Tracing Outflows and Shocked Disk Gas in an Assembling Galaxy Cluster

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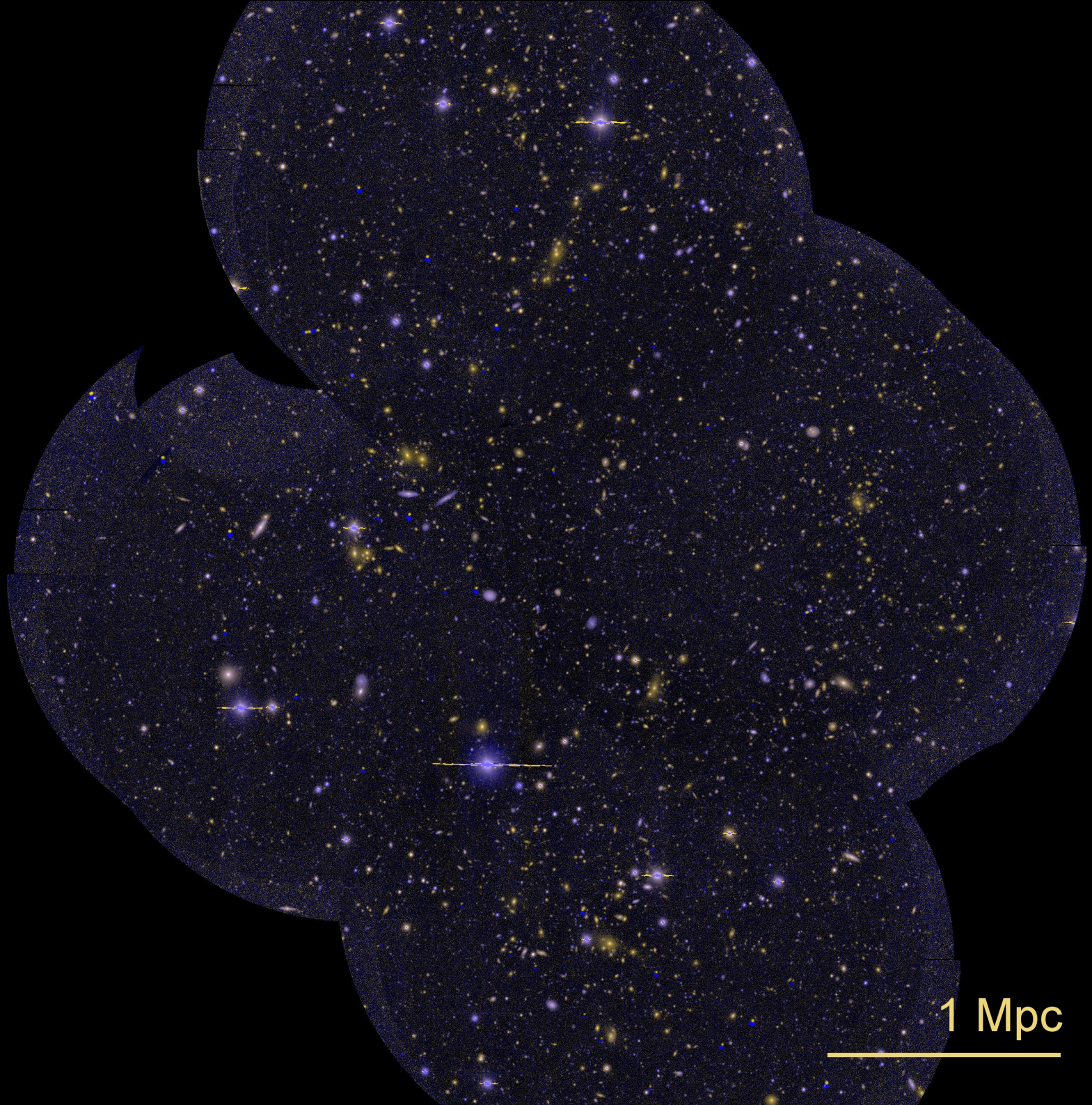
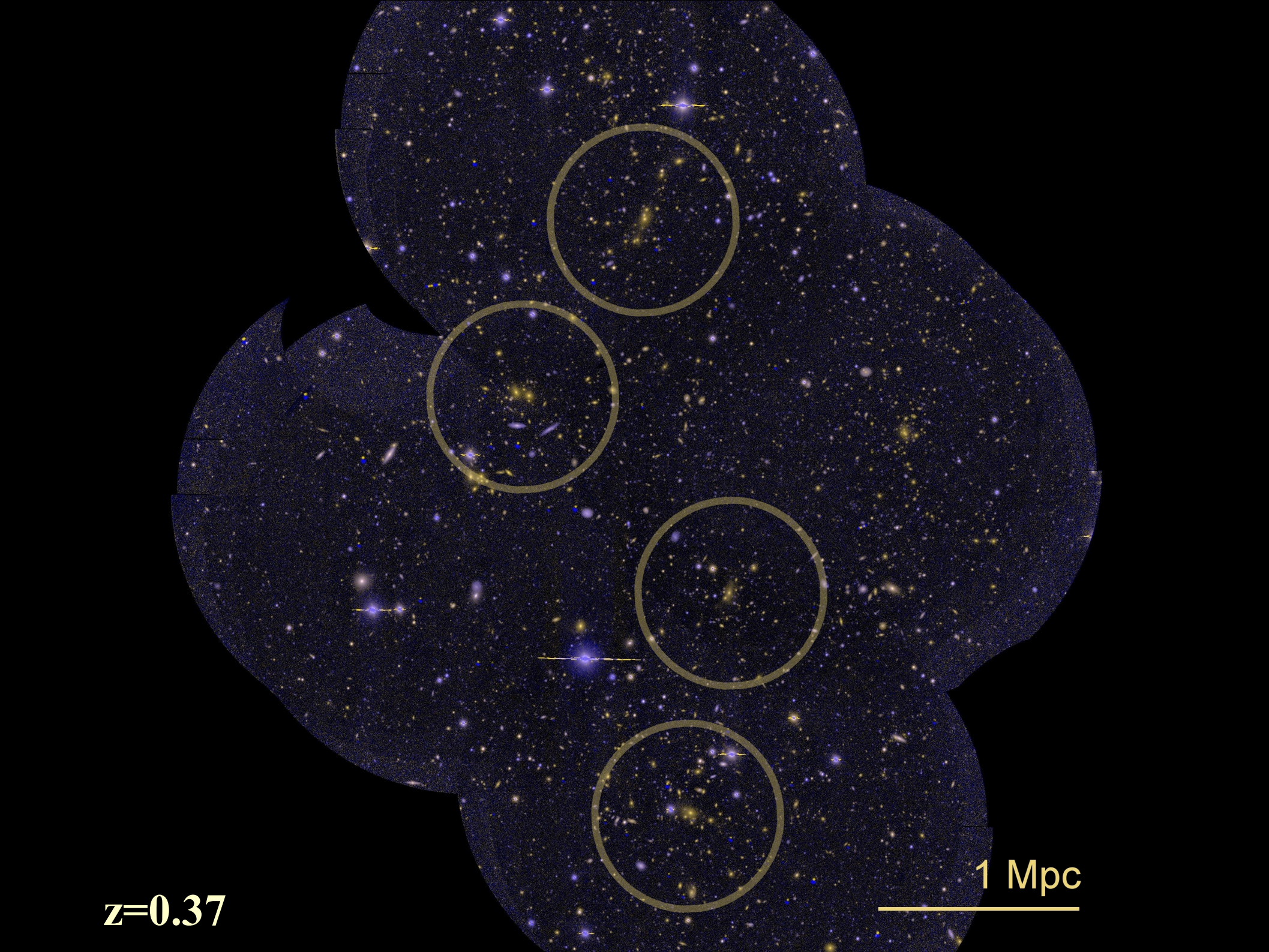
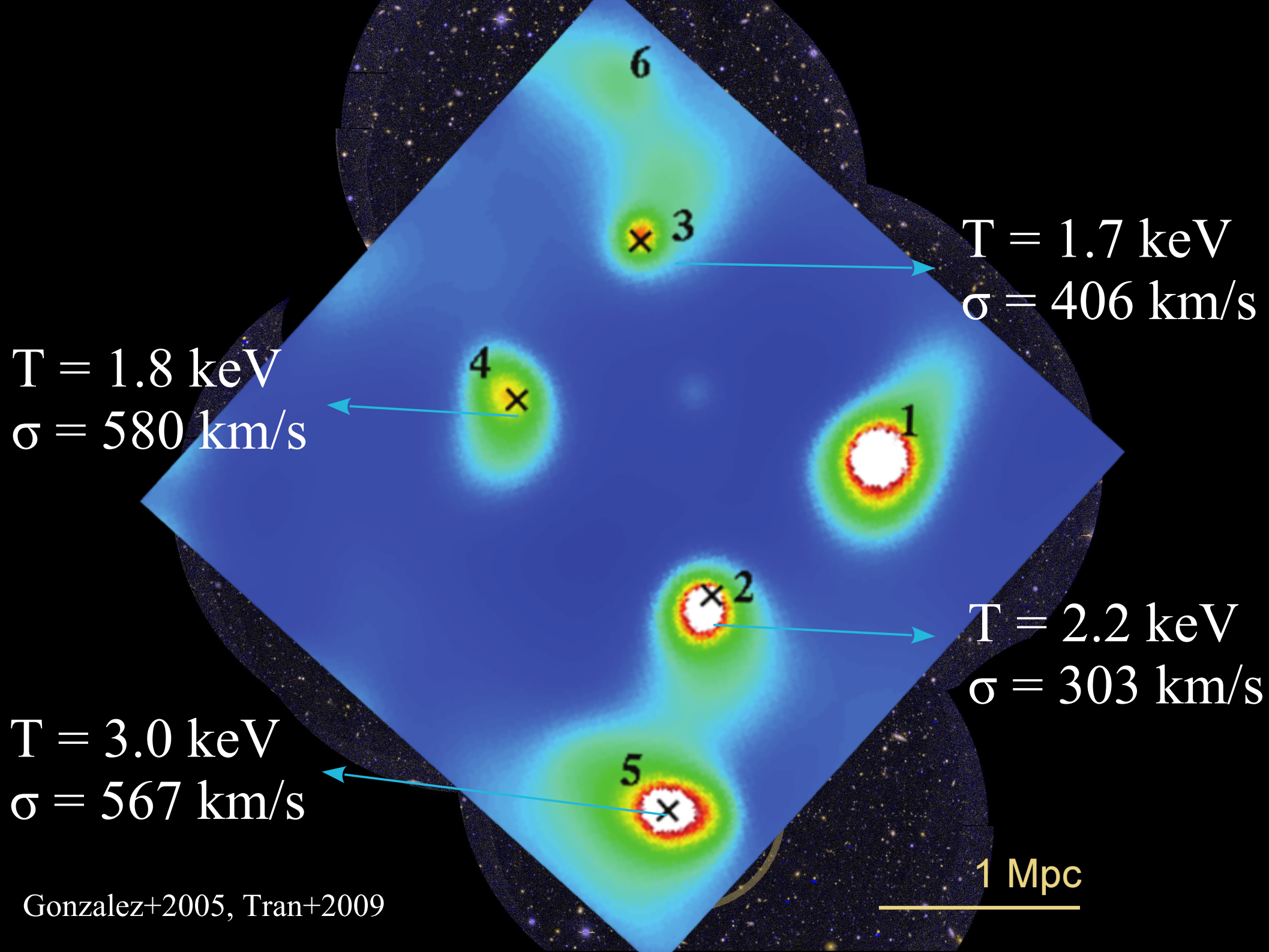
Collaborators : Kim-Vy Tran, Lea Giordano, Anthony Gonzalez, Trevor Irwin, Amélie Saintonge, Dennis Zaritsky

We directly study the progenitors of cluster galaxies while still in the group environment and find :

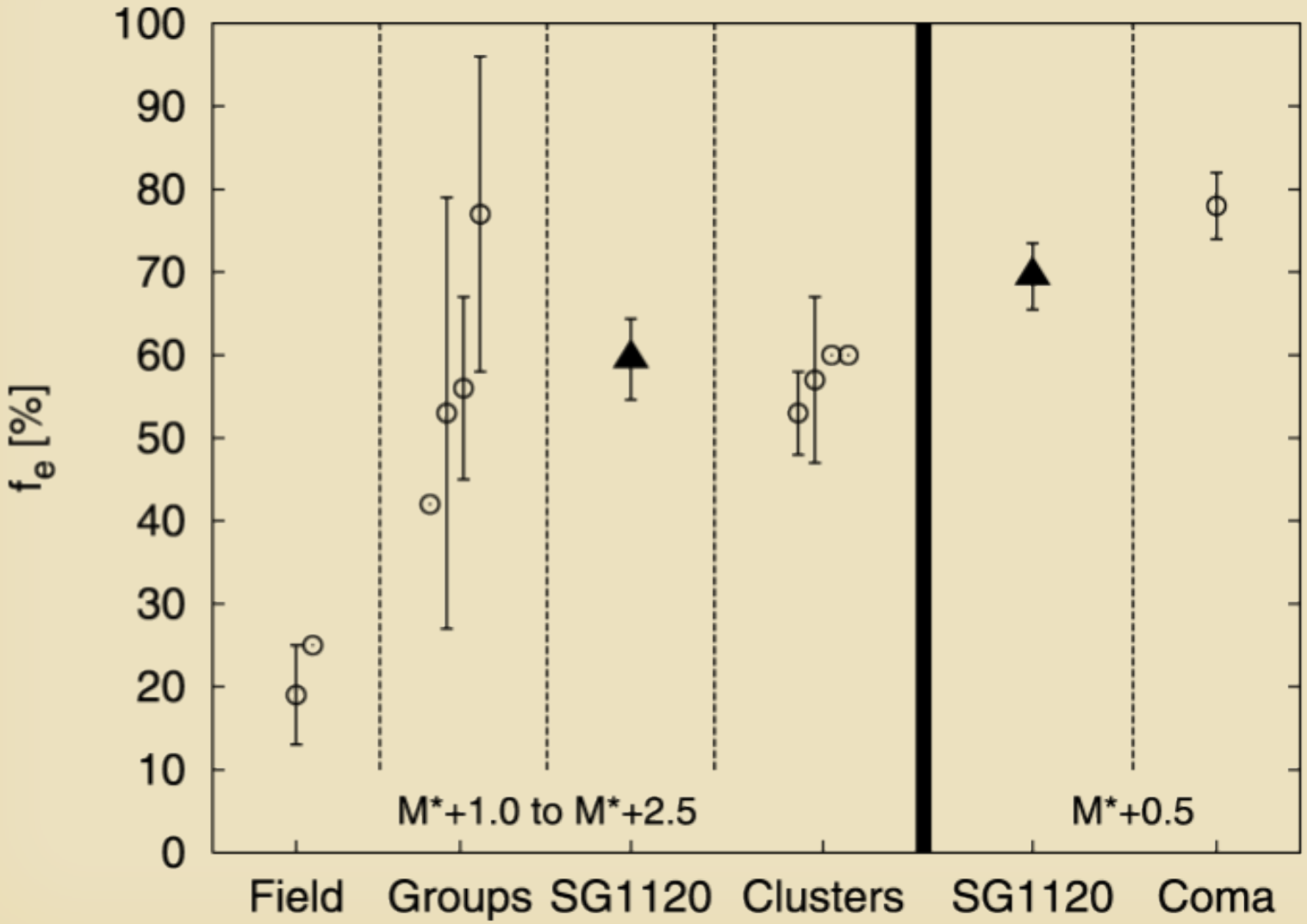
- An enhancement of low-mass star forming galaxies, radio AGN, and X-ray AGN
- Outflows are common among strongly star-forming galaxies
- Composite galaxies show evidence for shock heating throughout their disks – they may be galaxies in transition


1 Mpc


1 Mpc
z=0.37

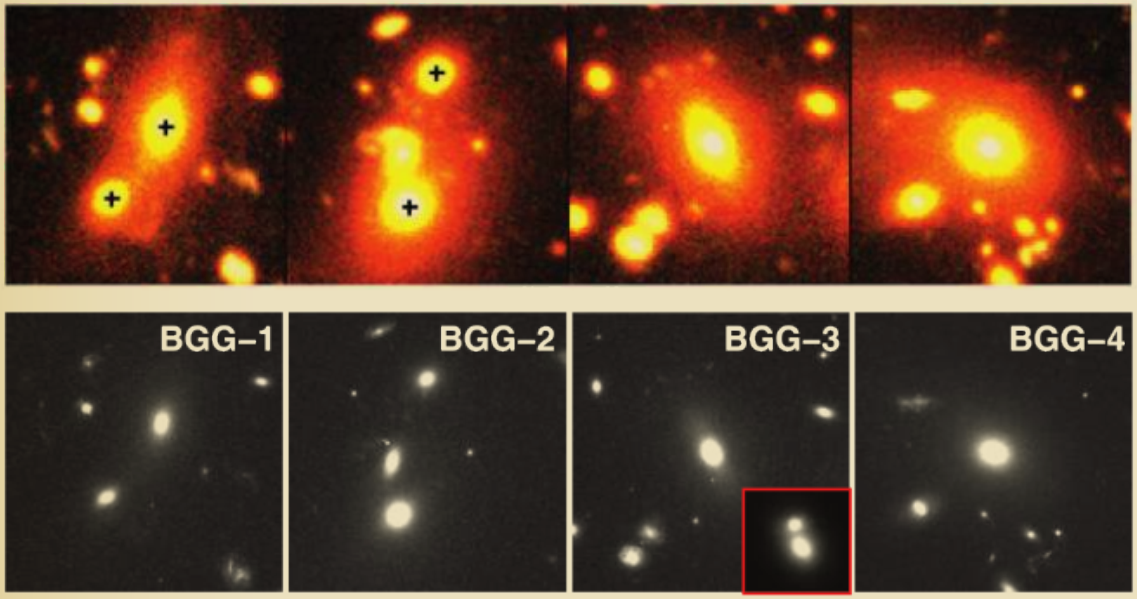

6
3
4
1
2
5
T = 1.7 keV
σ = 406 km/s
T = 1.8 keV
σ = 580 km/s
T = 2.2 keV
σ = 303 km/s
T = 3.0 keV
σ = 567 km/s
1 Mpc
Gonzalez+2005, Tran+2009

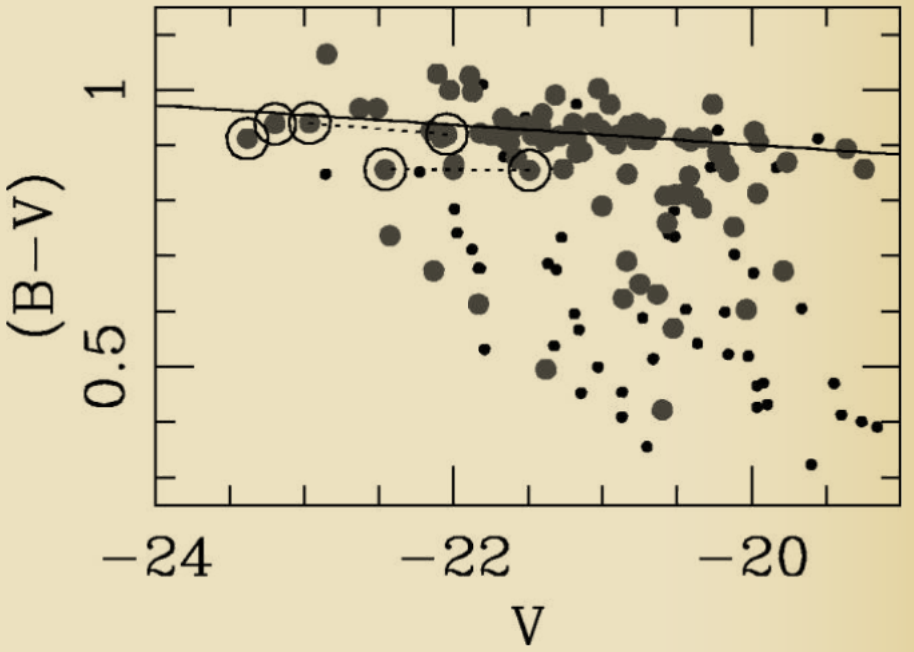
The early-type galaxy fraction is consistent with clusters at comparable redshift.



Kautsch+2008

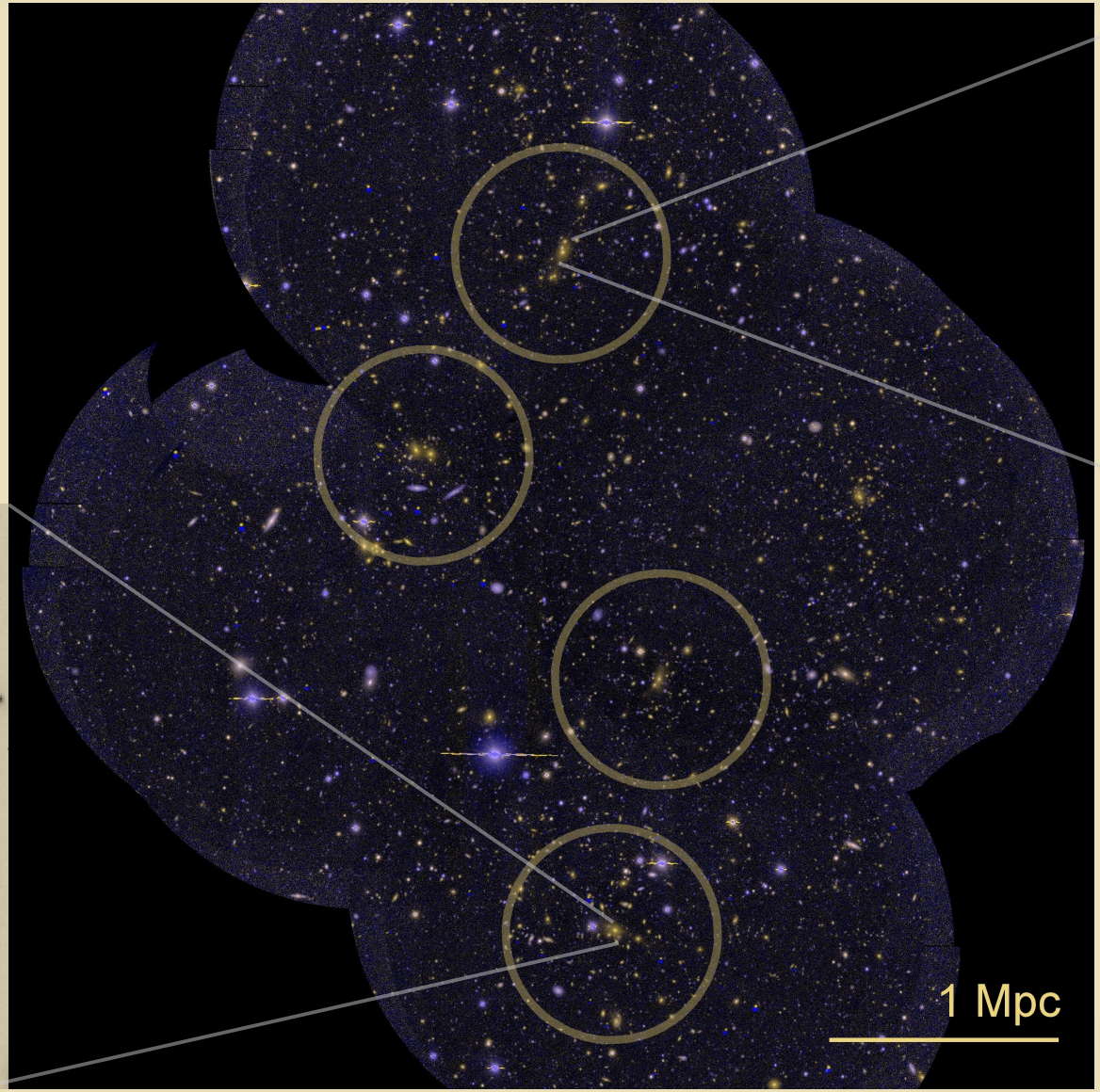
Central galaxy mass is increasing by ≥ 40% through merging and with no sign of current (or recent) star formation.

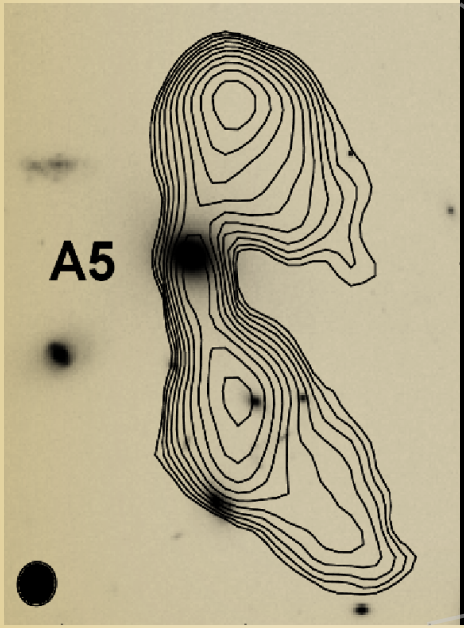




Tran+2008

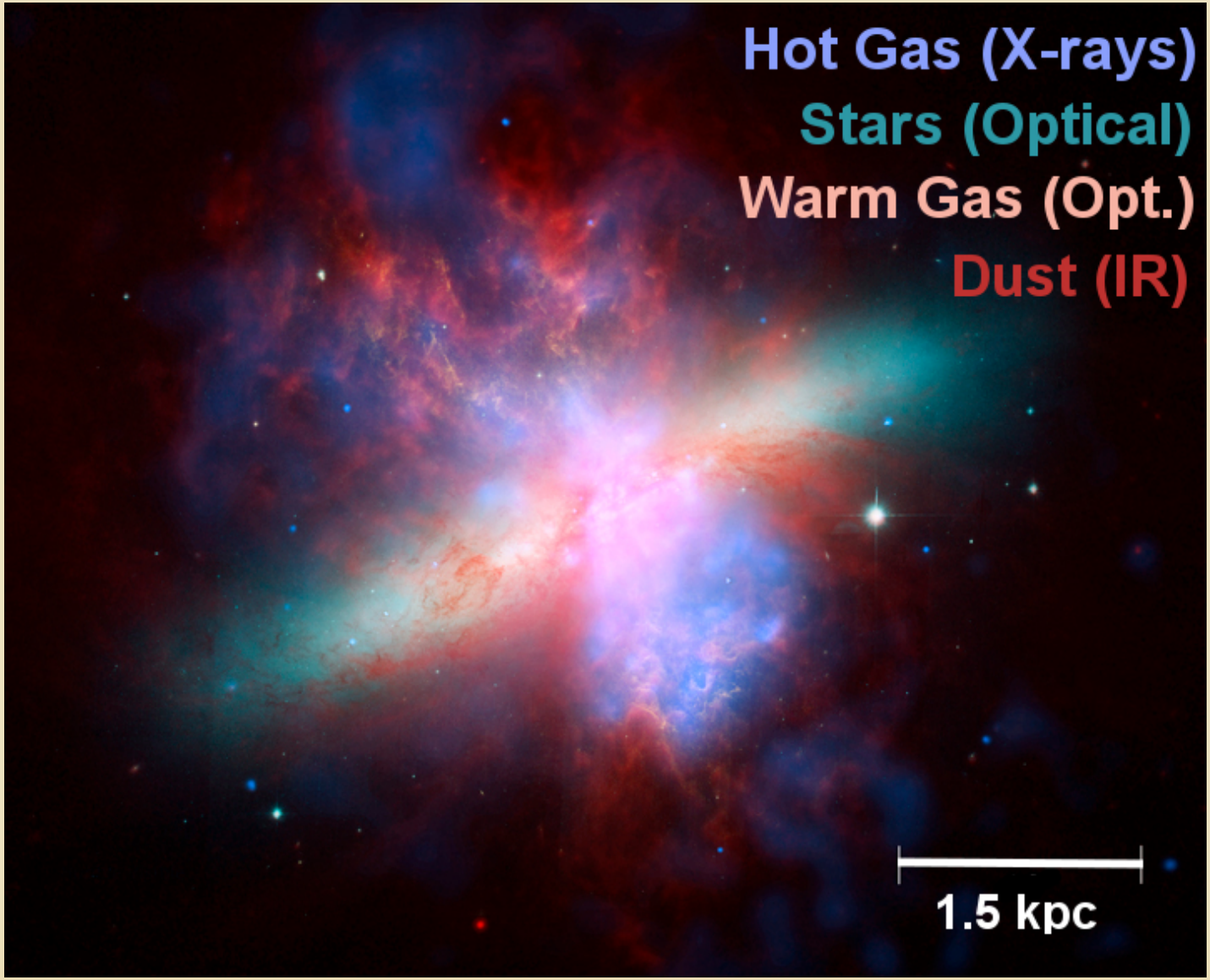
There are four times as many radio-active galaxies as field and cluster environments at similar redshift.



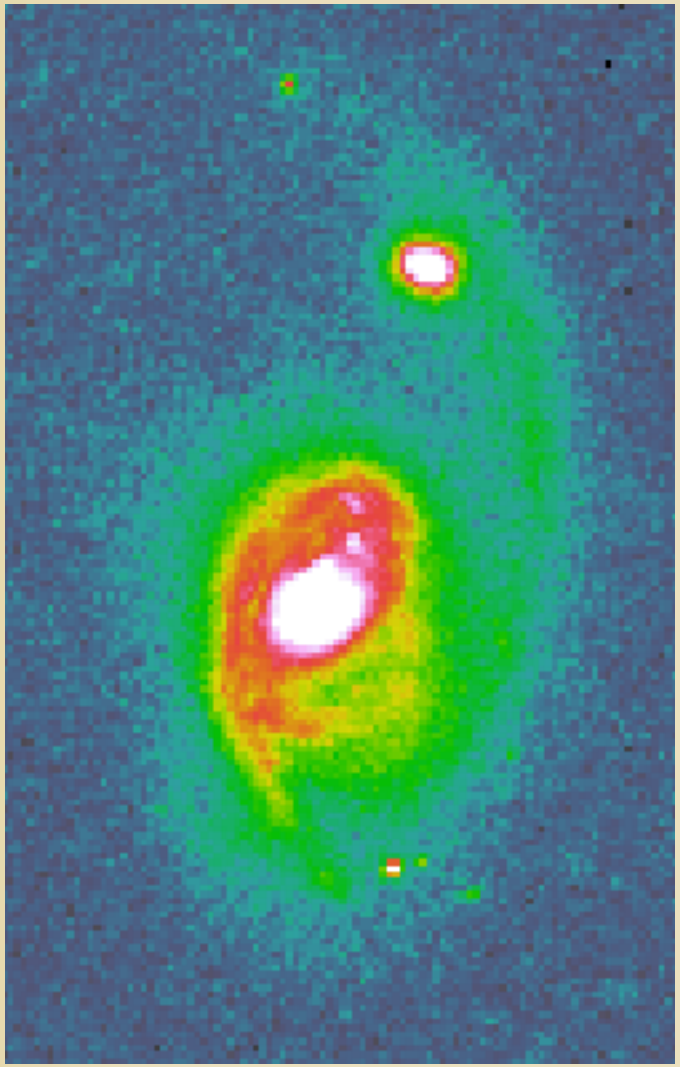


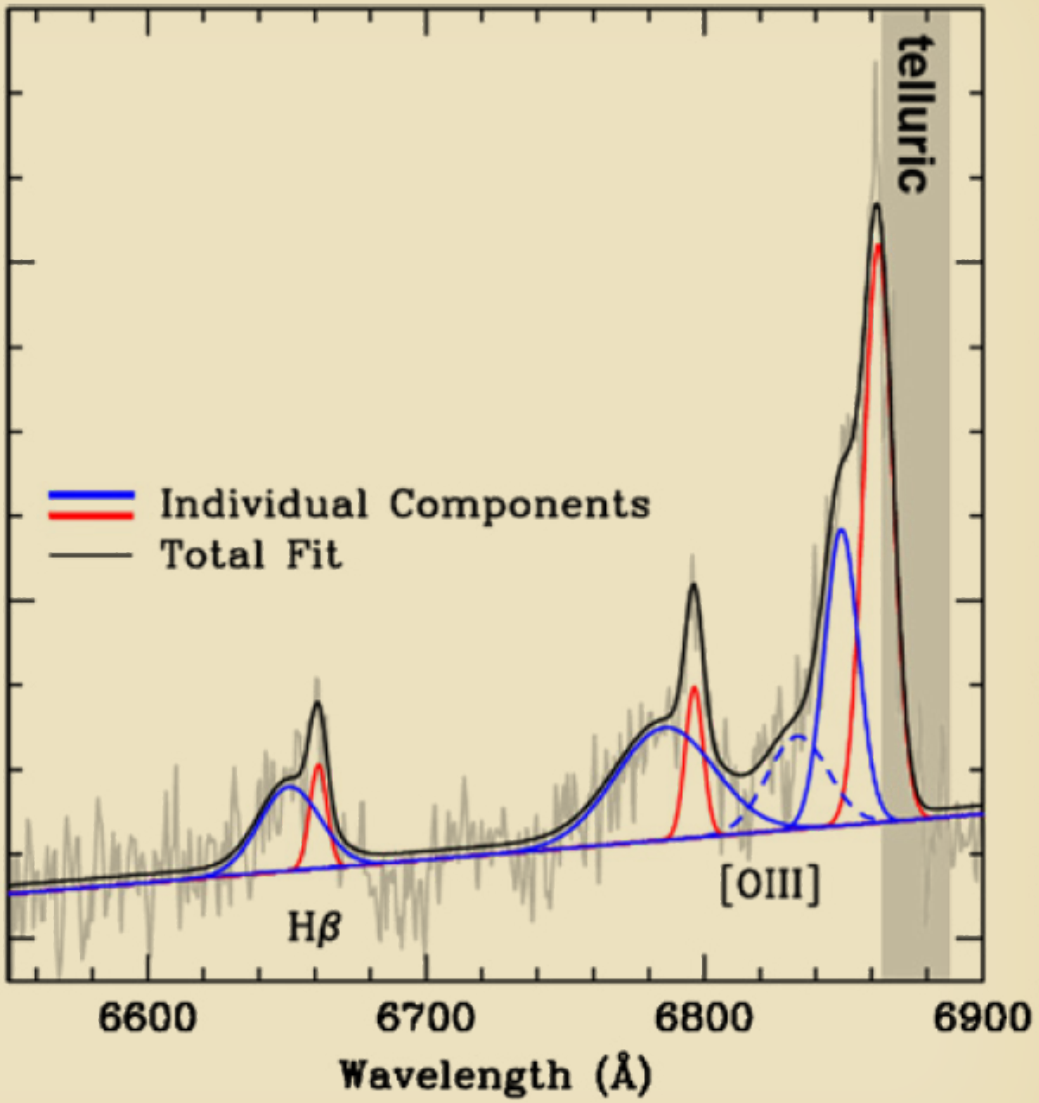
Freeland+in prep

$\geq$ 18% of galaxies with SFR > 8 $M_{\odot}$ / yr show ionized gas characteristics indicative of outflows.



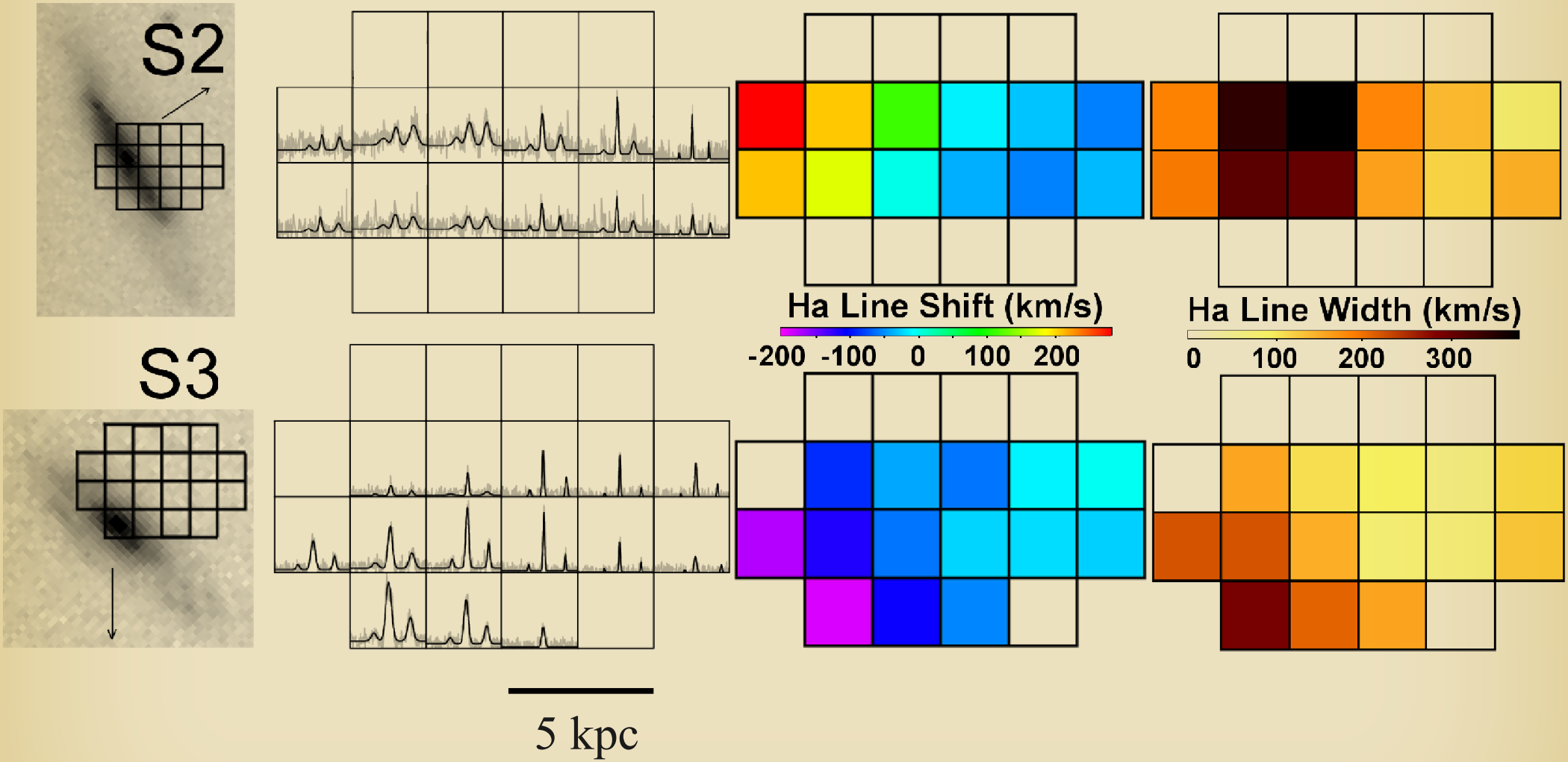
A fast outflow is observed from a ULIRG.





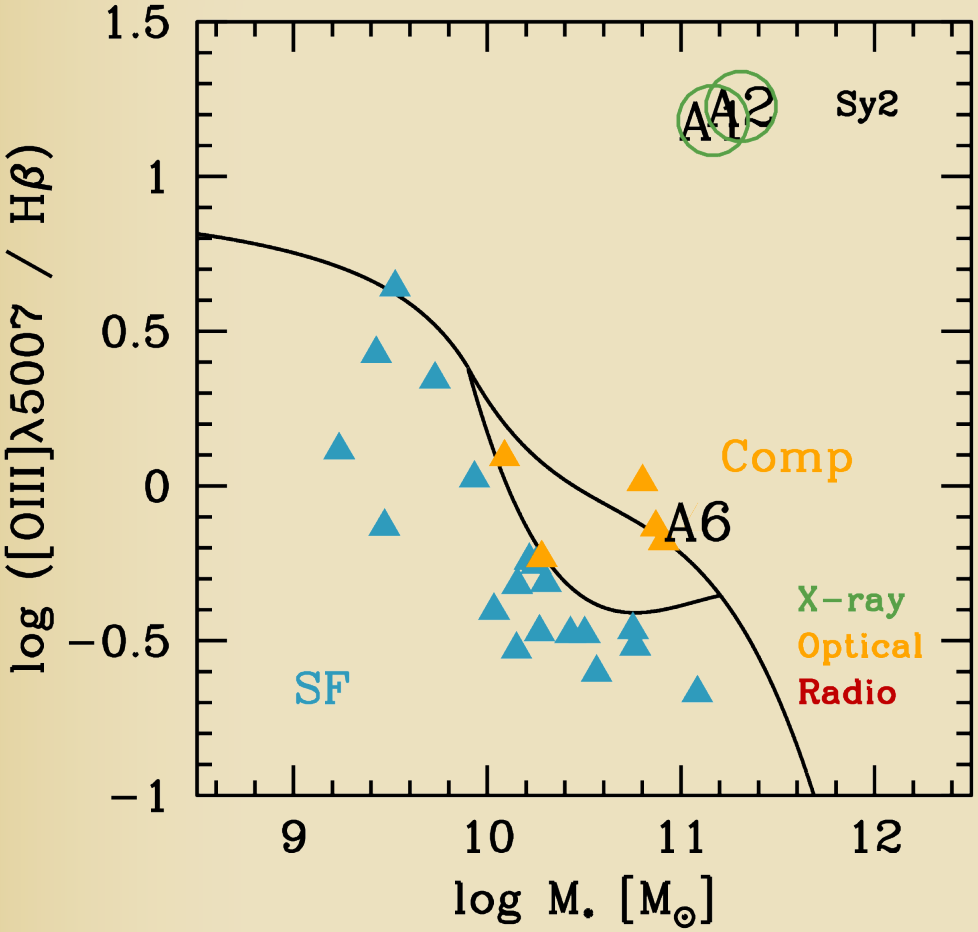
Freeland+2011

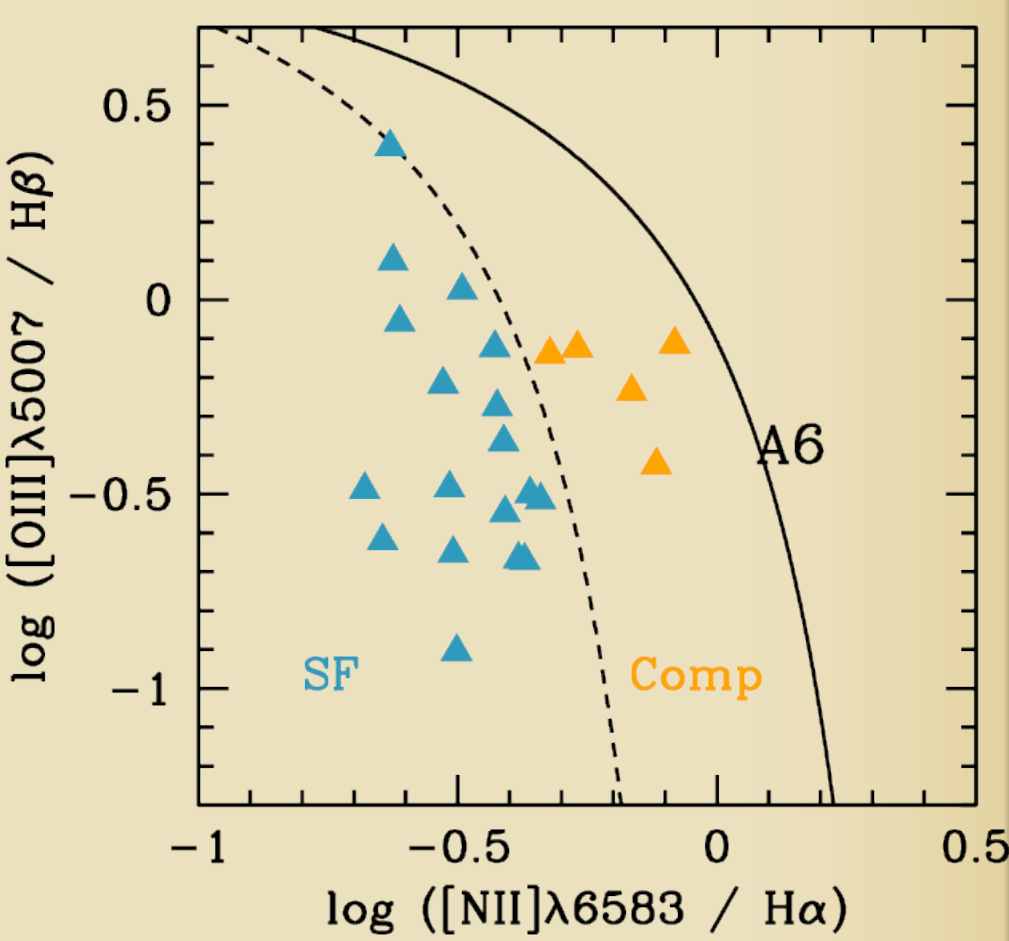
Warm extraplanar gas is seen in two edge-on galaxies whose SFR ~ 10 M_Θ / yr.



Freeland et al. 2011

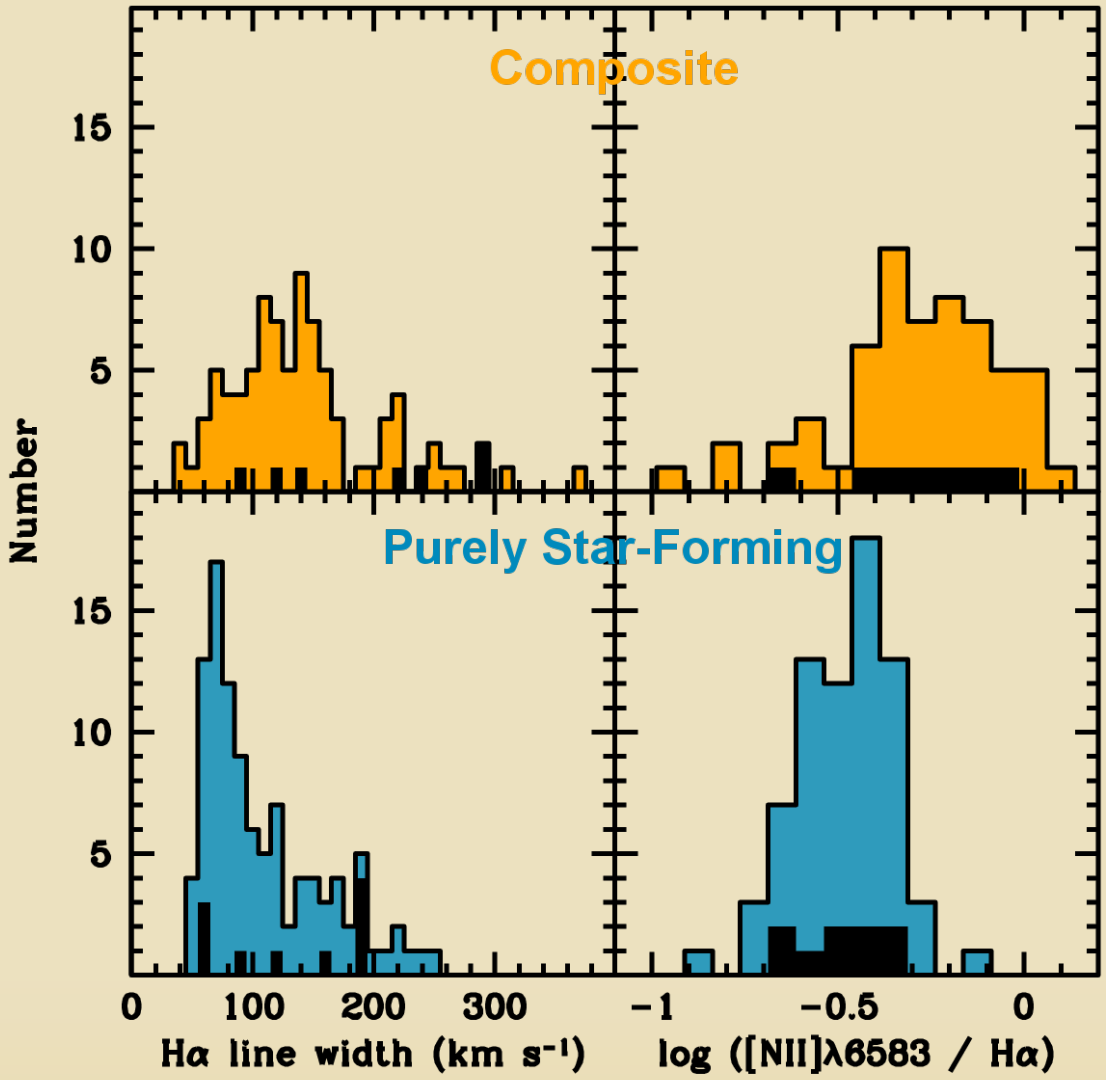
We use MEx & BPT diagrams to classify galaxies as star forming or composite systems.





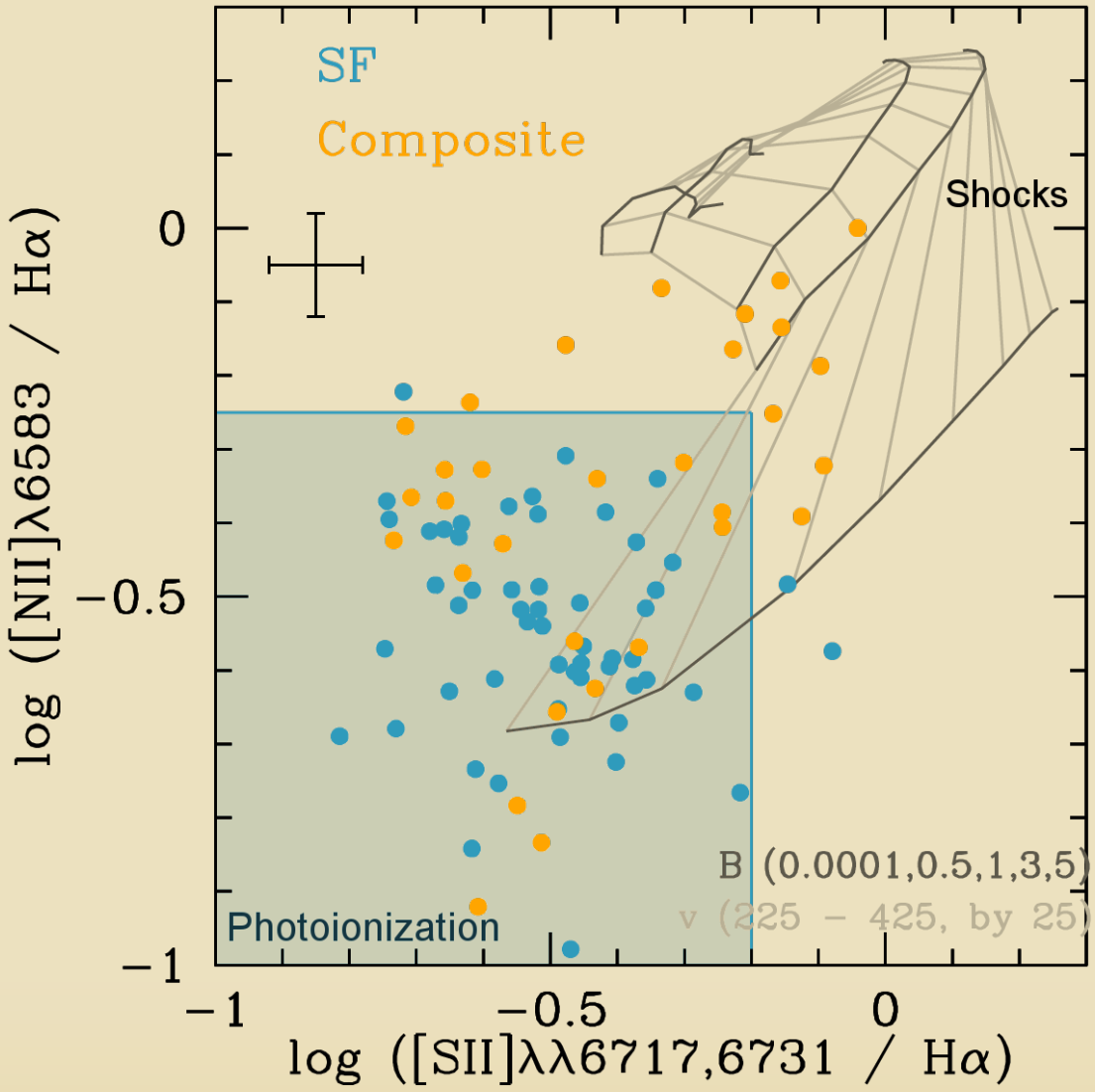
Freeland+in prep

Disk gas in composite galaxies is heated compared to disk gas in purely star-forming galaxies.



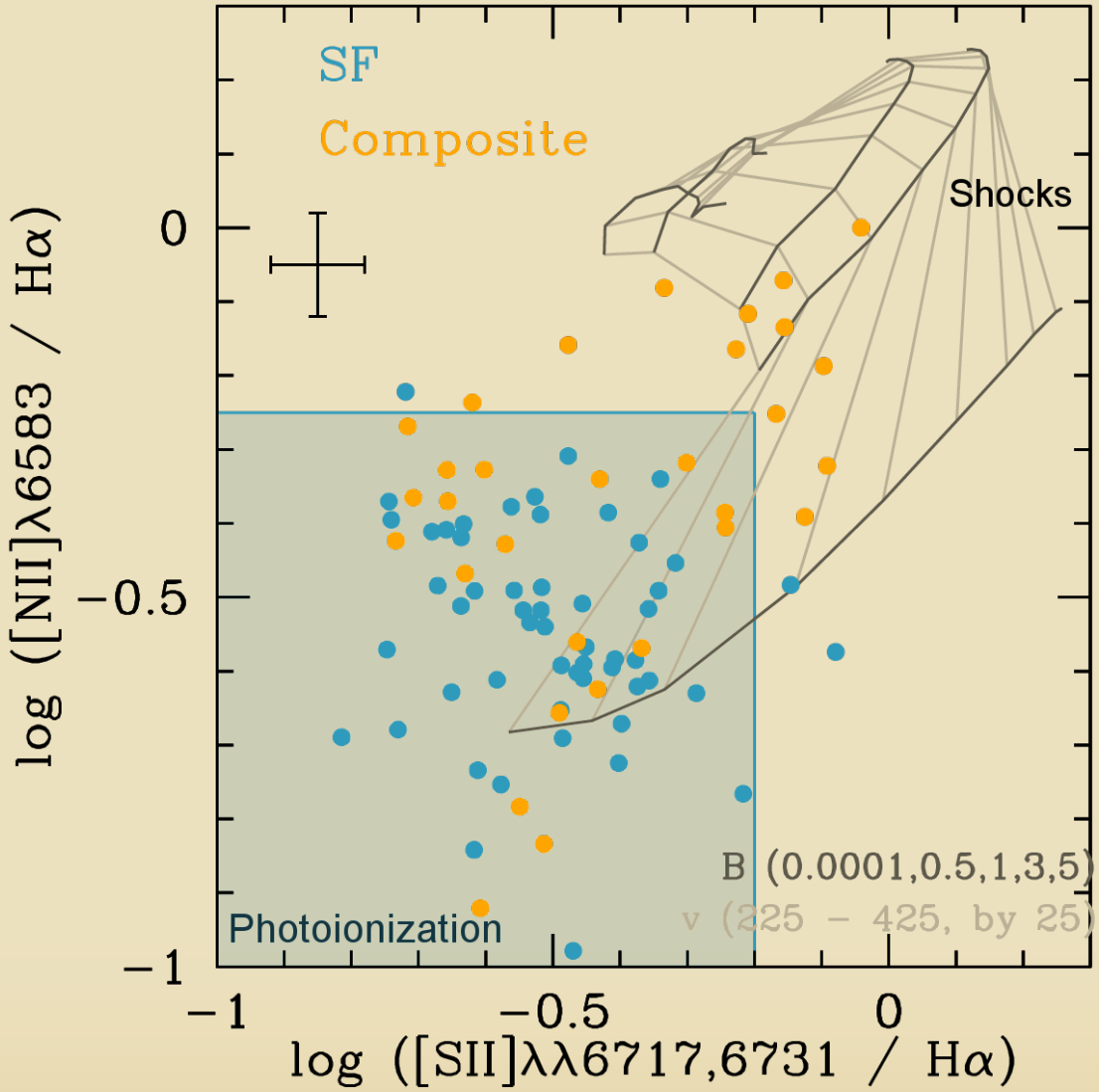
Freeland+in prep

The observed properties are consistent with shock heating which has implications for AGN selection.



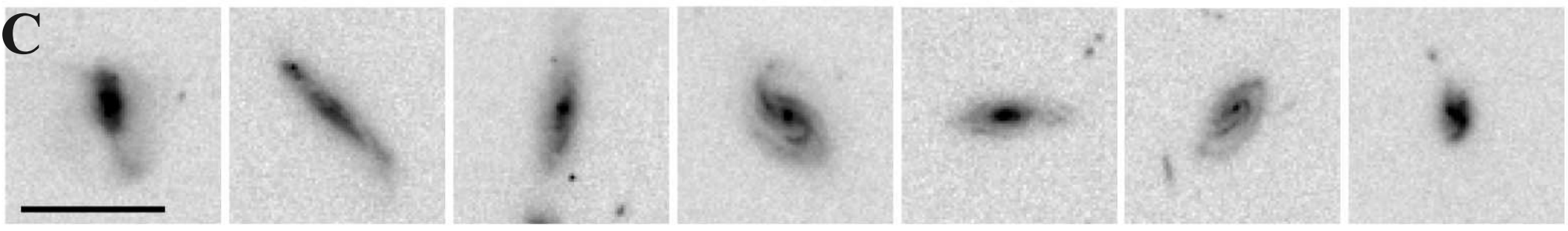
Freeland+in prep

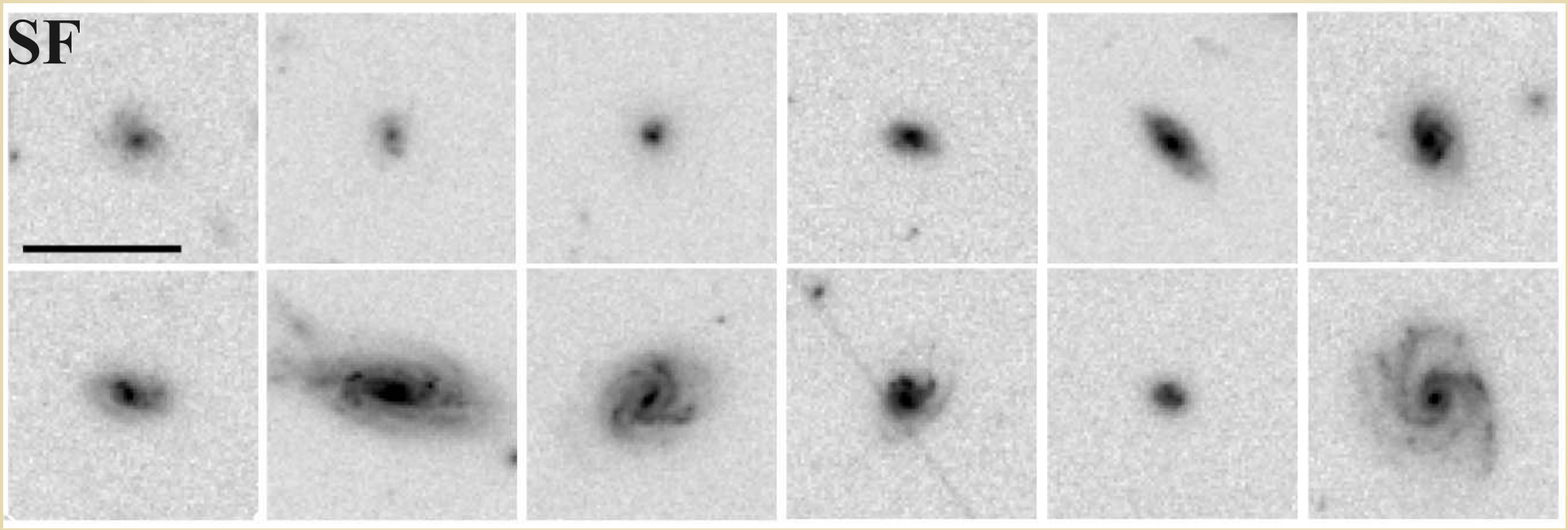
U/LIRGS with widespread shock ionization can be classified as composites despite having no AGN contribution (Rich+14). Our composite galaxies extend this to sub-LIRGs.



Freeland+in prep

What process is responsible for the shocks in these galaxies? Interactions?

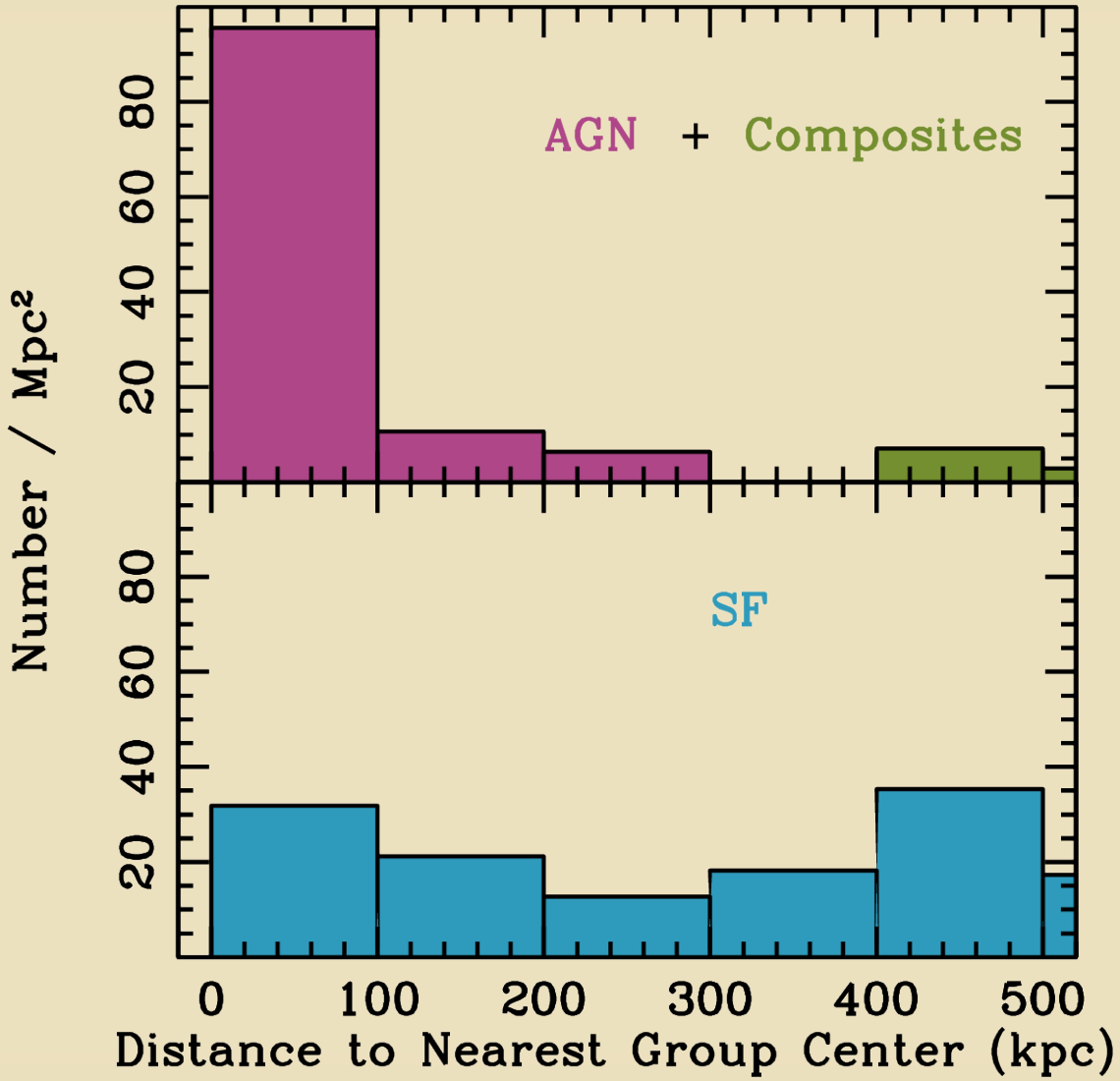




Scale bar is 25 kpc.

Freeland+in prep

AGN prefer group centers, composites prefer outskirts.



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