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HI in galaxy groups and clusters

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New Brunswick, NJ, USA

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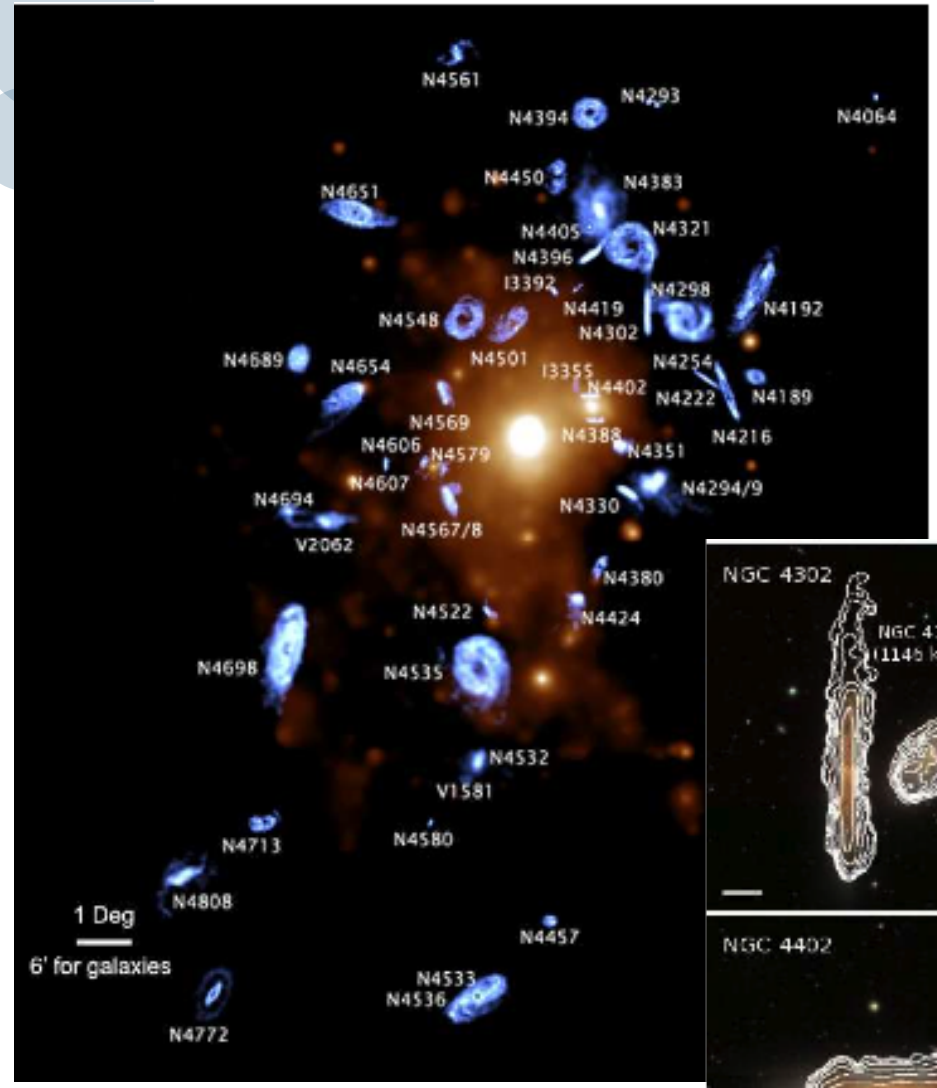
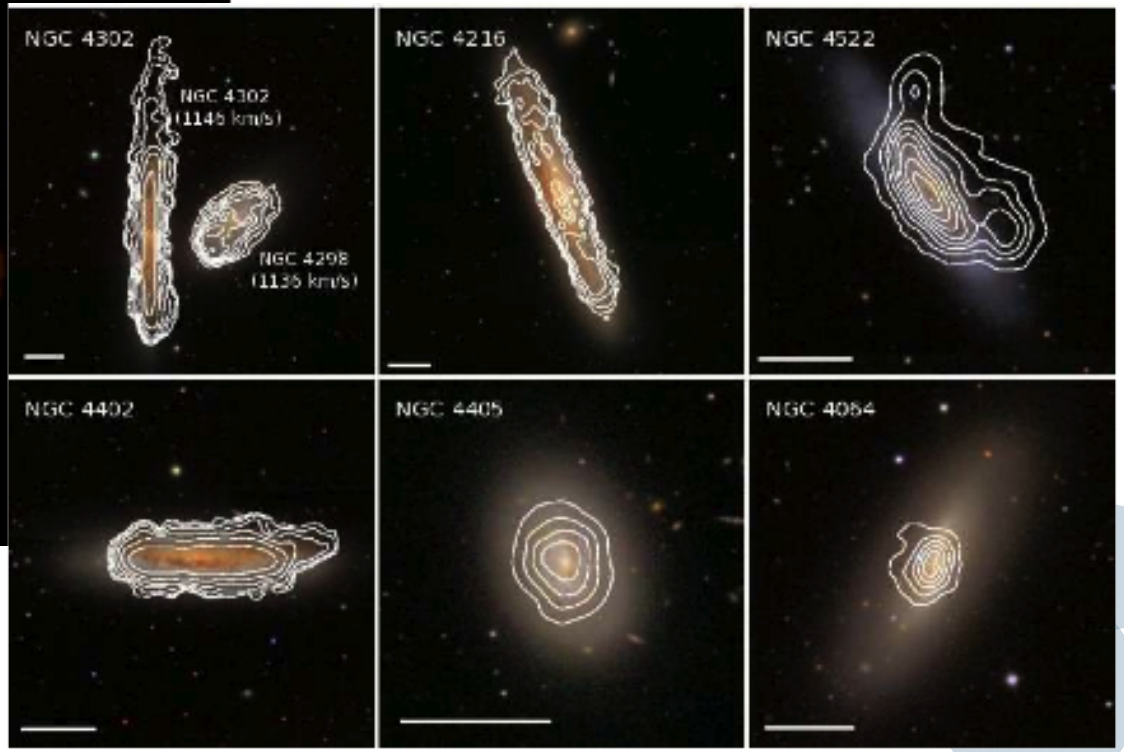
HI (combined with velocity and star formation information) can help us unravel the assembly history of large groups and clusters.

Accretion onto clusters

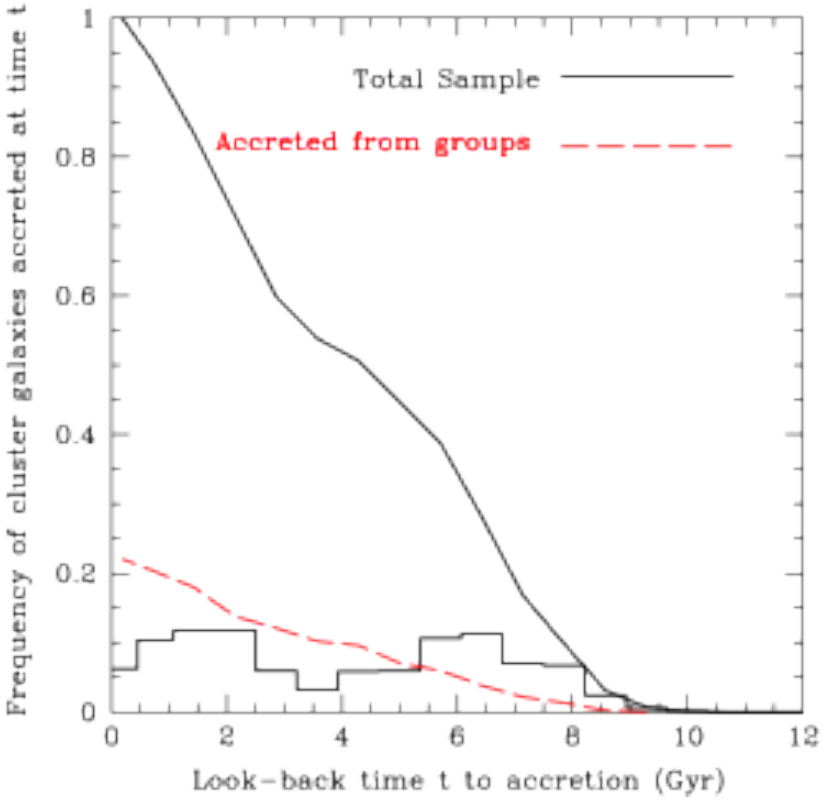
- HI traces recent accretion & impact of the cluster environment

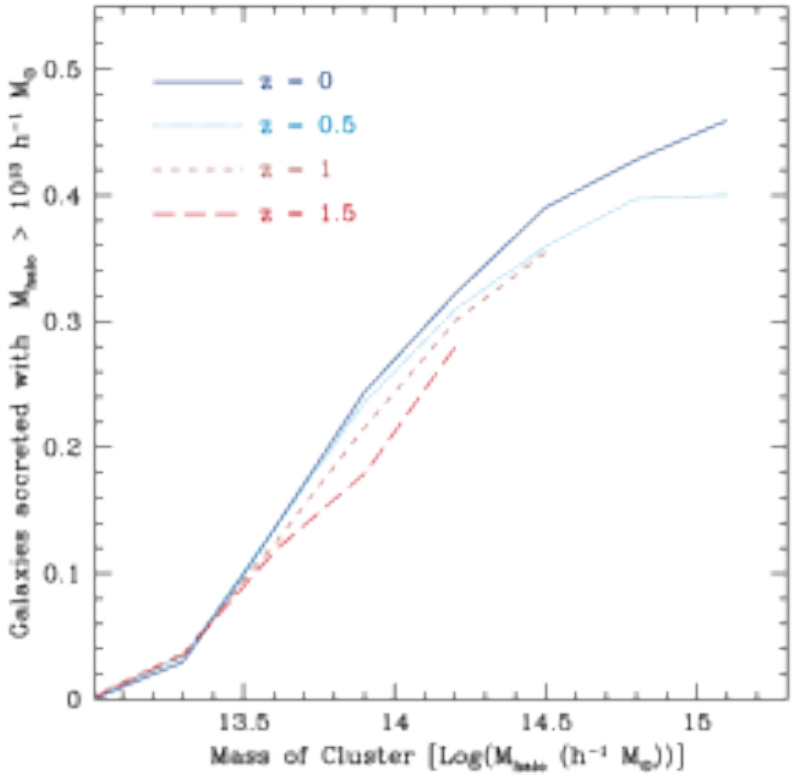


VIVA; Chung et al (2009)



Group accretion onto clusters

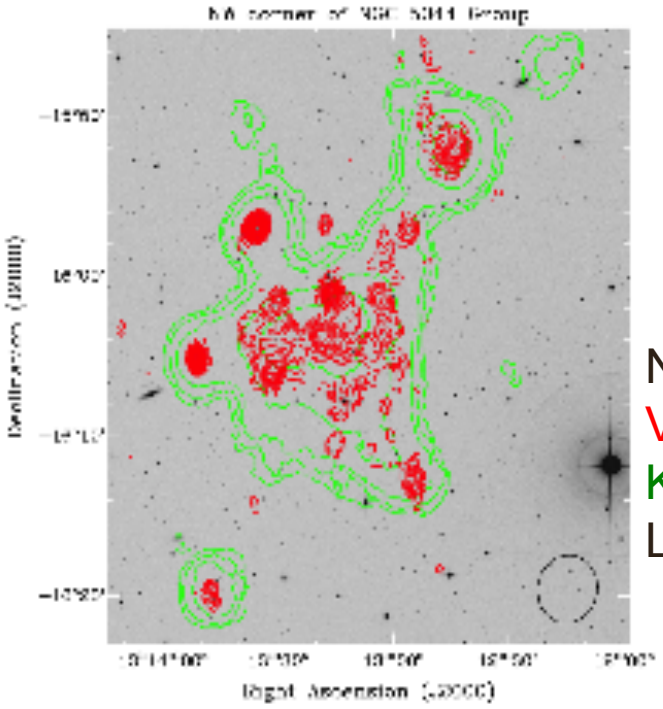




- Estimates from simulations vary: from 12-50% of galaxies in clusters have been accreted through groups

(Berrier et al, 2009; McGee et al, 2009; de Lucia et al 2012)

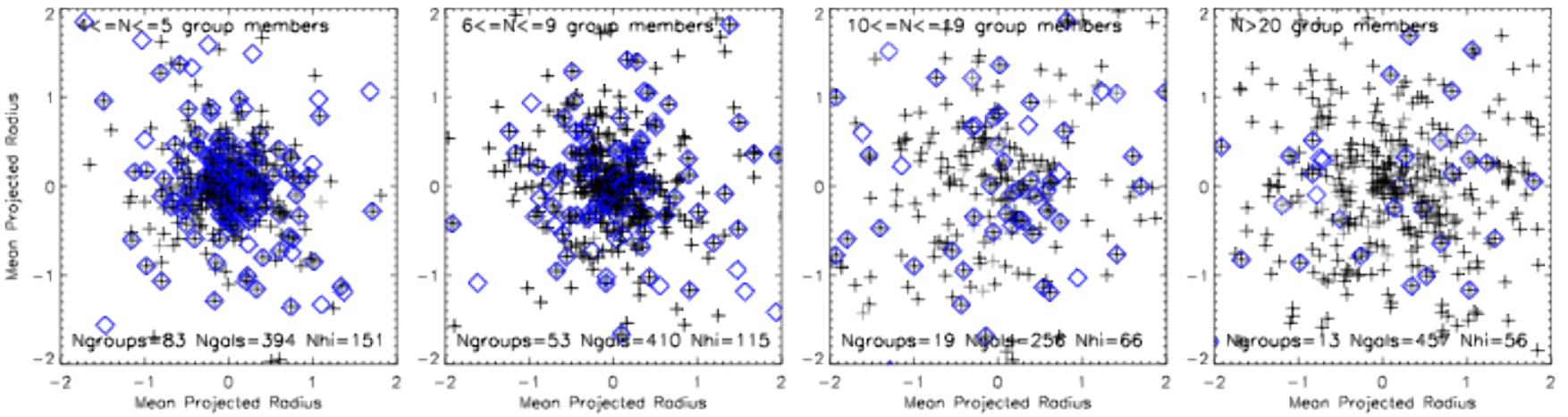
Preprocessing in Groups



NGC 5044
VLA D +
KAT-7
Lucero et al
in prep

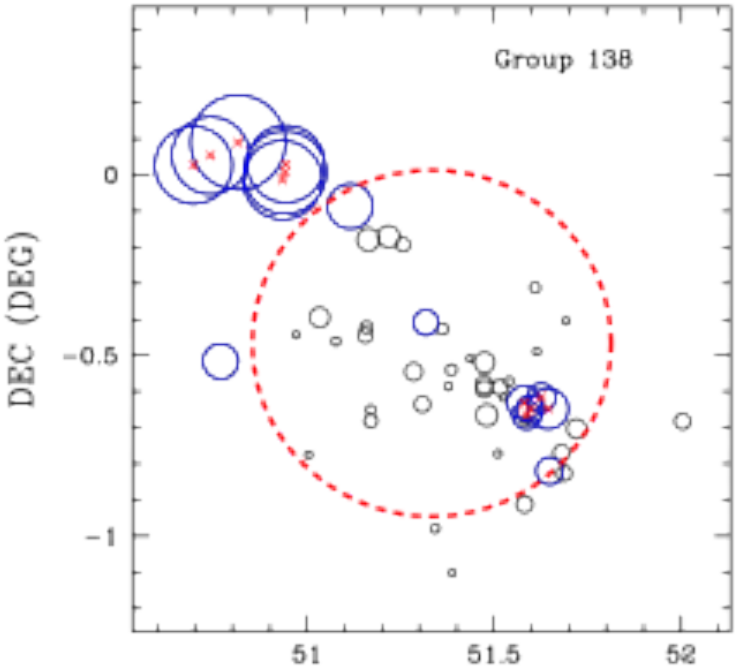
- High density, low velocity dispersion environment
- Preprocessing removes gas, impacts star formation, color, morphology
- How much pre-processing occurs in groups?

ALFALFA + SDSS group catalog

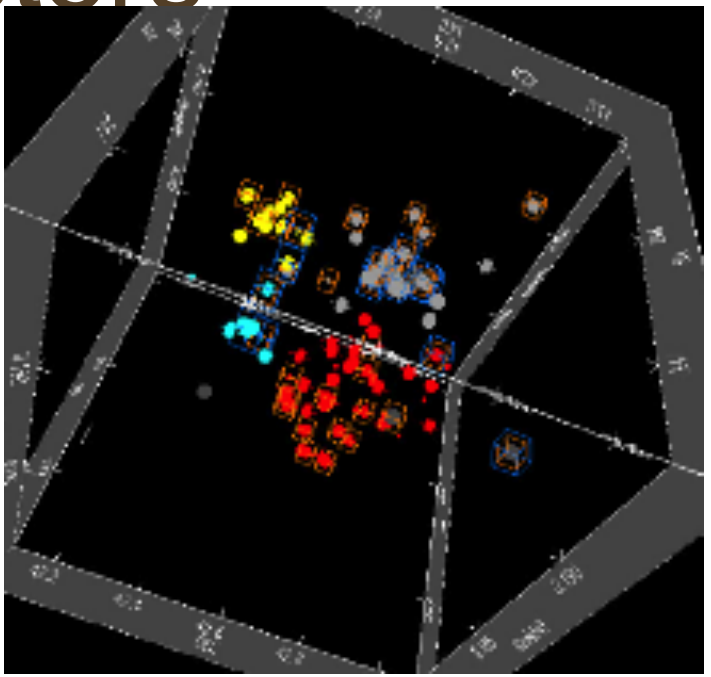


Hess & Wilcots 2013

Identifying substructure/subhalos in groups & clusters

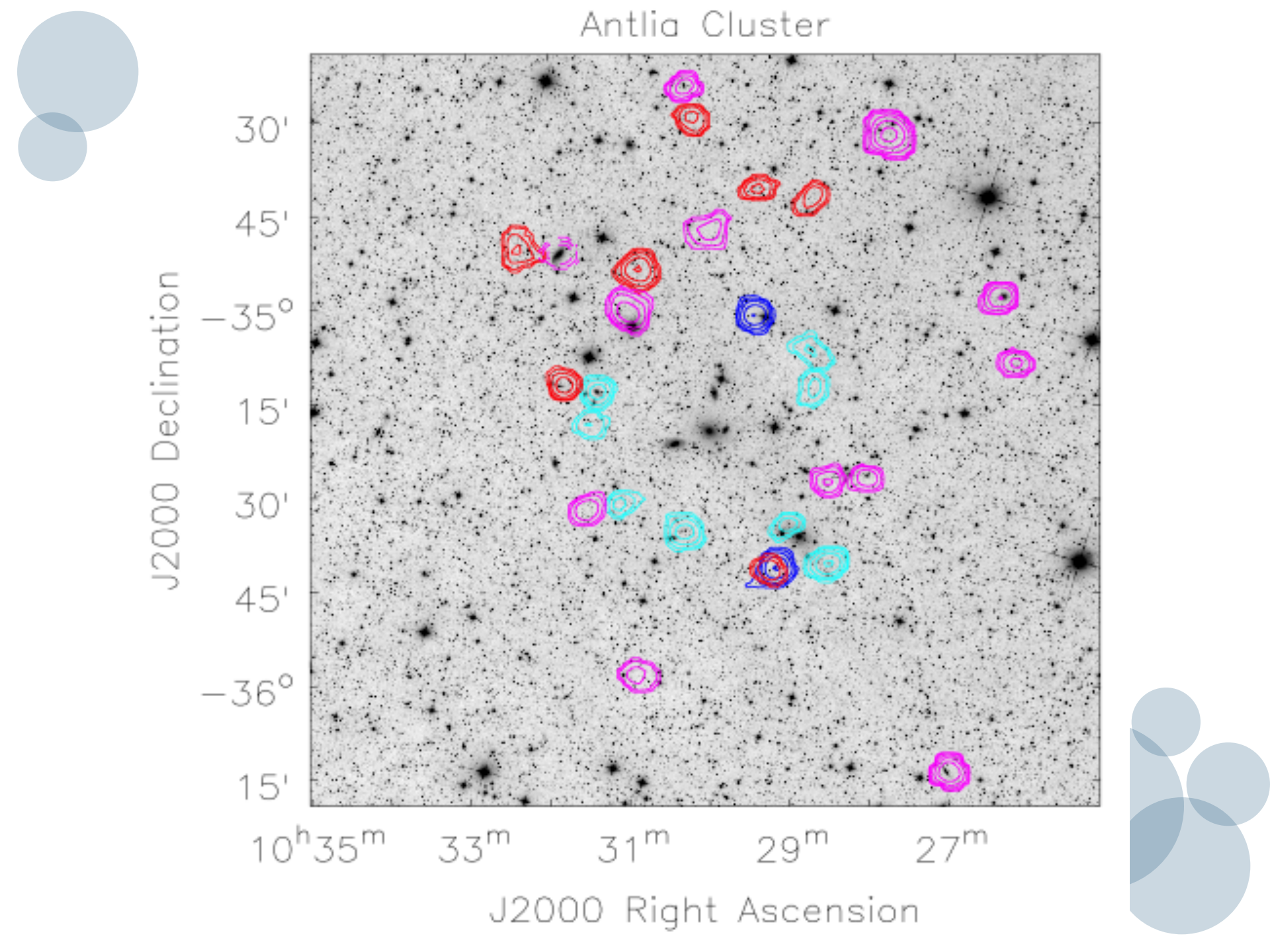


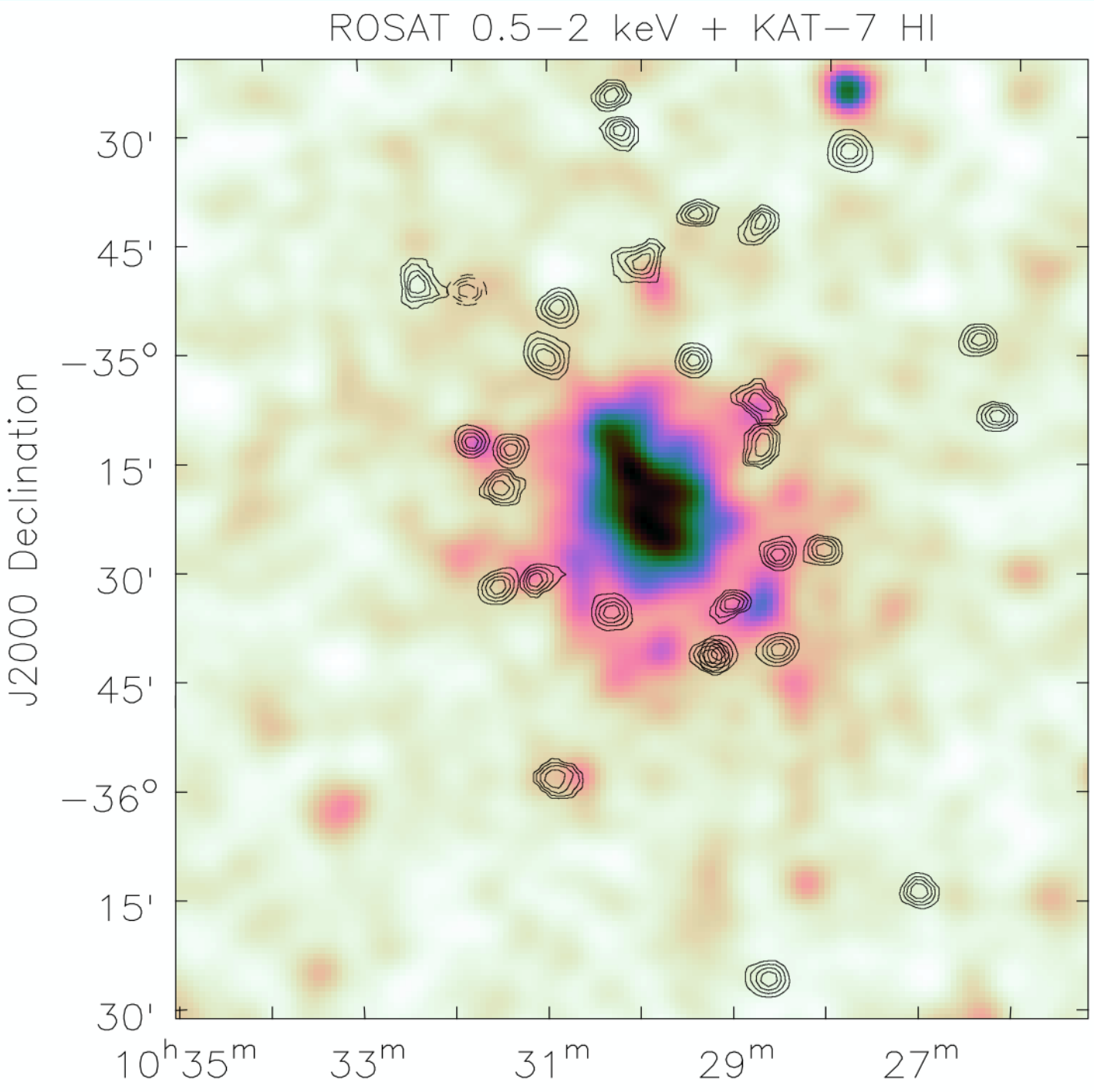
Hou et al (2014)



Jaffé et al (2012)

- Use galaxy positions + line-of-sight velocities to identify substructure (e.g. Dressler Shechtman 1988)


Antlia Cluster
30'
45'
−35°
15'
30'
45'
−36°
15'
J2000 Declination
10h35m
33m
31m
29m
27m
J2000 Right Ascension


ROSAT 0.5−2 keV + KAT−7 HI
J2000 Declination
30'
45'
−35°
15'
30'
45'
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15'
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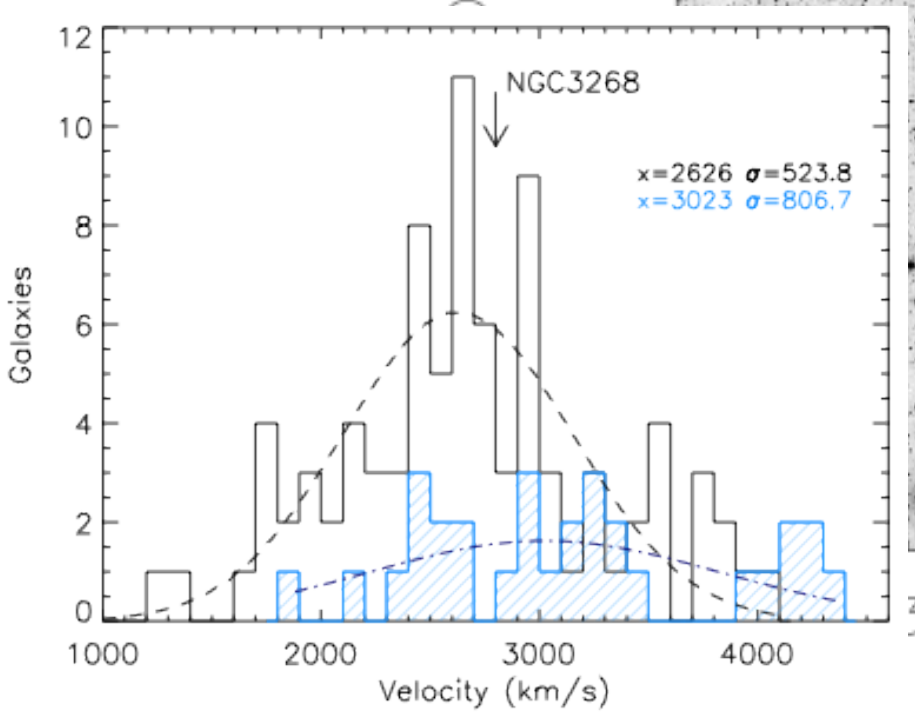
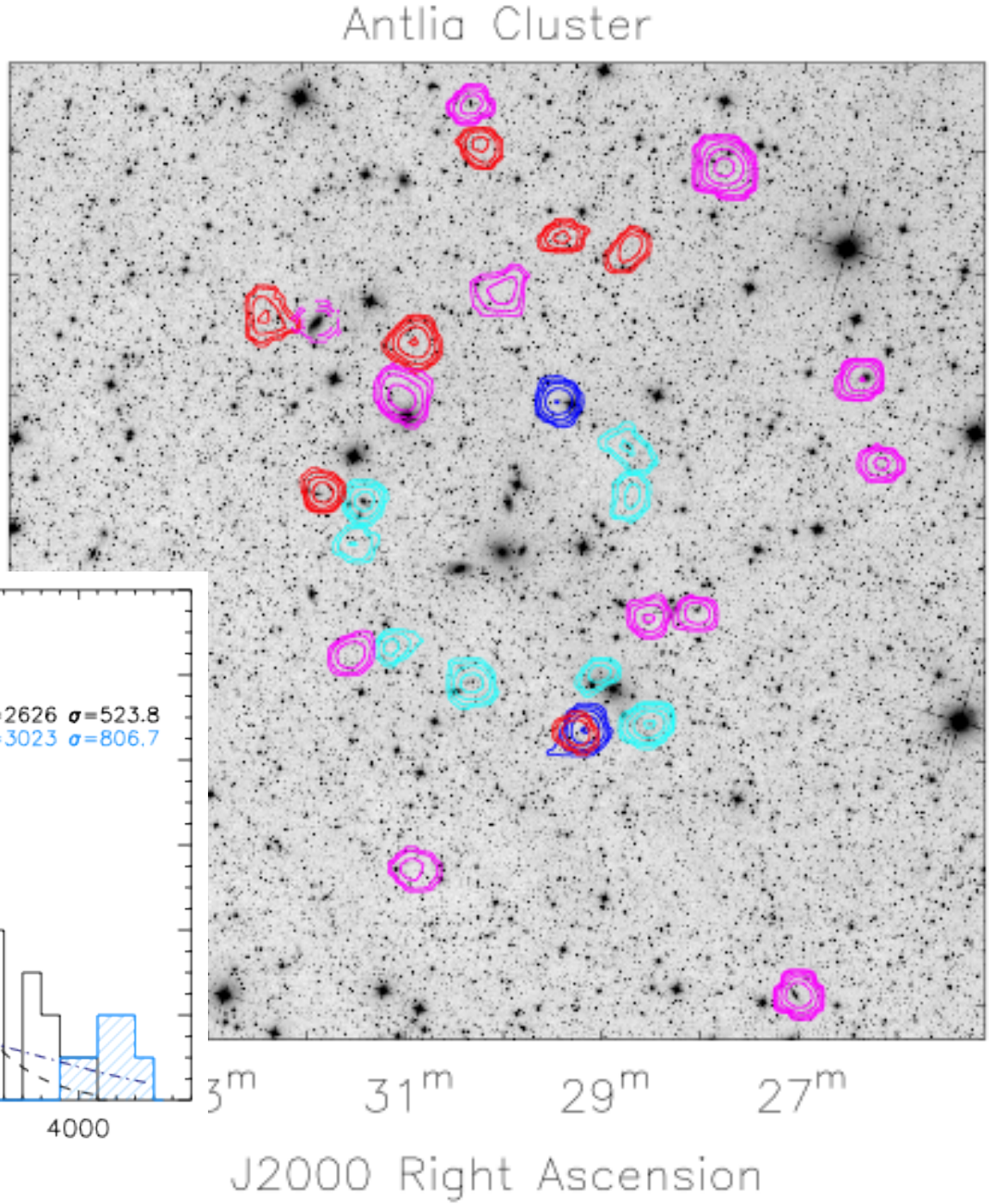
10h35m
33m
31m
29m
27m

HI Traces Infalling Galaxy Population

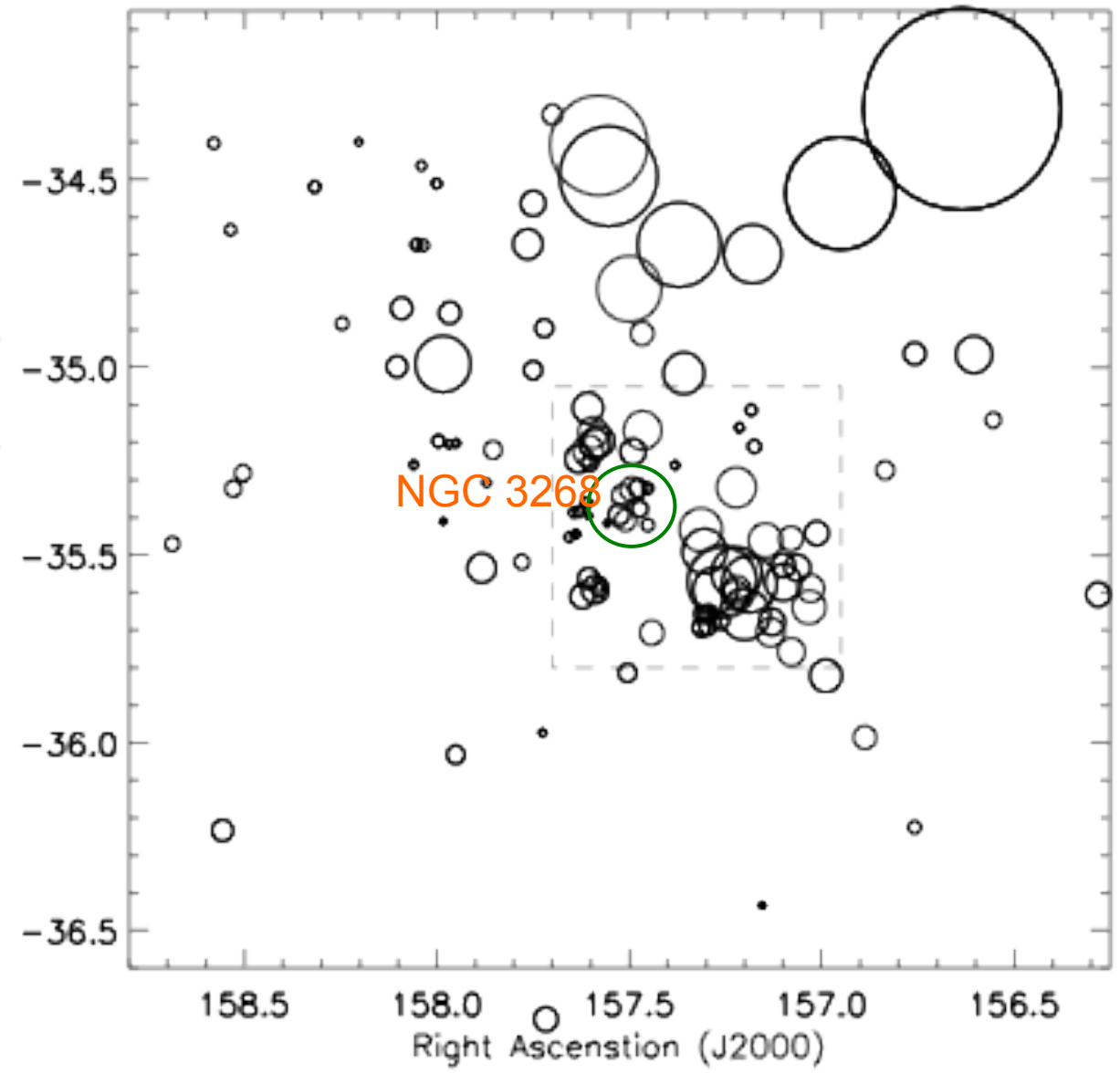
- Accretion is asymmetric
- Lack HI detections at the cluster center





Substructure in Antlia:

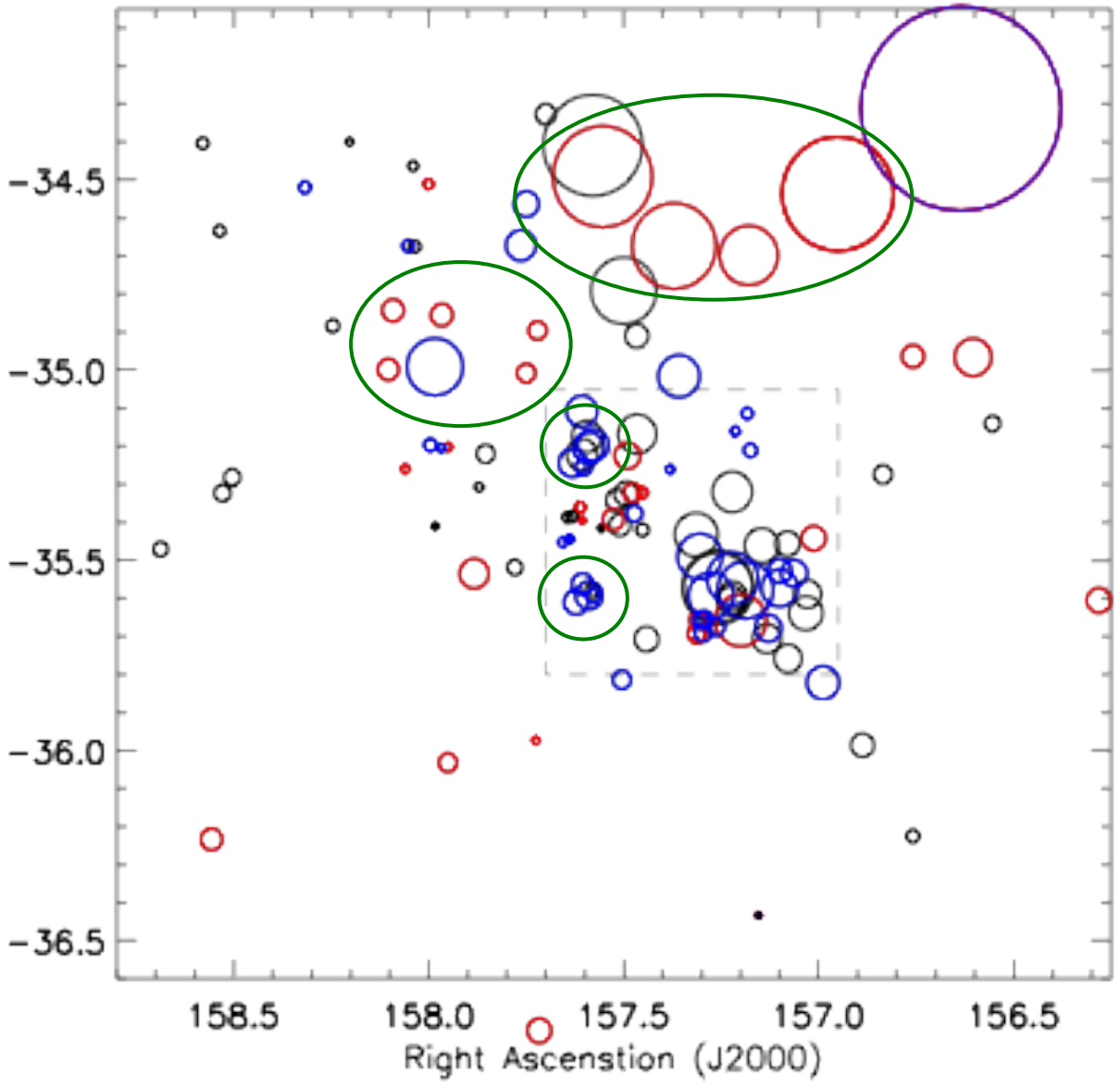
- Accreted substructure maintains its identity for several gigayears
- Dressler Schectman Test:
  - Kinematic deviation of galaxy subsets from the global cluster kinematics
  - Identify substructures that are co-spatial, similar velocities, similar deviation



$$\delta_i = \left(\frac{N_{nn}+1}{\sigma^2}\right)\left[(\bar{v}^i_{local}-\bar{v})^2+(\sigma^i_{local}-\sigma)^2\right]$$

Substructure in Antlia:

- Simulations: distance from cluster center correlated with time since accretion
- Observations: HI content correlated with distance from cluster center



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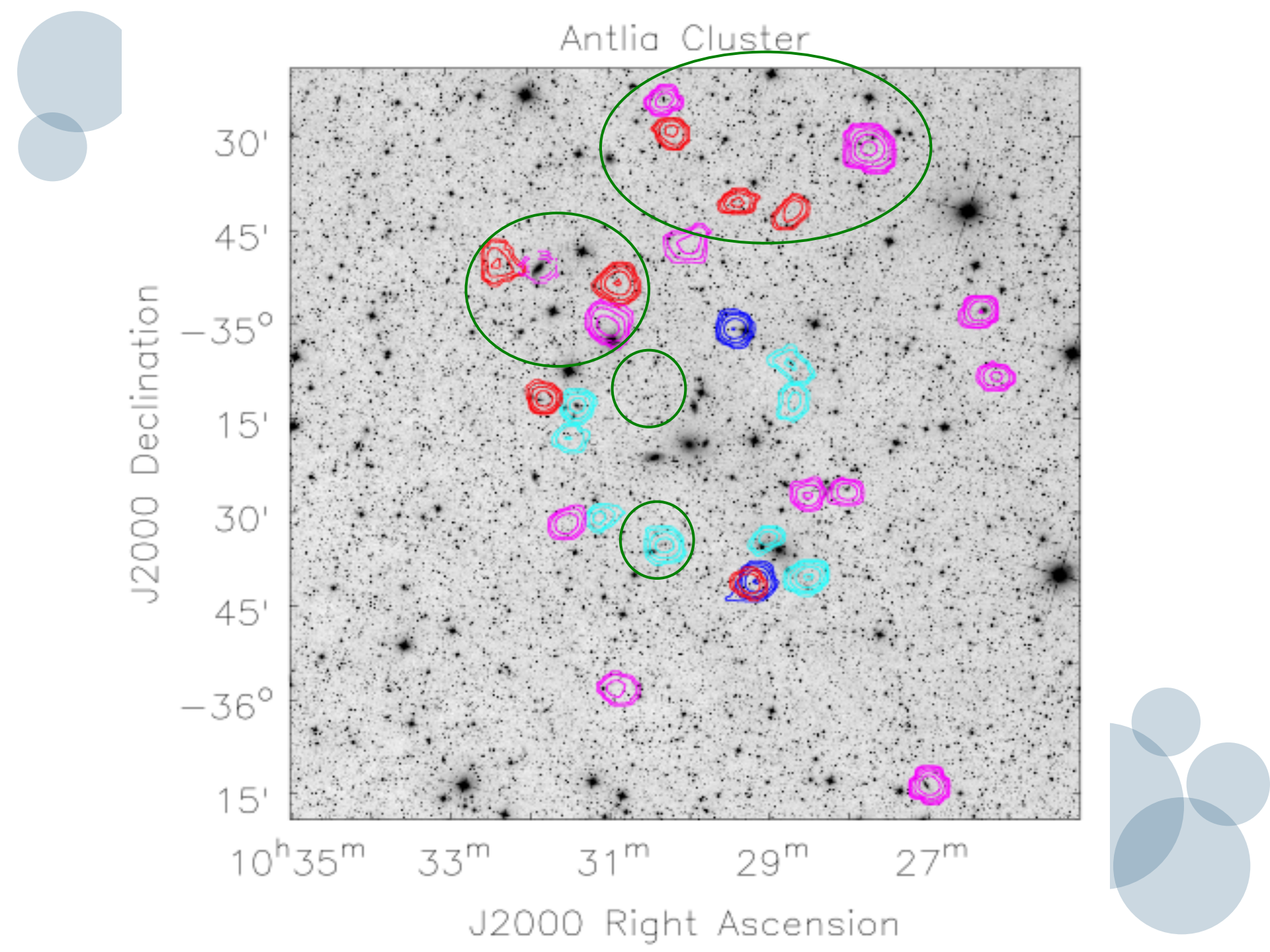
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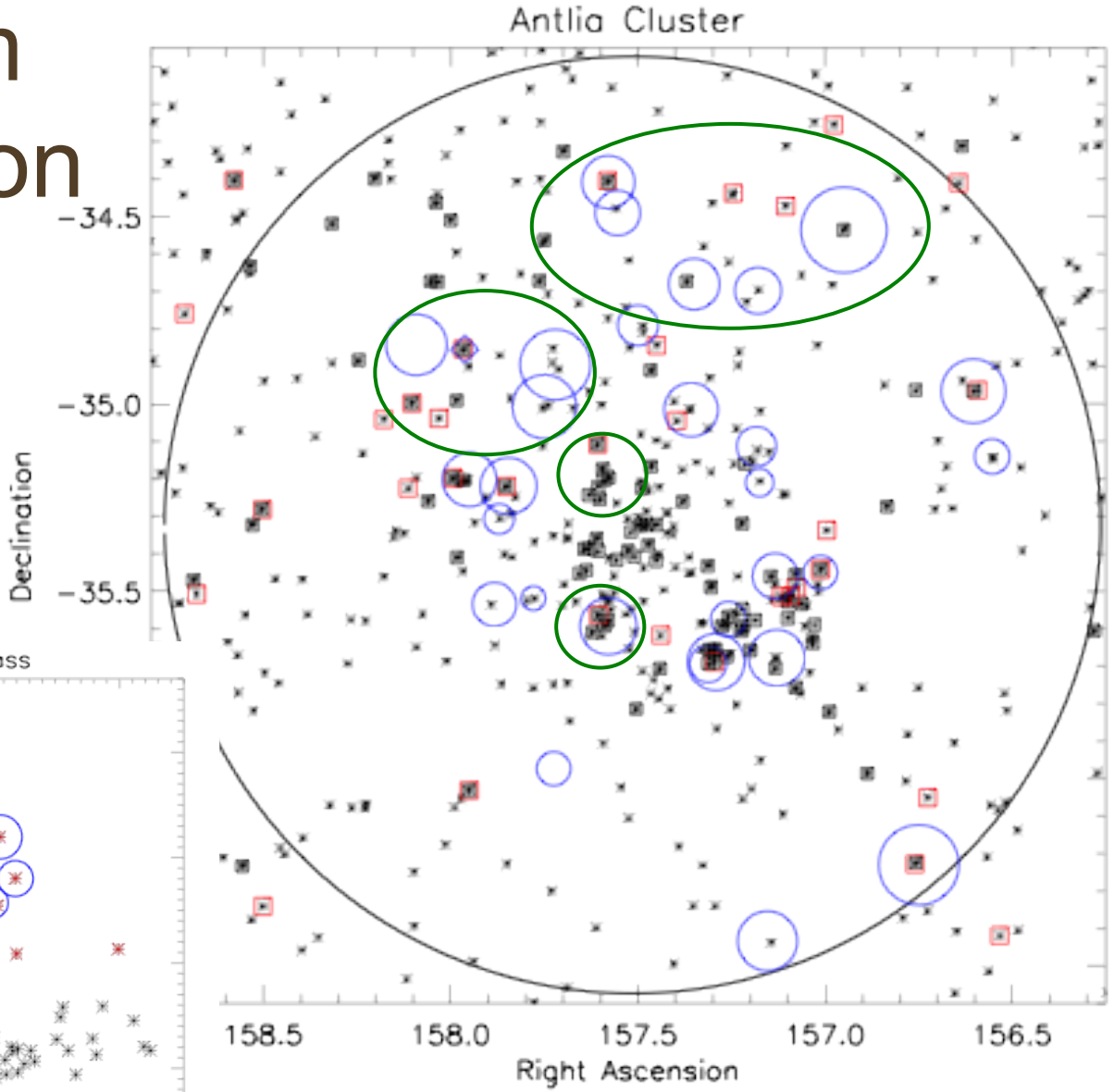
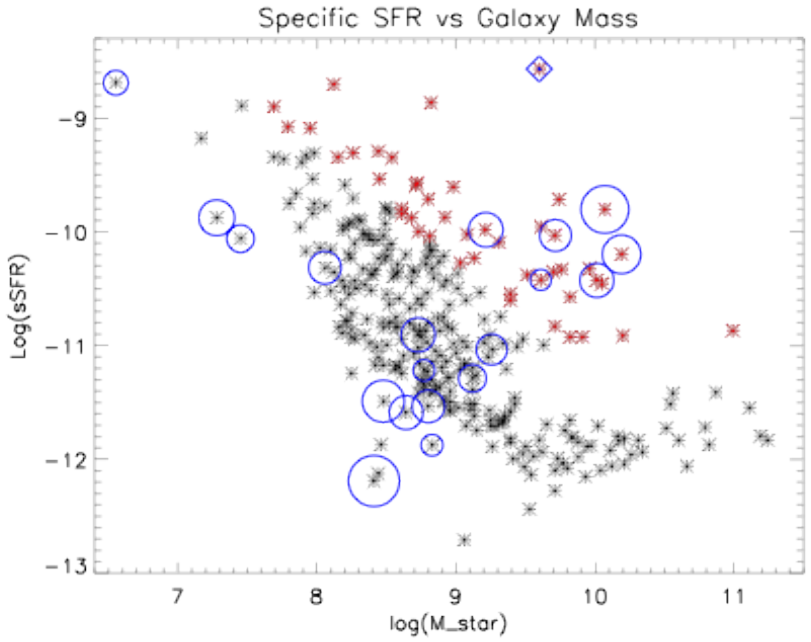
WISE 12μm Star Formation

- Star formation detected in subhalos longer than HI





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Summary

- HI traces substructure/infall on the outskirts of the cluster
- 30 HI detected objects, +21 new redshifts
- Identified (4 major) infalling substructures within Antlia with clues to how the cluster has assembled with time
- HI/SF content in subhalos is correlated with distance to the cluster center

- Future surveys will provide equivalent or greater HI mass sensitivity over a larger volume (with complementary optical redshift coverage), increasing the number of clusters for which we can do these studies.

Look for this coming to the arXiv near you…