



SARAO
South African Radio
Astronomy Observatory



Farnesina
*Ministero degli Affari Esteri
e della Cooperazione Internazionale*

Neutral Hydrogen, HI, in the Shapley Supercluster core .1 : Environmental Effects on Gas and Galaxy Evolution

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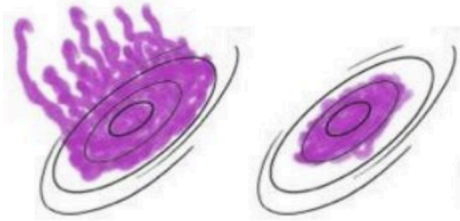
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Introduction: Environmental Physical Processes

Hydrodynamical: gas component of galaxies ($\propto v^2$)

- Ram pressure stripping
- Starvation

 Gas
 disk



Credit: B. Vulcani

Gravitational: gas and stars ($\propto v^{-2}$)

- Tidal interactions
- Mergers
- fly-bys

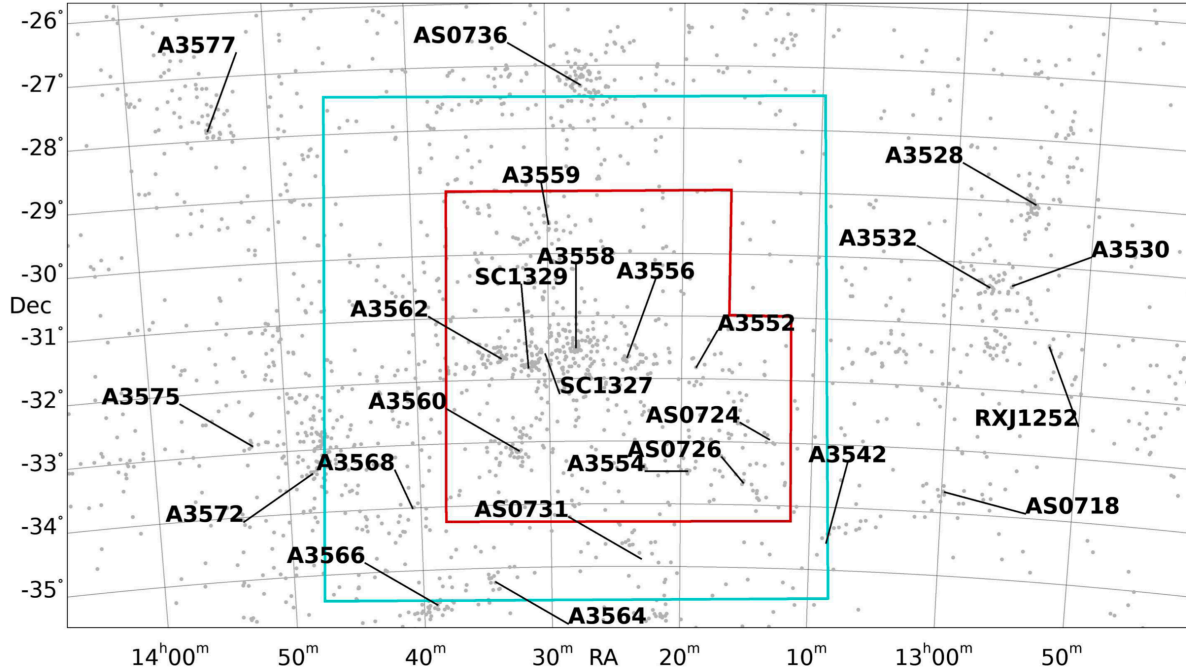


Credit: B. Vulcani



Dylan Nelson et al. 2019

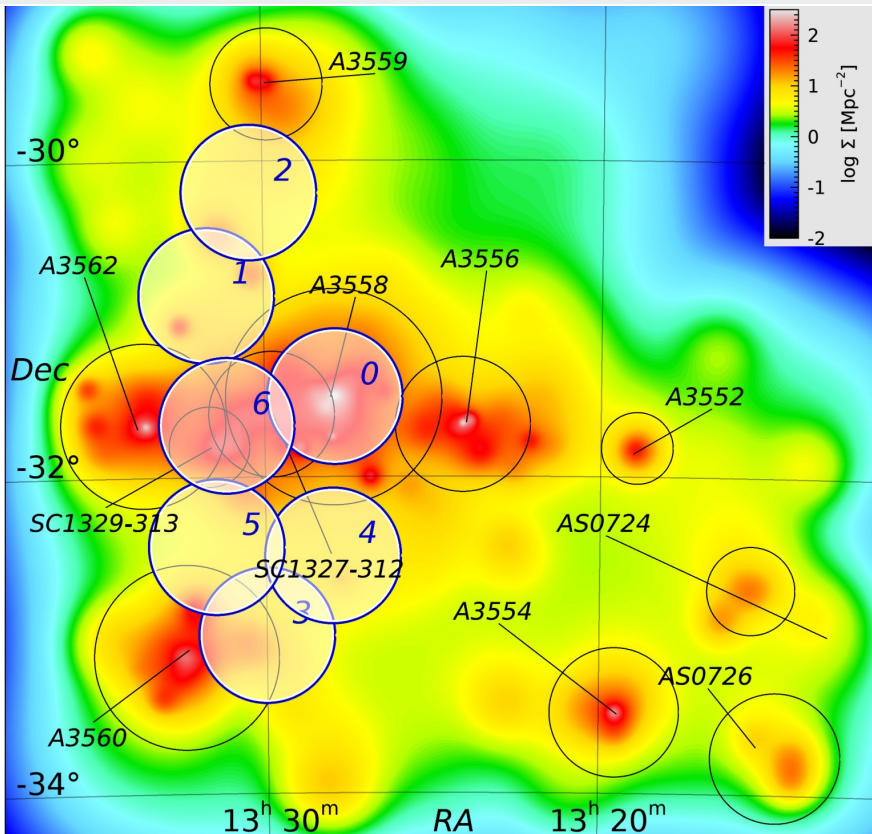
Introduction: The Shapley Supercluster (i.e., SSC)



- The most massive supercluster in the local Universe.
- With at least 25 Abell clusters plus tens of small groups.
- Redshift range $0.03 < z < 0.06$, distributed over 150 deg^2 in the Southern Hemisphere (Raychaudhury 1989; Einasto et al. 2001; De Filippis et al. 2005; Quintana et al. 2020).
- And connected by filaments of galaxies (Quintana et al. 2000; Proust et al. 2006; Haines et al. 2018; Quintana et al. 2020).

The Shapley Supercluster (Shapley 1930). The cyan lines highlight the area covered by the ASKAP observations, the red lines highlight the coverage of the ESO-VST optical imaging of Shapley Supercluster Survey (ShaSS, Merluzzi+2015). Image credit to Venturi et al. (2022).

Aim and Available HI data



| Item | Summary |
|------------------|---|
| New Observations | 5 proposed OT5 pointings covering the two filaments toward A3560 and A3559. |
| H I Sensitivity | $N_{\text{HI}} \sim 4.7 \times 10^{19}$ atoms /cm ² at 8'' (~7–8 kpc). |
| Resolution | 32k channels → velocity width of 5.76 km s ⁻¹ . |
| Integration Time | 7 hr on-source per pointing (9 hr including overheads). |
| Total Time | 45 hr. |
| Status | Proposal approved (A rating, MKT-24093); all fields observed. |

Table 2. Summary of newly acquired H I observations of the SSC core.

- Existing Data MGCLS HI cubes for A3558 and SC1329 (SSC core).
- Proposal approved (A rating, MKT-24093); all fields observed.

- We aim to study the role of the environment on the evolution of galaxies by mapping the HI content of galaxies in the SSC.

Data products: MGCLS pointings on SSC-core

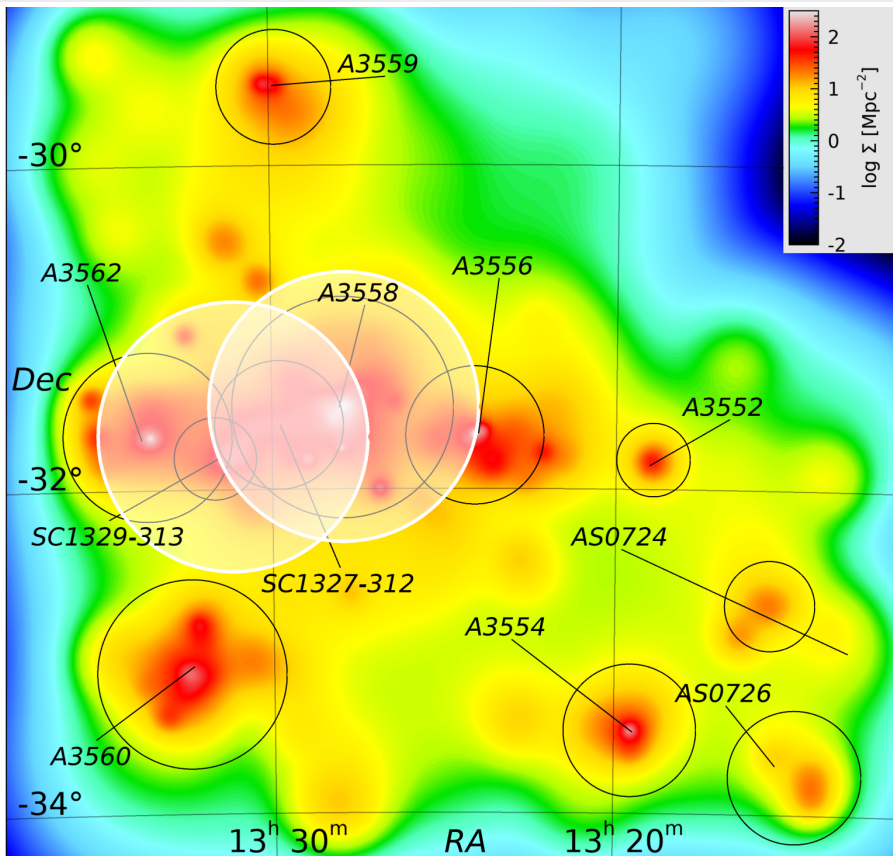


Table 1. HI properties for data cubes of Abell 3558 and SC1329-313.

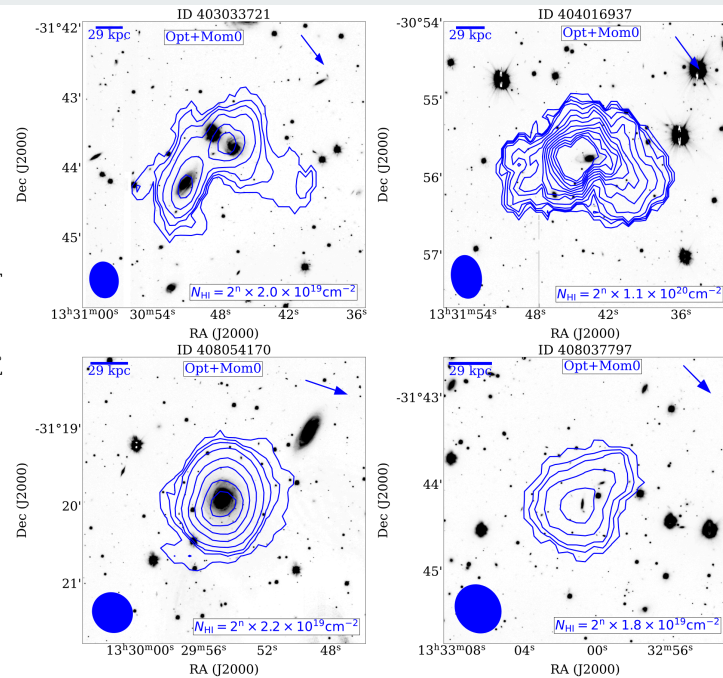
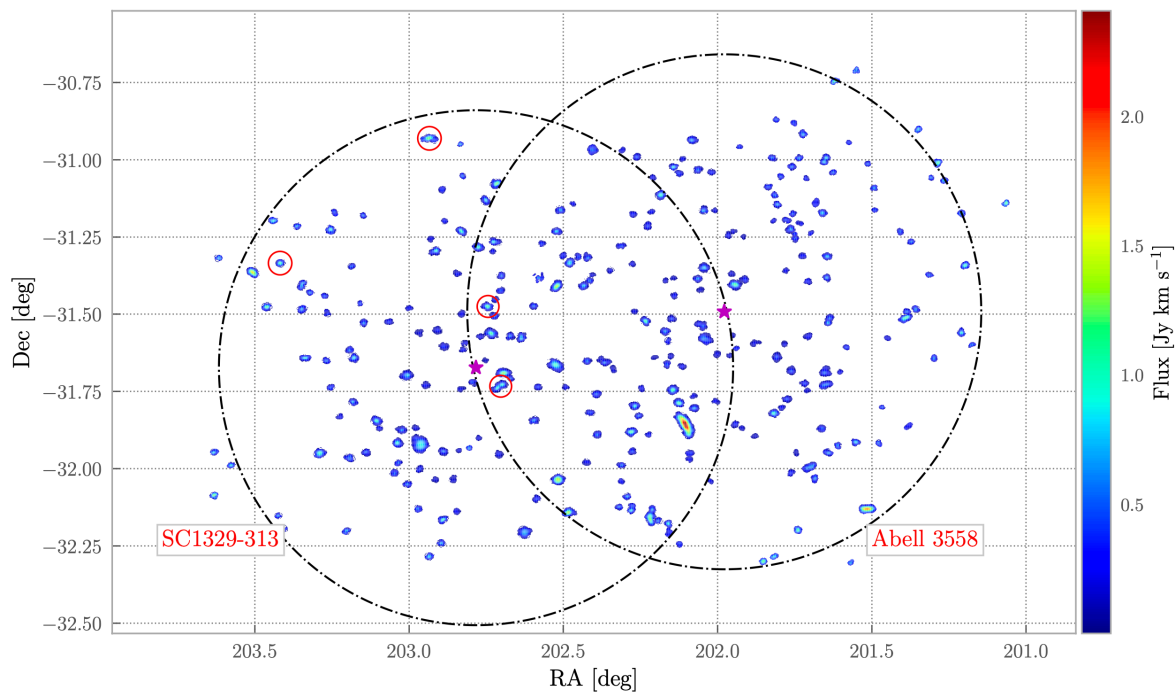
| Cluster | Abell 3558 | SC1329-313 |
|----------------------------------|---|---|
| RA (J2000) | 13 ^h 27 ^m 54 ^s | 13 ^h 31 ^m 08 ^s |
| Dec (J2000) | -31° 29' 32'' | -31° 40' 23'' |
| V_h [km/s] | 14500 ± 39 | 13416 ± 49 |
| σ_v [km/s] | 1007 ± 25 | 373 ± 28 |
| z | 0.048 | 0.045 |
| RMS [mJy/beam] | ~ 0.22 | ~ 0.22 |
| Channel width size [km/s] | ~ 44 | ~ 44 |
| Pixel scale [arcsec] | ~ 6 | ~ 6 |
| R_{200} [Mpc] | 2.32 | 0.862 |
| M_{200} [$h^{-1}M_\odot$] | $4.47^{+2.78}_{-2.38} \times 10^{14}$ | $1.79^{+2.93} \times 10^{13}$ |
| BMAJ [arcsec] | 33.03 | 34.75 |
| BMIN [arcsec] | 30.42 | 30.96 |
| BPA [deg] | 150.49 | 126.52 |

Notes: The right ascension (RA), declination (Dec) coordinates of the cluster, were sourced from [Venturi et al. \(2022\)](#). The central velocities (V_h), velocity dispersions (σ_v), and R_{200} radii values were obtained from [Haines et al. \(2018\)](#), while the M_{200} masses values were derived from the work of [Higuchi et al. \(2020\)](#).

- Robust parm (briggs): 0.5; tapering: 30''.
- $\sigma = \text{rms} \sim 0.22$ mJy/beam.
- $N_{\text{HI}} = 1.3 \times 10^{19}$ atoms/cm².

- 4K channelisation: $\Delta V = 44.11$ km/s.
- Vel. : $cz \sim 2000 - 25000$ km/s.

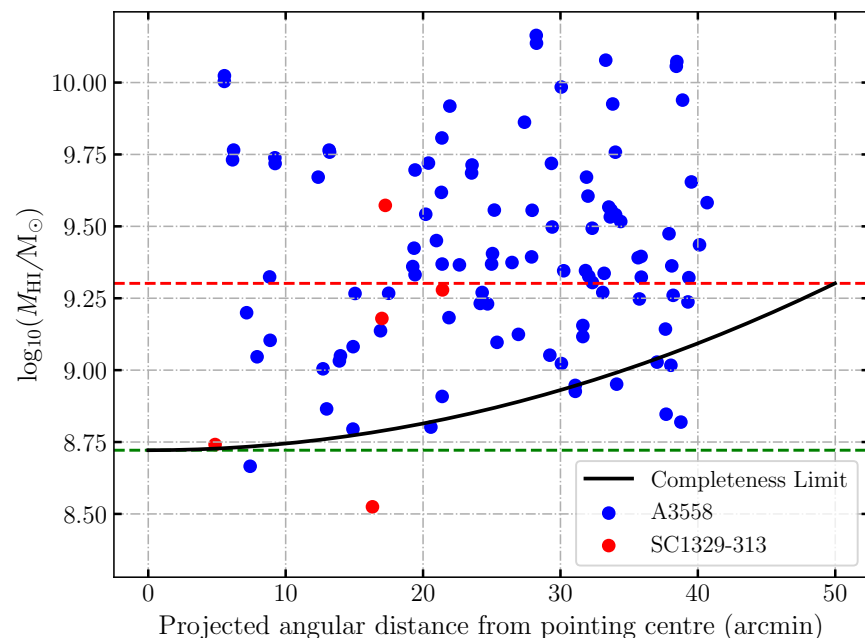
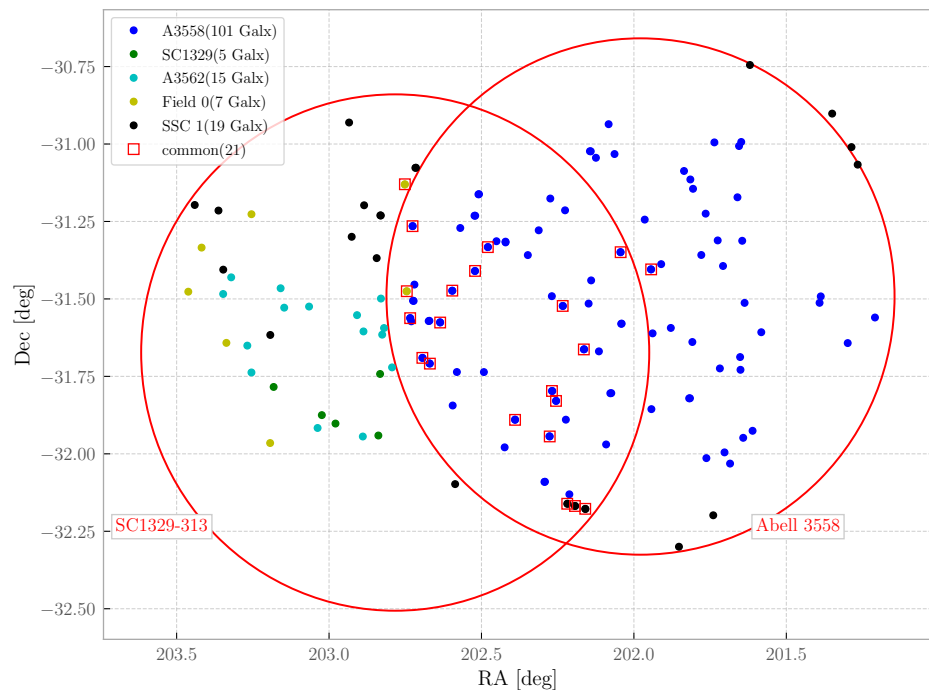
Detection of HI and Cross-correlation with the spectroscopic catalogue of ShaSS



- We use SoFiA 2 pipeline (Serra et al. 2015; Westmeier et al. 2021) to detect sources of HI emission.
- We detected 155 sources in A3558 and 154 in SC1329. With 37 sources common on both pointings.
- FoV $\sim 50'$.

- ShaSS is based on the ESO-VST catalogue.
- ShaSS catalogue is 95% complete at the $i < 18$, corresponding to about $\log_{10}(M_{\star}/M_{\odot}) \sim 9.3$, but extends down to $\log_{10}(M_{\star}/M_{\odot}) = 8$ (Haines et al. 2018).
- There are 169 detected HI sources with optical counterparts (76 from SC1329 and 93 from A3558).

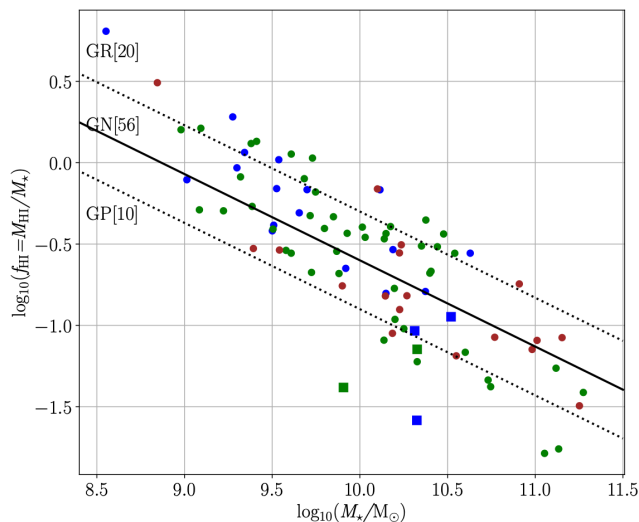
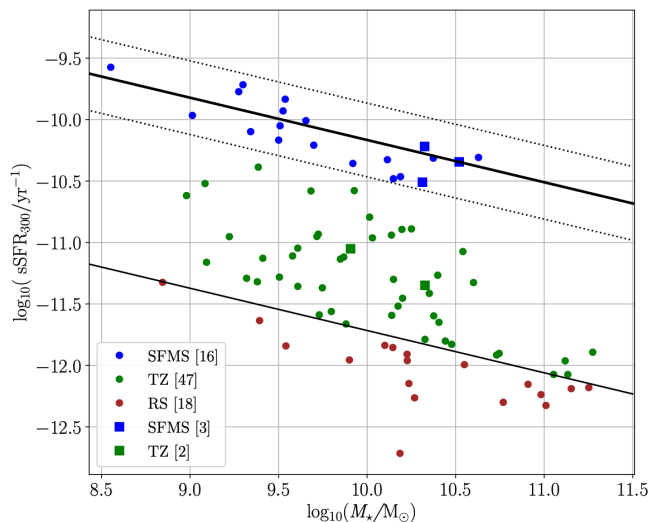
Dynamical analysis and complete HI sample, at SSC-ShaSS redshift



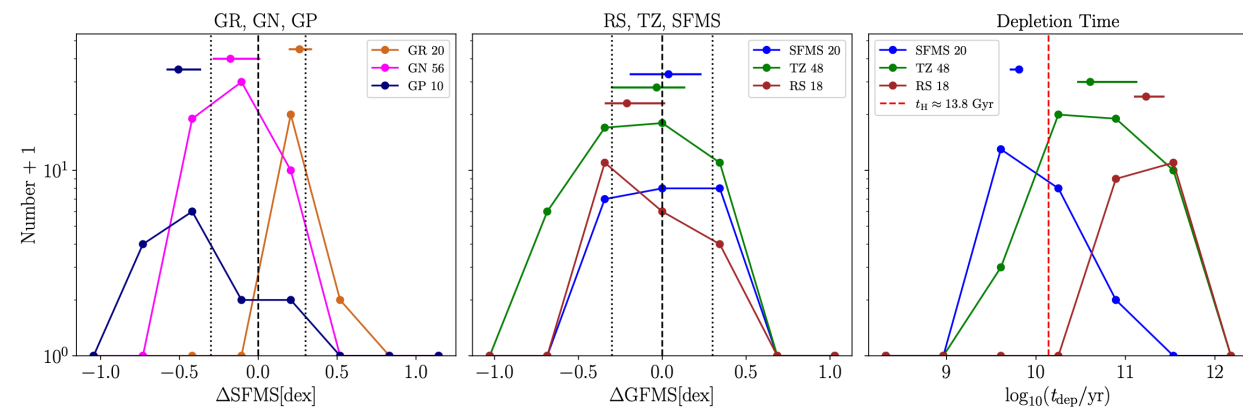
- We use Dynamical analysis from [Haines et al. 2018](#), and assigned 101 sources to A3558 and 5 sources to SC1329. There are 21 sources common on both cubes.
- The ratio of HI detections is $101:5 = 20.2$ and consistent with the underlying mass ratio $M_{200} \sim 19.5$ ([Higuchi et al. 2020](#)).

- Minimum detectable HI is $M_{\text{HI}}^{\text{centre}} \sim 5.27 \times 10^8 M_{\odot}$ at centre.
- At the edge of the FoV (i.e. $\sim 50'$), HI mass detection limit increases to $M_{\text{HI}}^{\text{edge}} \sim 2 \times 10^9 M_{\odot}$ (i.e., $N_{\text{HI}}^{\text{edge}} \sim 3 \times 10^{20}$ atoms/cm²).
- There are 68 sources in the complete HI sample (67 from A3558 and 1 from SC1329).

Results and Discussion



- We divided our sample into sub-classes, Δ SFMS populations (SFMS, TZ, and RS) following Janowiecki et al (2020).
- We also separate our galaxies into three categories in GFMS (GR, GN and GP)
- $\sim 84\%$ of TZ galaxies have f_{HI} which are consistent with GN or even above GR that of SFMS galaxies.

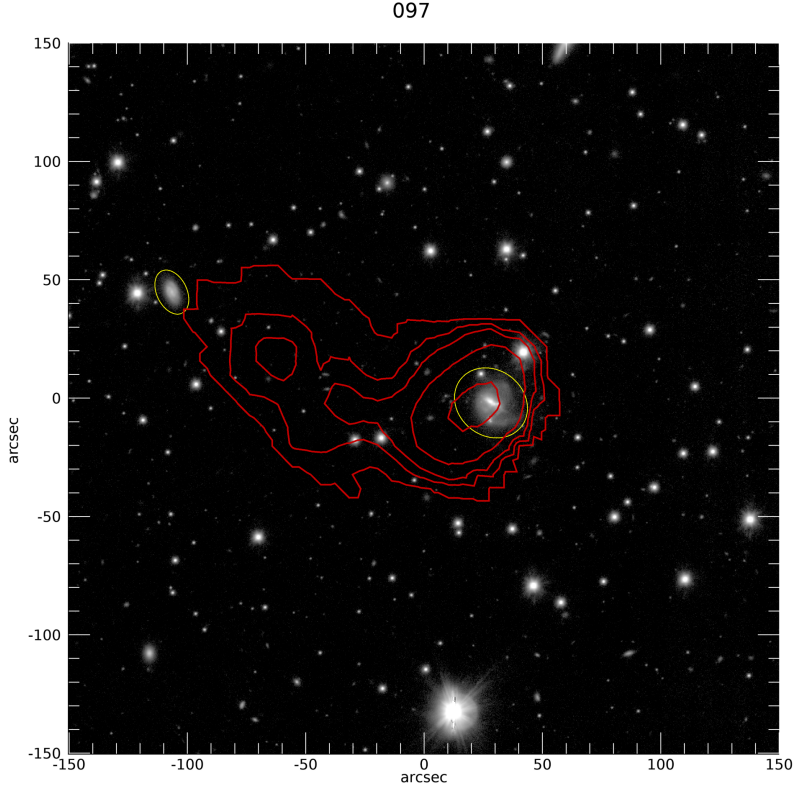
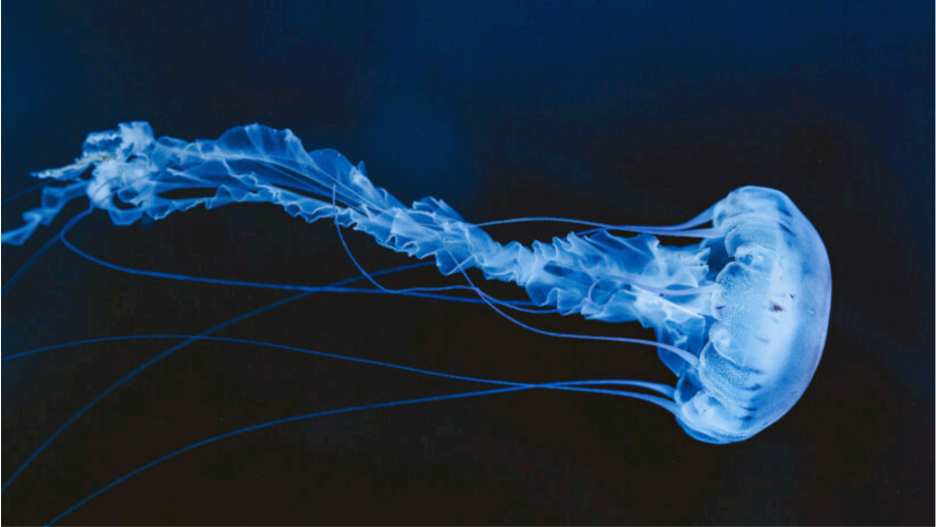


- We look at the Δ SFMS populations and plot the distribution of Δ GFMS for each.
- Moreover we look at the t_{dep} for each Δ SFMS populations.
- t_{dep} for galx in each Δ SFMS: SFMS, TZ, and RS, is = 5.89 Gyr, 40.39, Gyr and 170.02 Gyr, respectively.

Summary & Conclusion

- Our goal was to investigate how the SSC environment affects the cold gas content and star formation activity of galaxies.
 - We present a catalogue of 106 HI-detected galaxies within the SSC-ShaSS redshift range ($0.036 \leq z \leq 0.058$).
 - We identify clear trends in star formation, gas richness, and depletion timescales that provide insight into the environmental regulation of galaxy evolution.
 - Most HI-detected galaxies lie on TZ, but a large population of SFMS and RS galaxies also retain detectable HI.
 - The TZ and RS galaxies show suppressed star formation rates and long gas depletion timescales, suggestive of quenching via starvation, strangulation, or weak ram-pressure stripping rather than rapid removal of cold gas.
 - The HI scaling relations for galaxies in the SSC-core follow the expected trends of decreasing gas fraction with increasing stellar mass.
 - The SSC-core provides direct evidence that environment drives gradual quenching through starvation and mild stripping.

Thank you :)

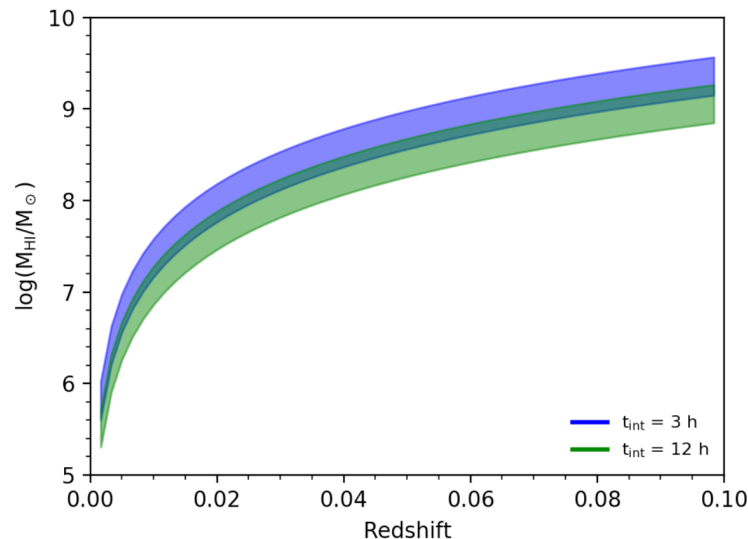


Could this be a jellyfish galaxy?

MeerKAT & MGCLS



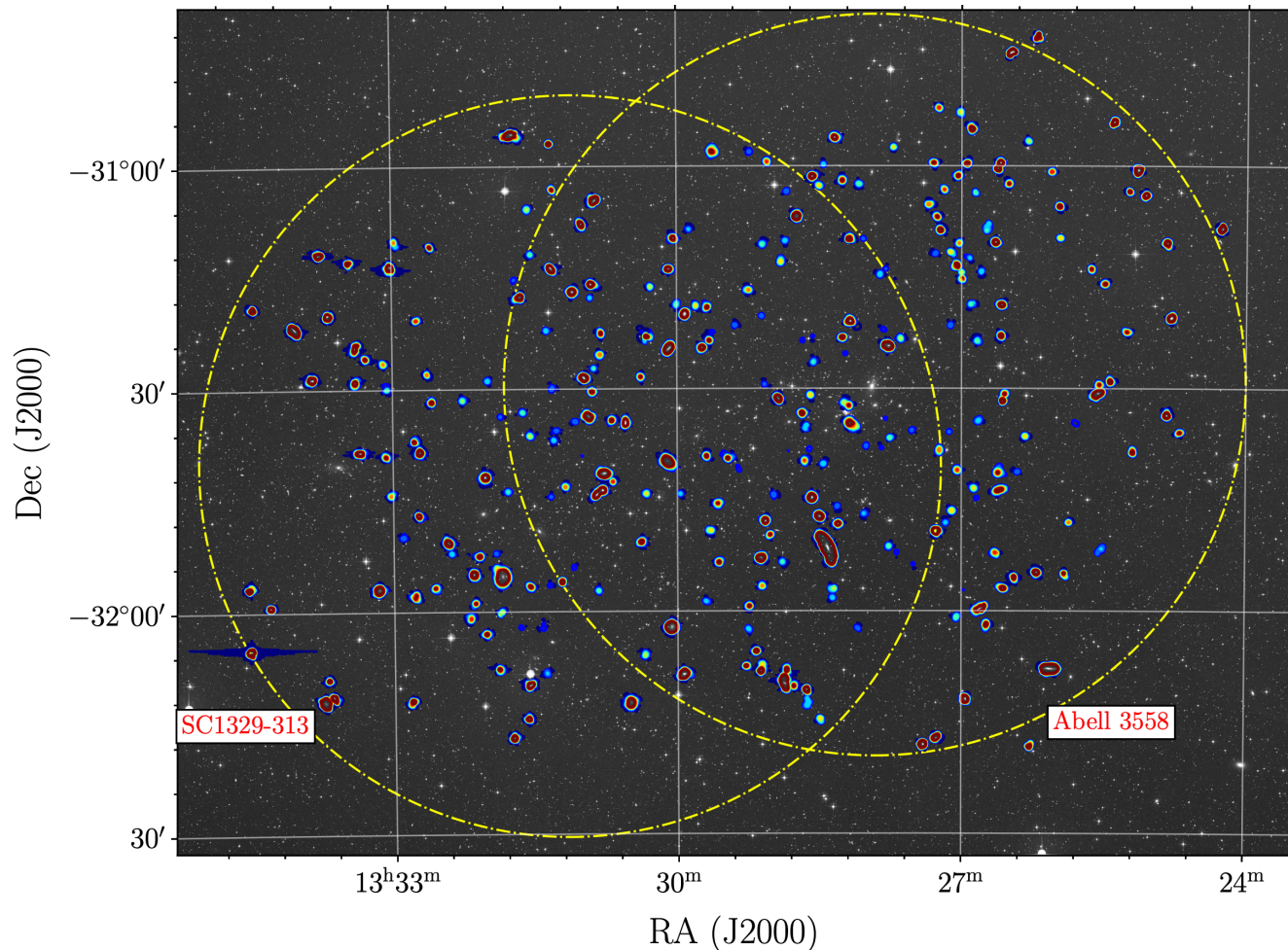
- MeerKAT is a 64-dish radio interferometer.
- Observing the sky at declinations below +45 deg with a minimum elevation of 15 deg.
- It operates across the UHF (580–1015 MHz), L (900–1670 MHz), and S bands (1.75–3.5 GHz) ([Jonas & Team \(2016\)](#) and [Camilo et al. \(2018\)](#)).



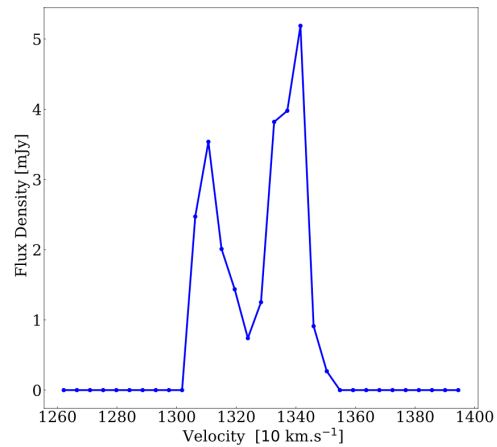
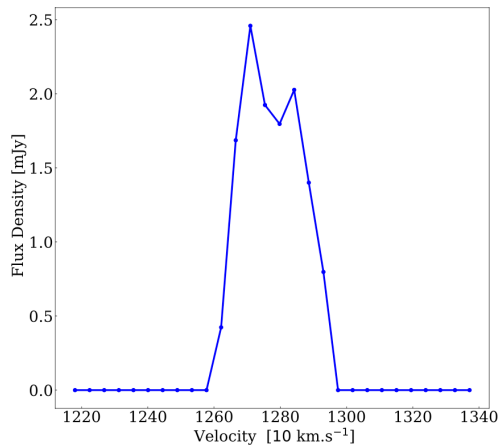
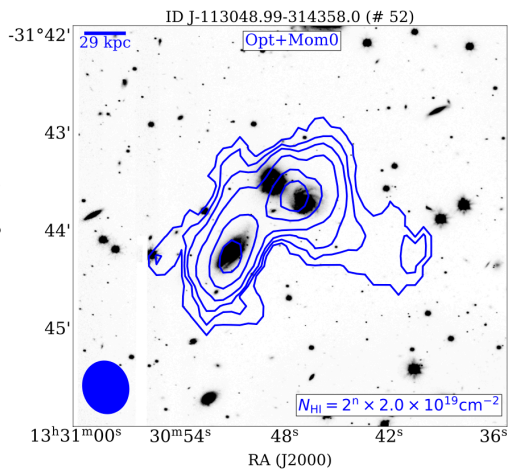
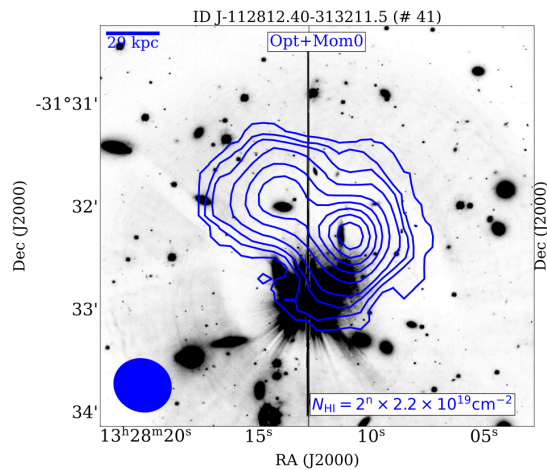
Credit: [K. Knowles et al. \(2022\)](#)

- MGCLS enable research on HI morphologies in clusters and the cosmic evolution of cluster HI up to a redshift of $z = 0.48$, with a velocity resolution of $\sim 44 \text{ km/s}$ at $z = 0$.
- MGCLS can detect galaxies with M_{HI} below the “knee” $\log_{10}(M_{\text{HI}}/M_{\odot}) < 9.94$ up to $z \sim 0.1$.

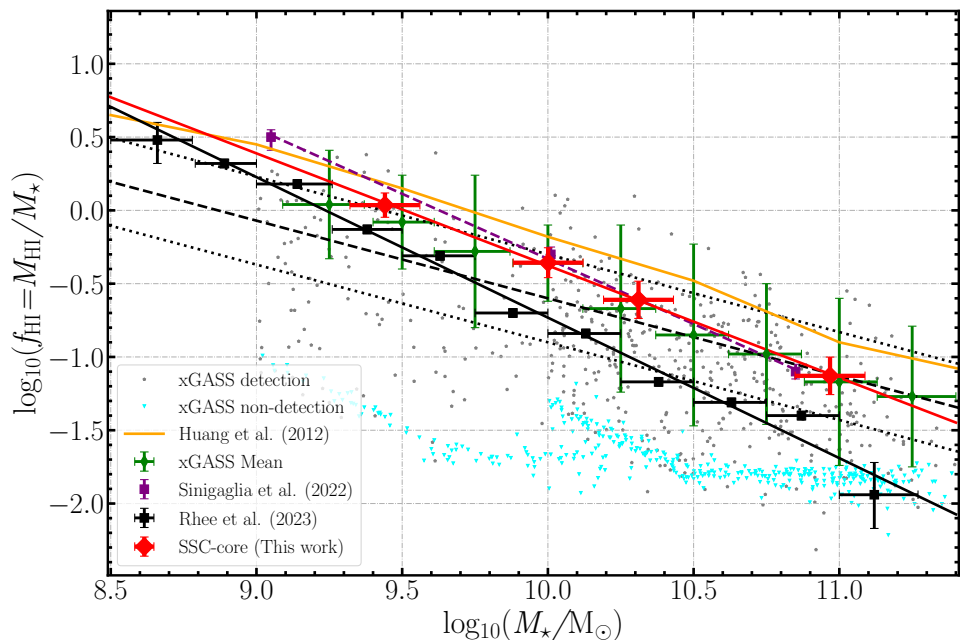
Full image



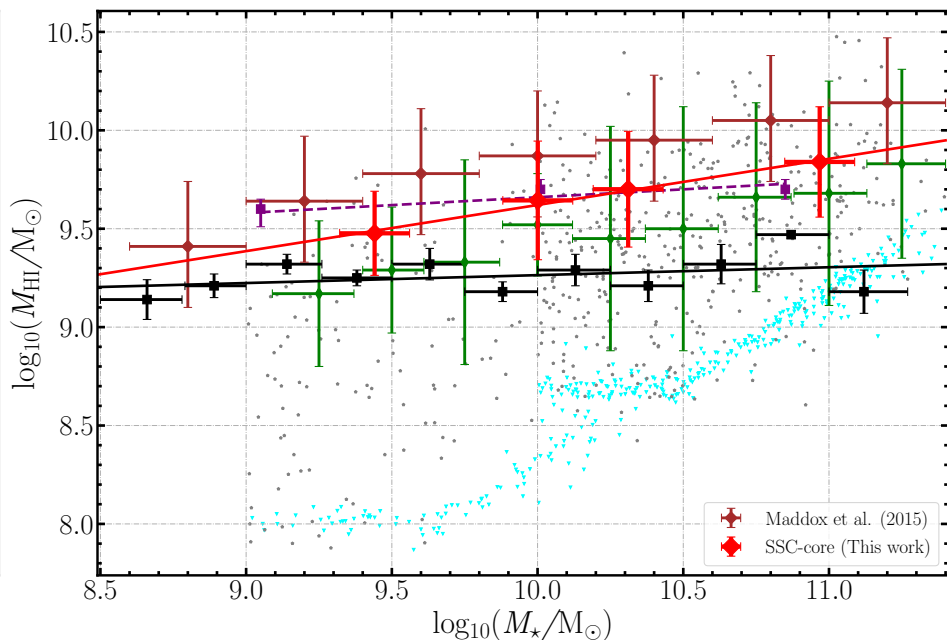
Images



Results and Discussion



- SSC-core broadly follow the same qualitative trend as field galaxies.
- All relations lie systematically below the ALFALFA α .40 field averages.



- Our sample is systematically HI-richer at $\log_{10}(M_*/M_\odot) \gtrsim 10$, compared to DINGO by $\gtrsim 0.3$ dex.