (Korean astronomers) want (or need) to join the wave?
  - Scientific needs from the community?
  - Scientific values independent of the needs from the community?
  - Synergy with other fields?