

Why Does Environment Matter?

An Incomplete & Biased Guide

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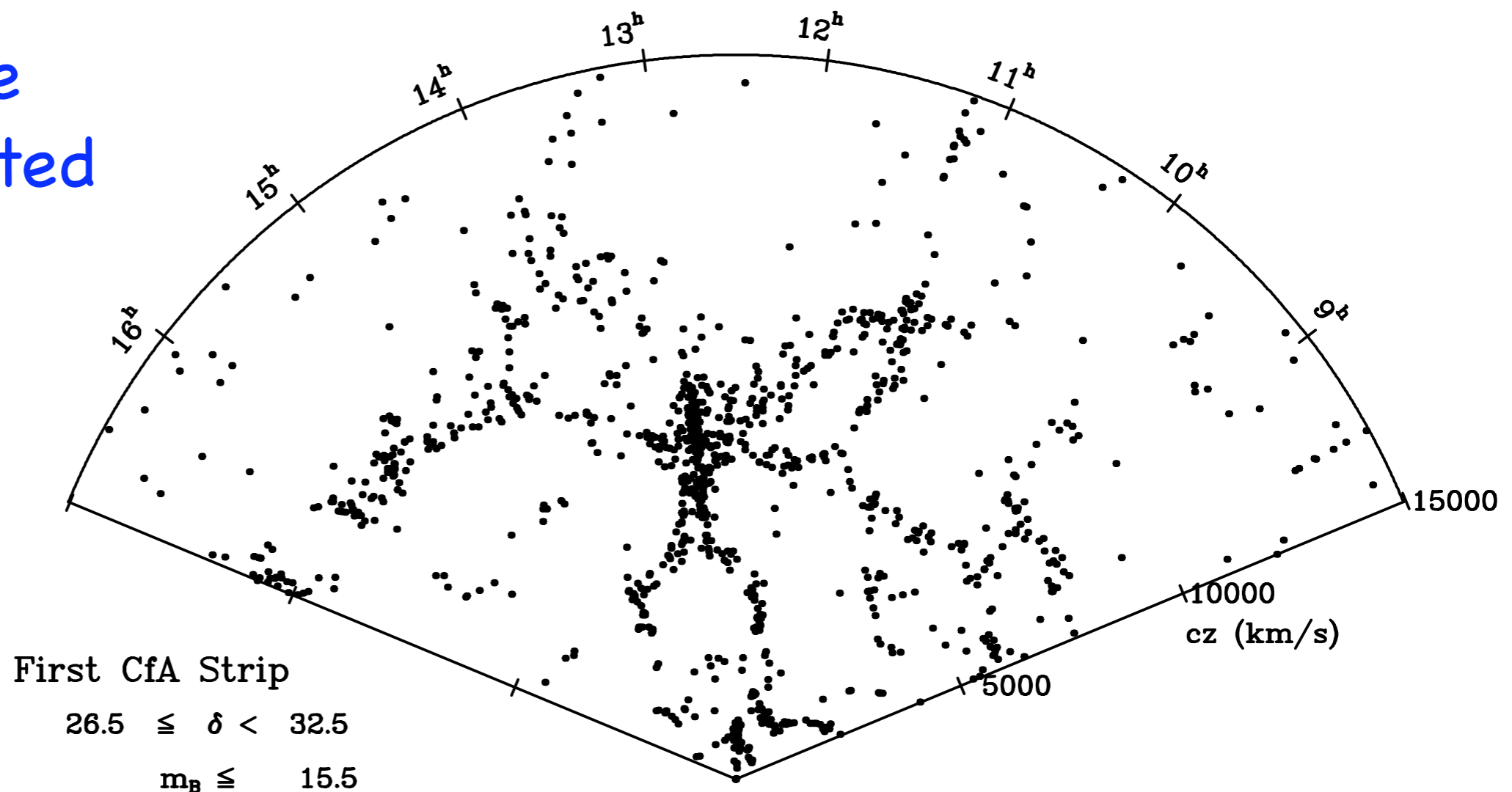
Redshift Surveys

Center for Astrophysics Redshift Survey (1980s)

First observational evidence of Large-Scale Structure

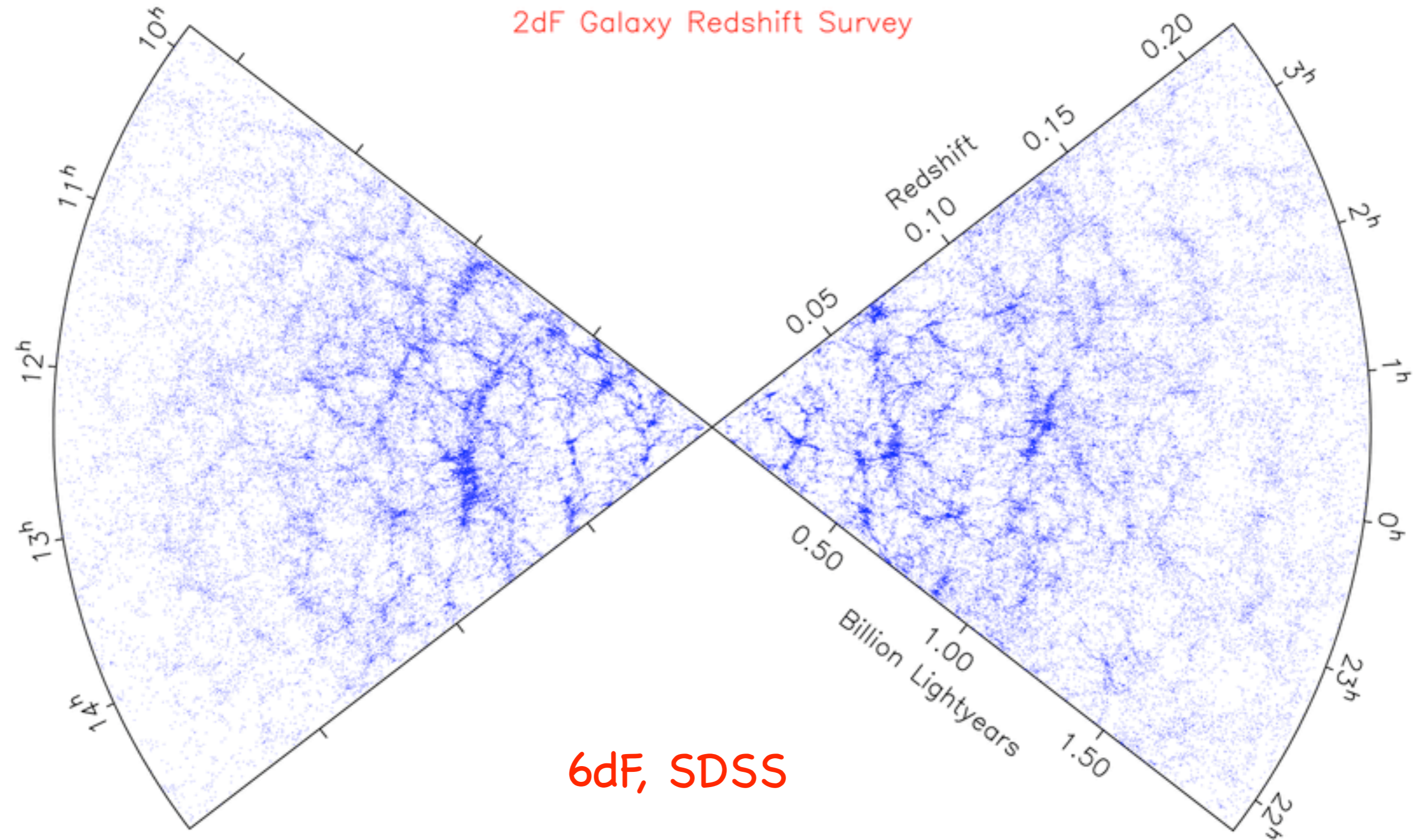
Davis, Huchra, Geller, Latham, Tonry

Galaxies are
not distributed
randomly



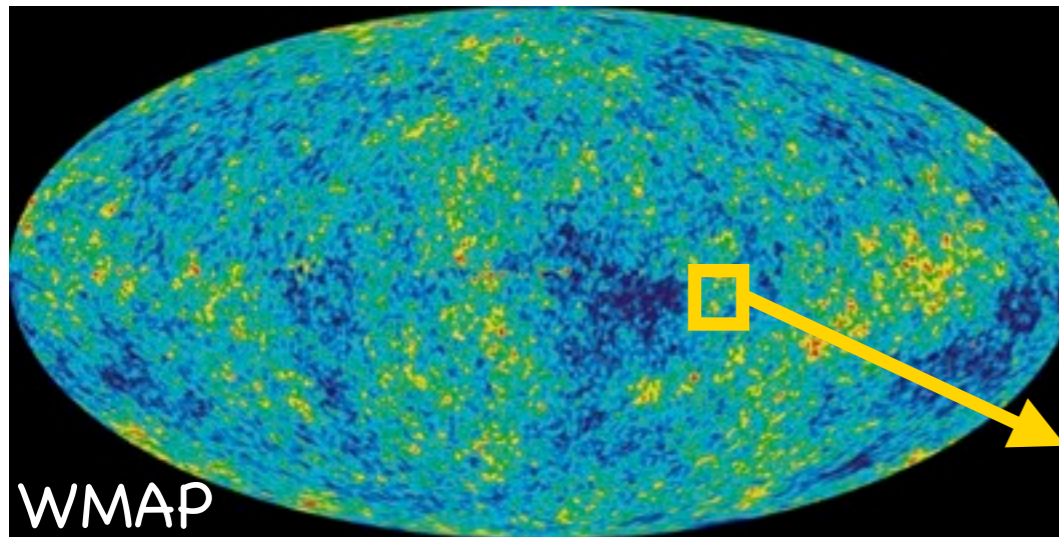
LSS: Local Universe

2dF Galaxy Redshift Survey



6dF, SDSS

Hierarchical Formation



Primordial
fluctuations
to collapsed,
bound structures
(Peebles 1972):

Galaxies,
Galaxy Groups,
Galaxy Clusters

Large Scale Structure



A large-scale structure map of the universe, showing the distribution of matter on a scale of billions of light-years. The map is predominantly dark blue and black, with a prominent, bright, curved structure on the left side, likely representing the Local Supercluster or the Virgo Cluster. The overall appearance is that of a complex, interconnected web of matter.

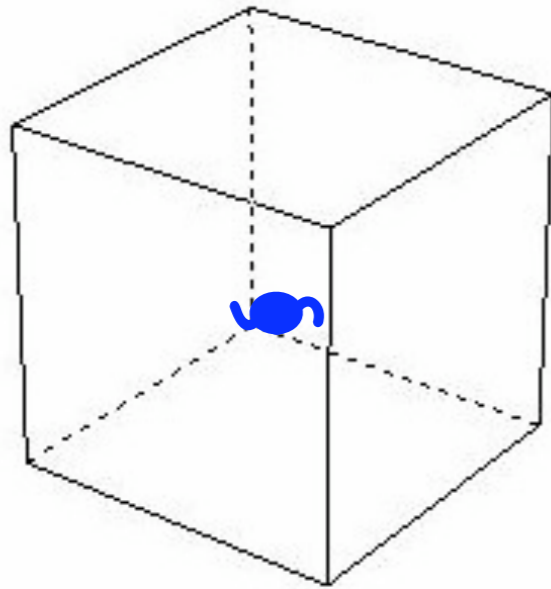
13.3960

B. Allgood

Defining Environment

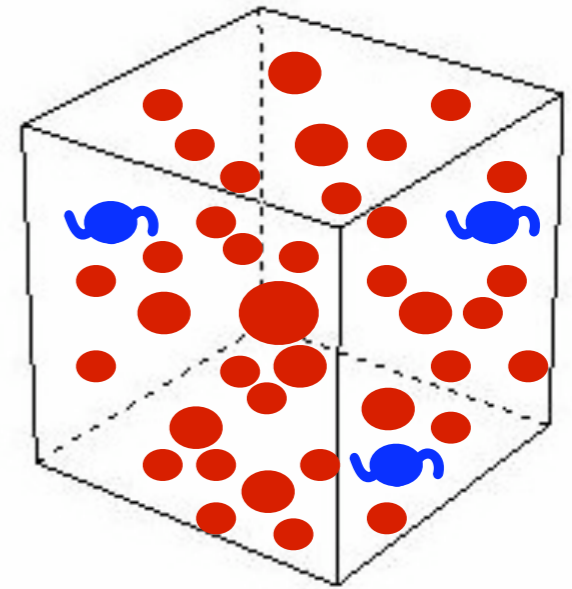
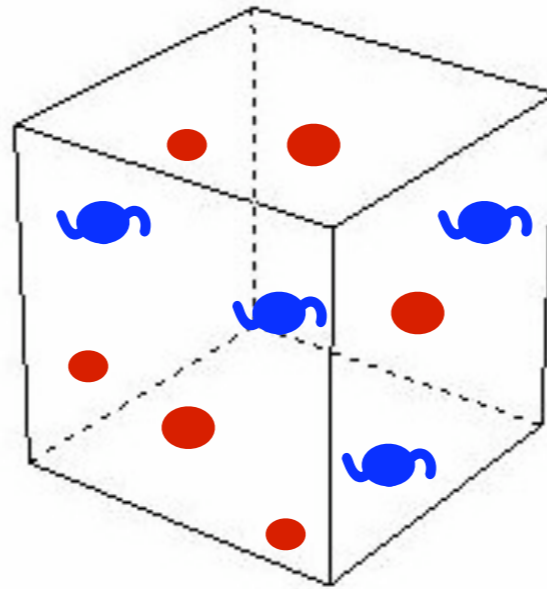
Group:

$\sim 10 L^*$ Galaxy/Mpc³
 $\delta(\text{velocity}) \sim 200\text{--}300$ km/s



Field:

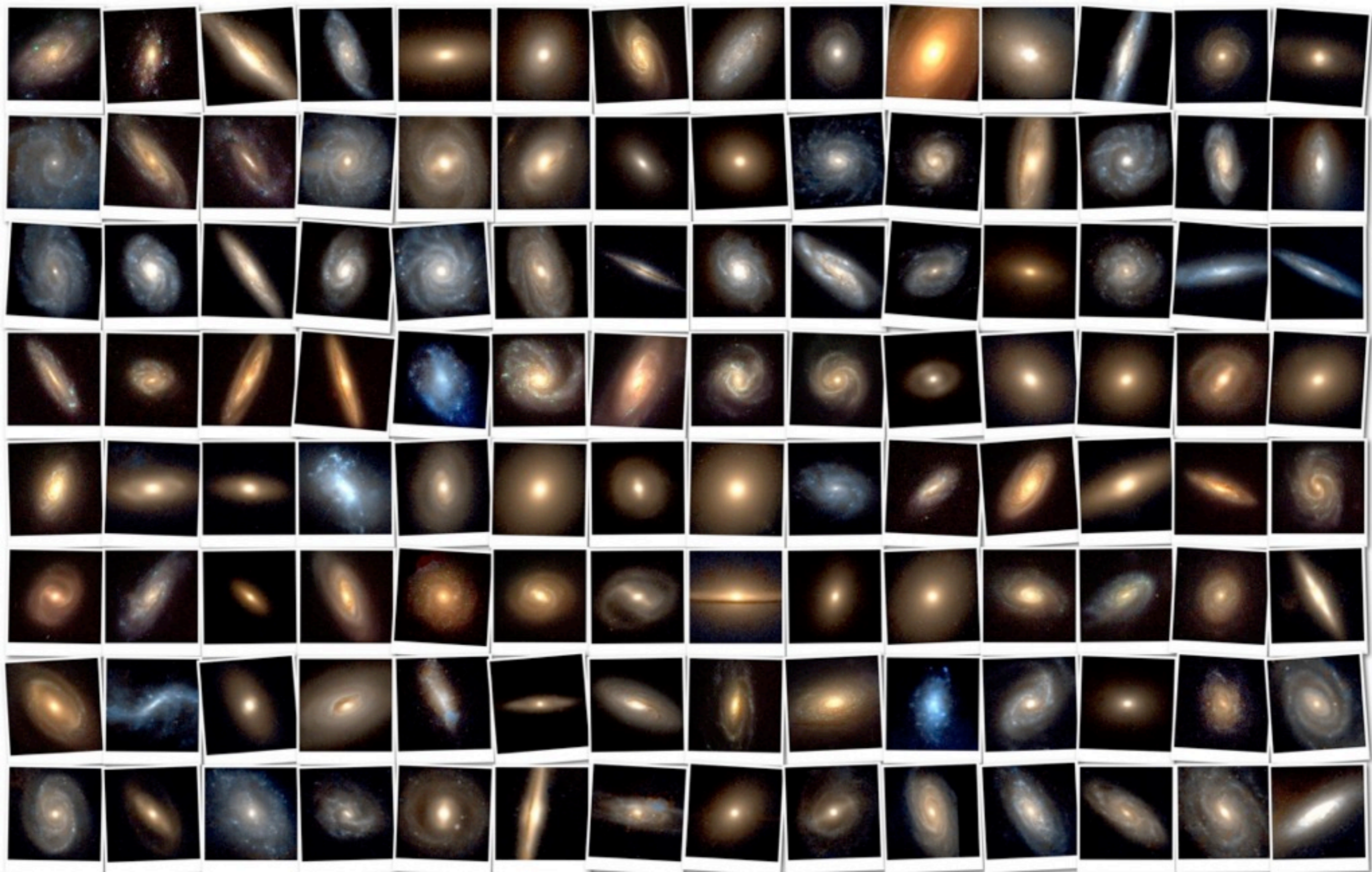
$\sim 1 L^*$ Galaxy/Mpc³
cz=Hubble Expansion



Cluster:

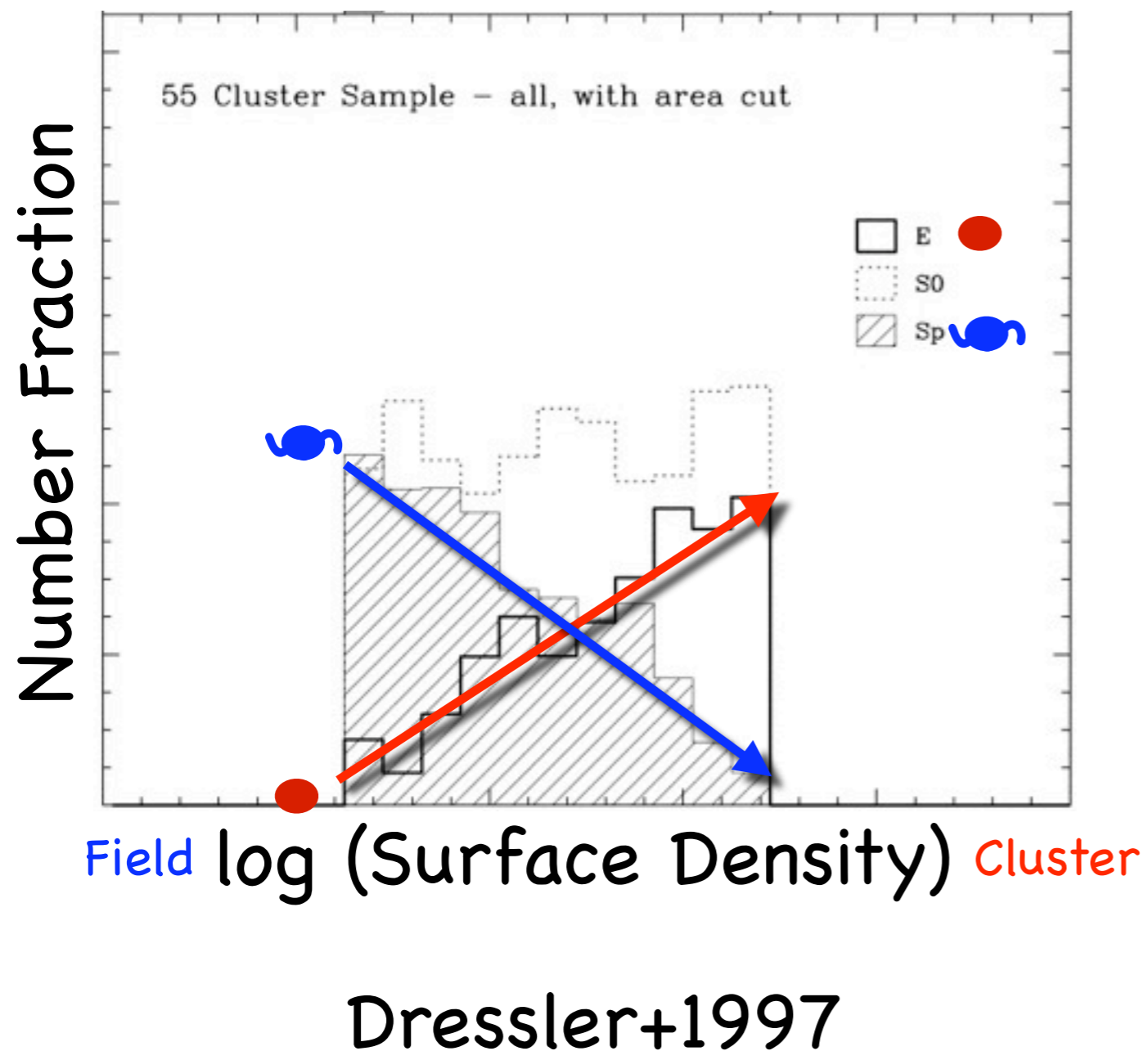
$\sim 10^2\text{--}10^3 L^*$ Galaxy/Mpc³
 $\delta(\text{velocity}) \sim 1000$ km/s

Frei Catalog of Local Galaxies

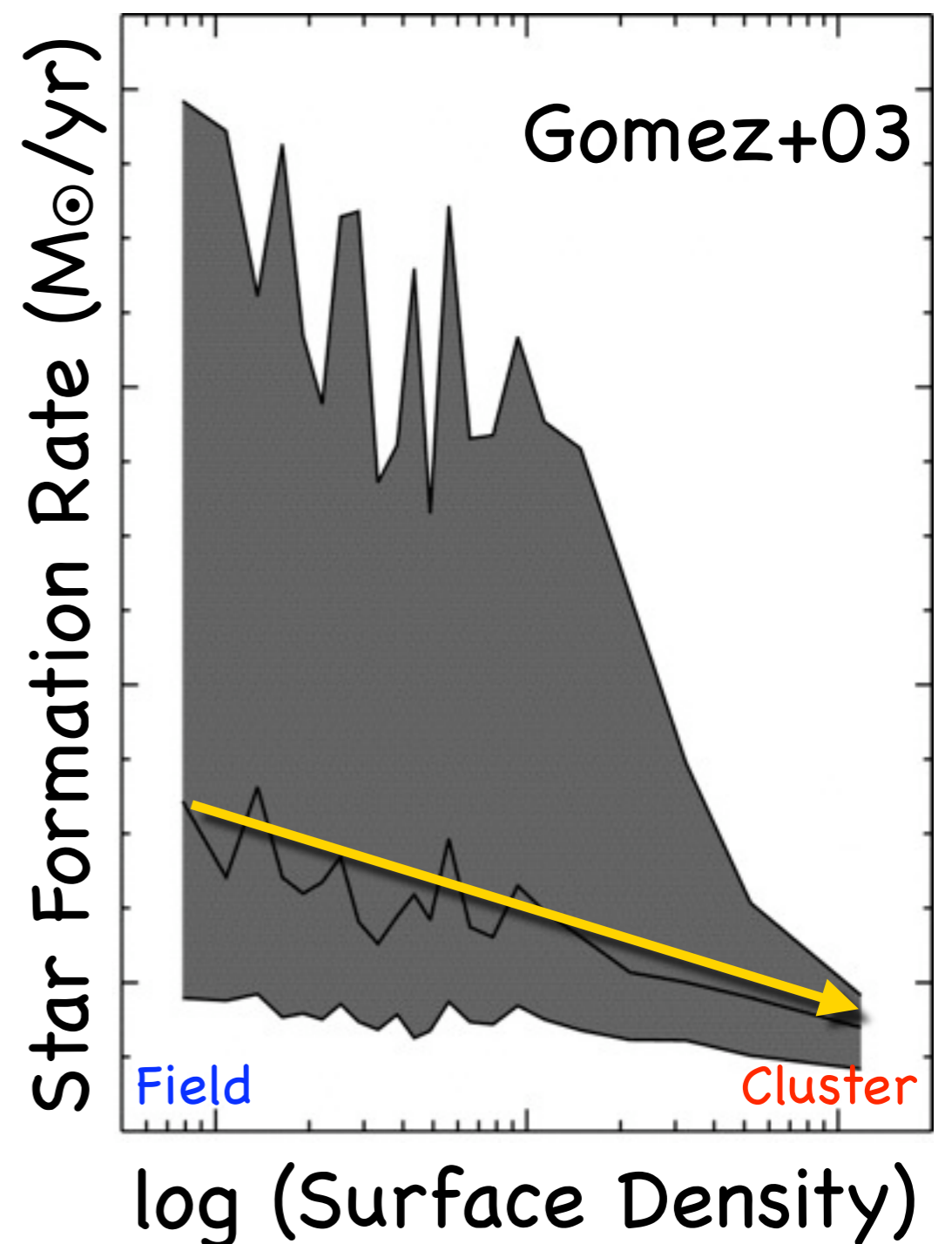


Observed Environmental Trends

Changes in Morphology



Changes in Star Formation



Observables

Galaxies:

masses (stellar & gas), sizes, luminosities, metallicities, star formation histories (ages), kinematics (scaling relations)

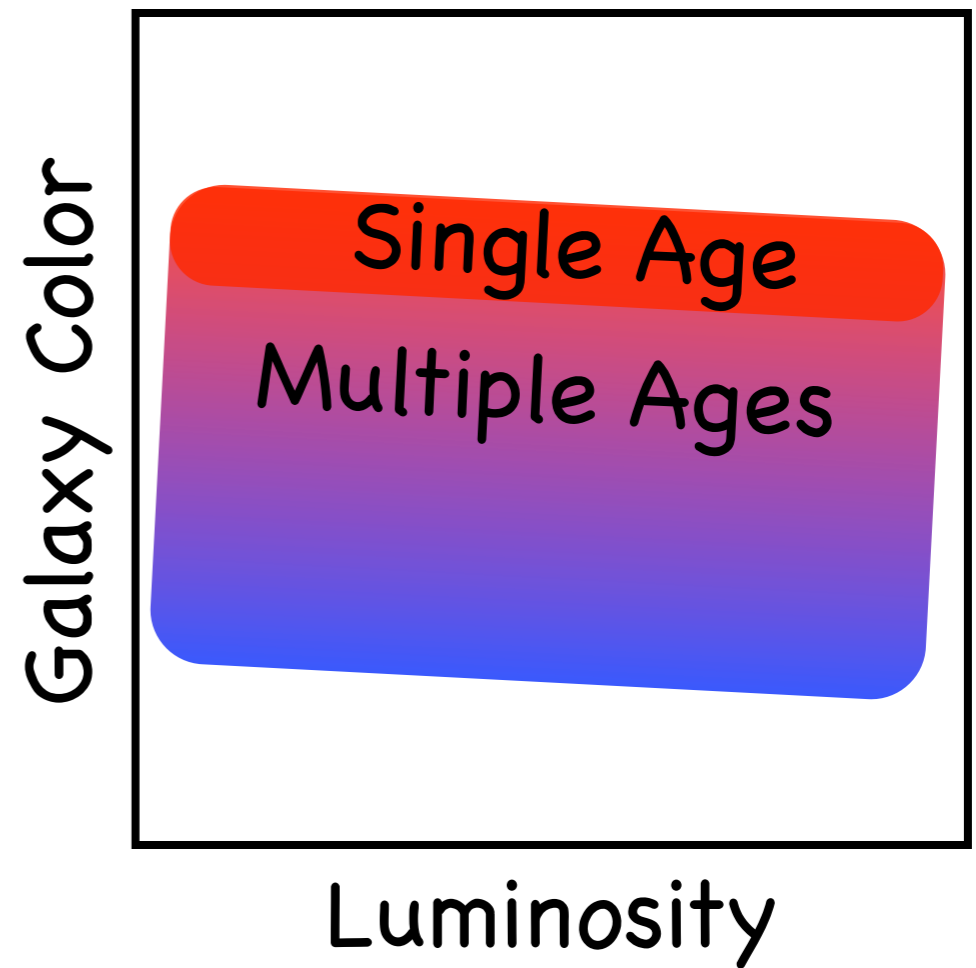
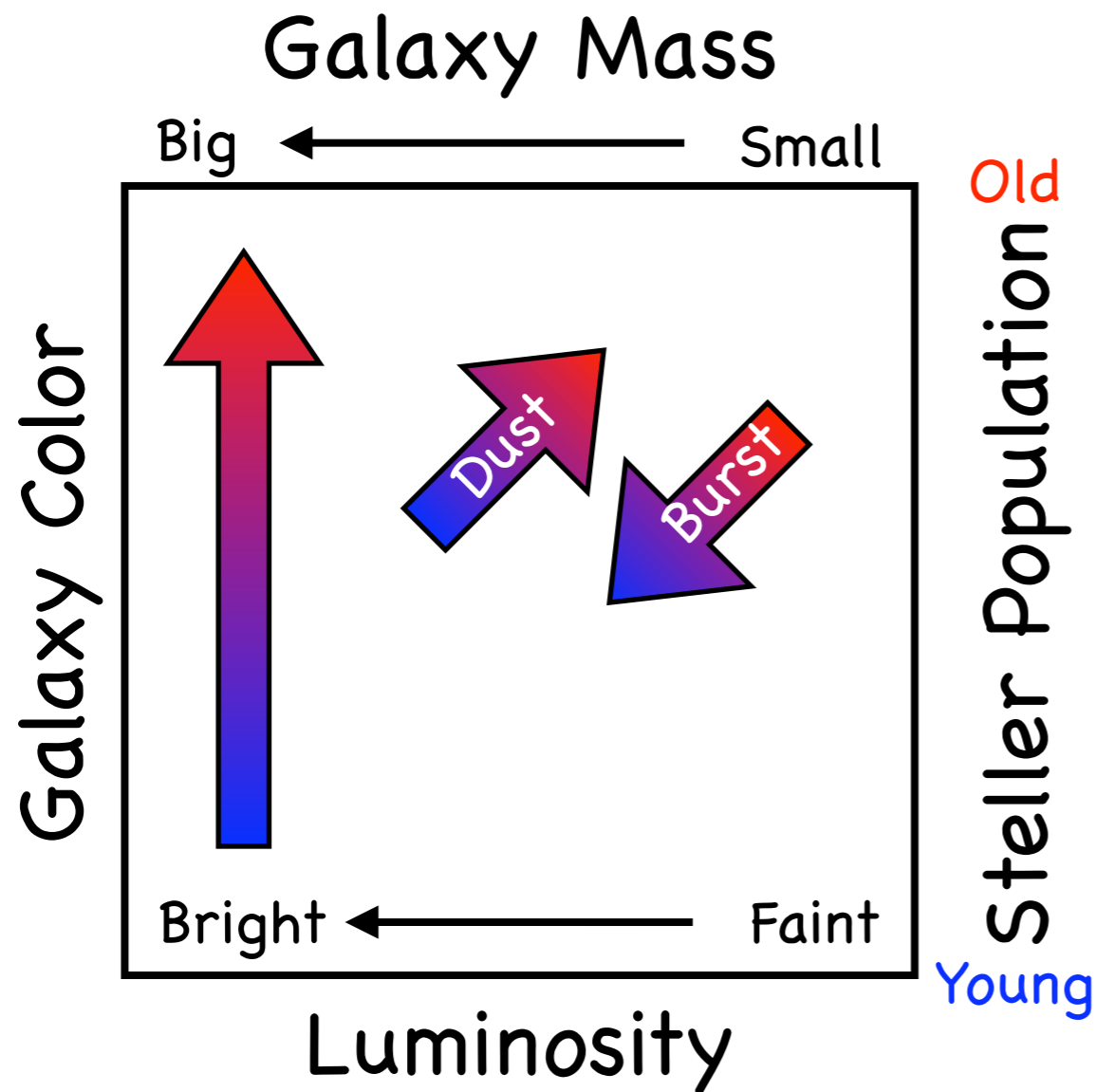
Intra-cluster/group medium:

masses (stellar & gas), sizes, luminosities, metallicities, star formation histories (ages), kinematics, temperatures (X-ray)

Dark Matter:

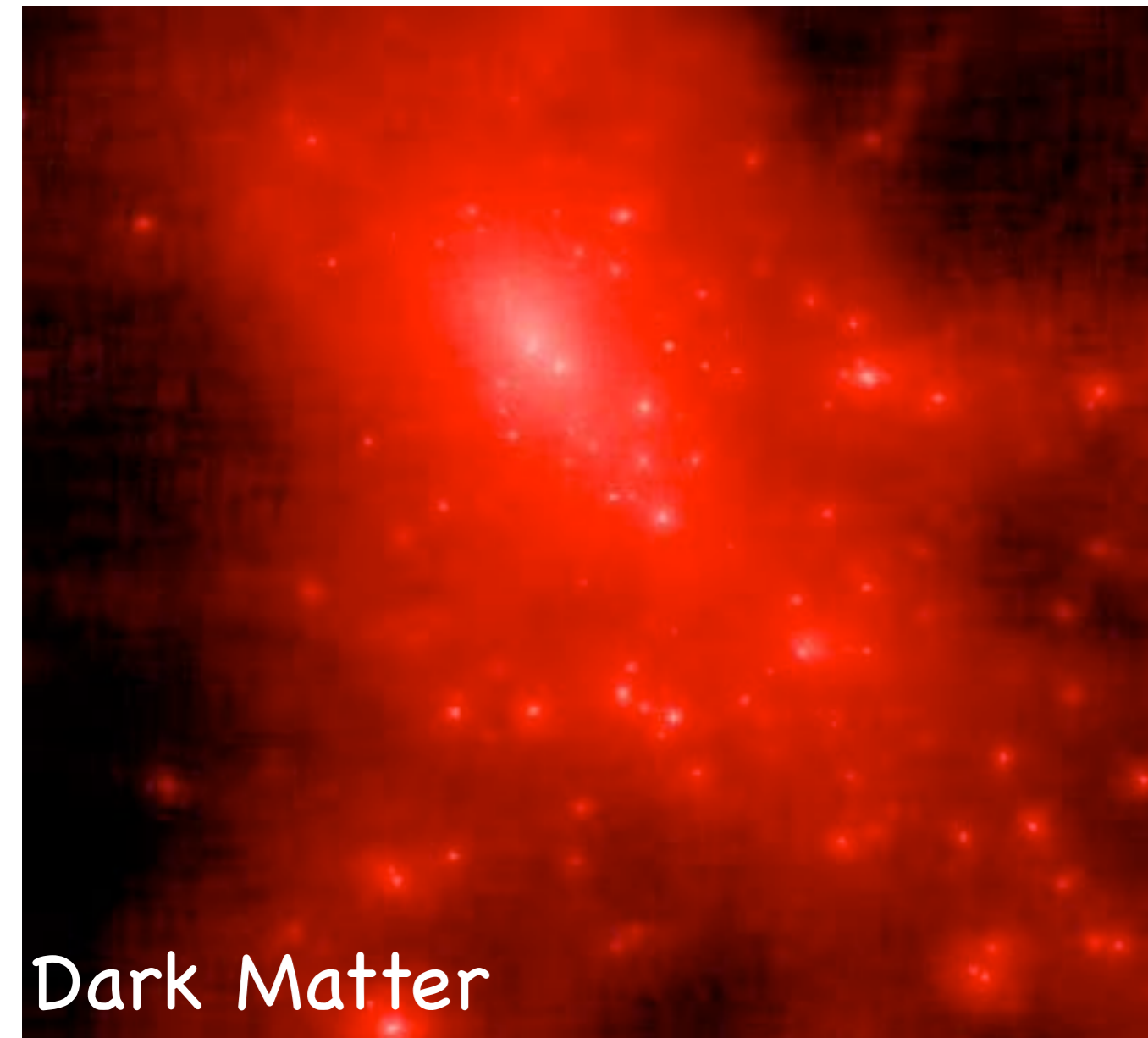
mass & distribution via lensing & galaxy kinematics

Color-Magnitude Diagram

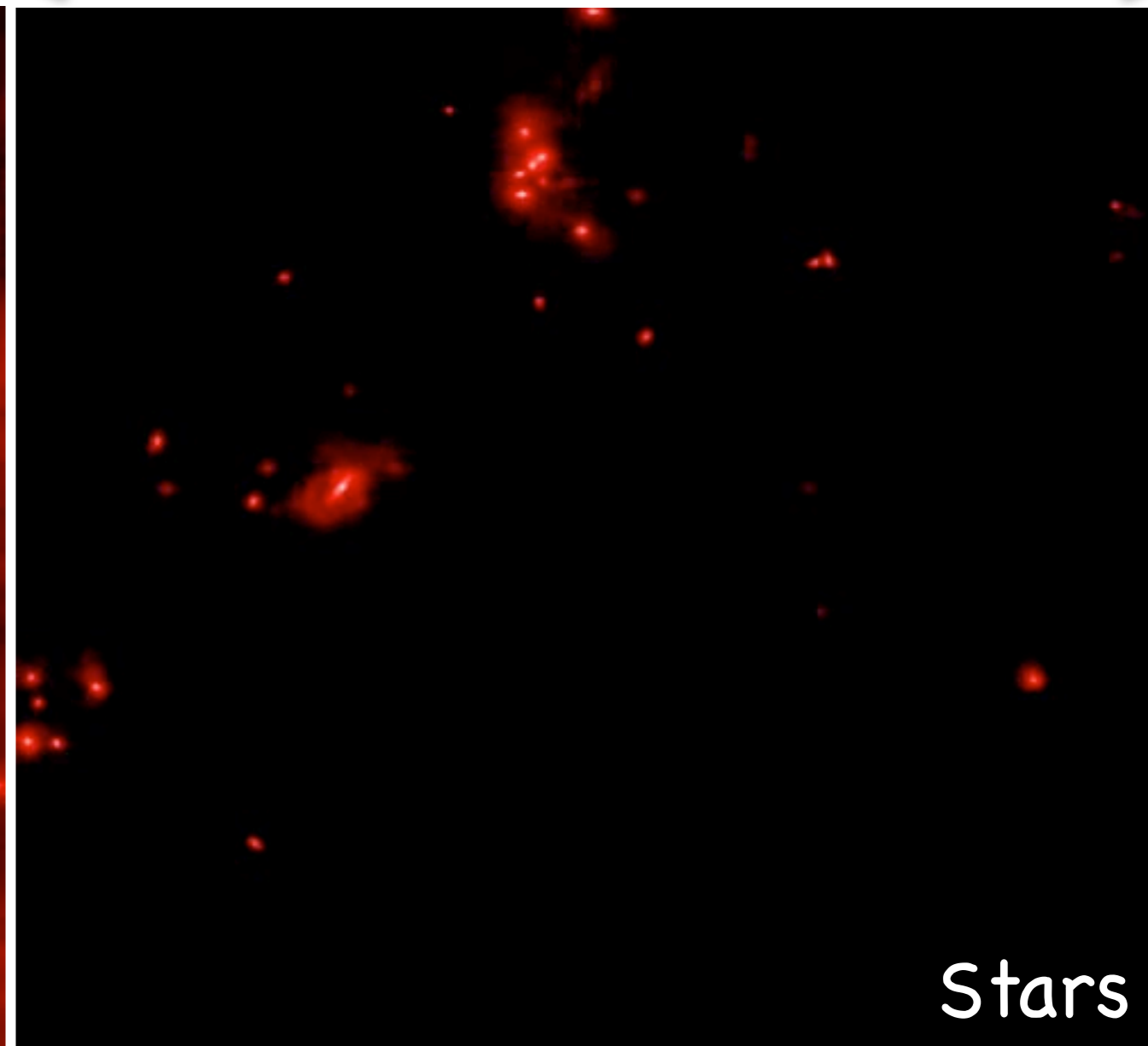


#1: Merging & Massive Galaxies

10 Mpc



Dark Matter



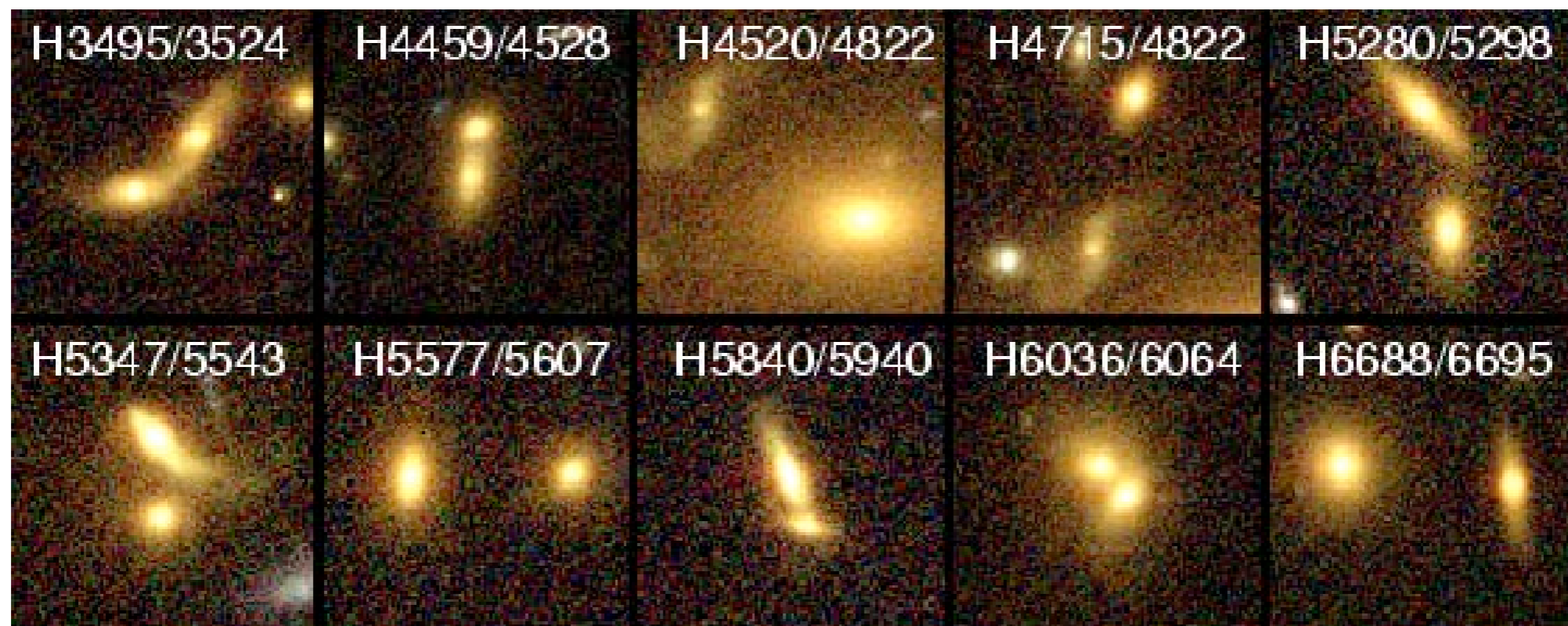
Stars

Bryan+08: ENZO AMR, $10^{15} M_{\text{sun}}$ cluster

Galaxy-Galaxy Merging: MS1054

MS 1054-04 ($z=0.83$, lookback time 7 Gyr)

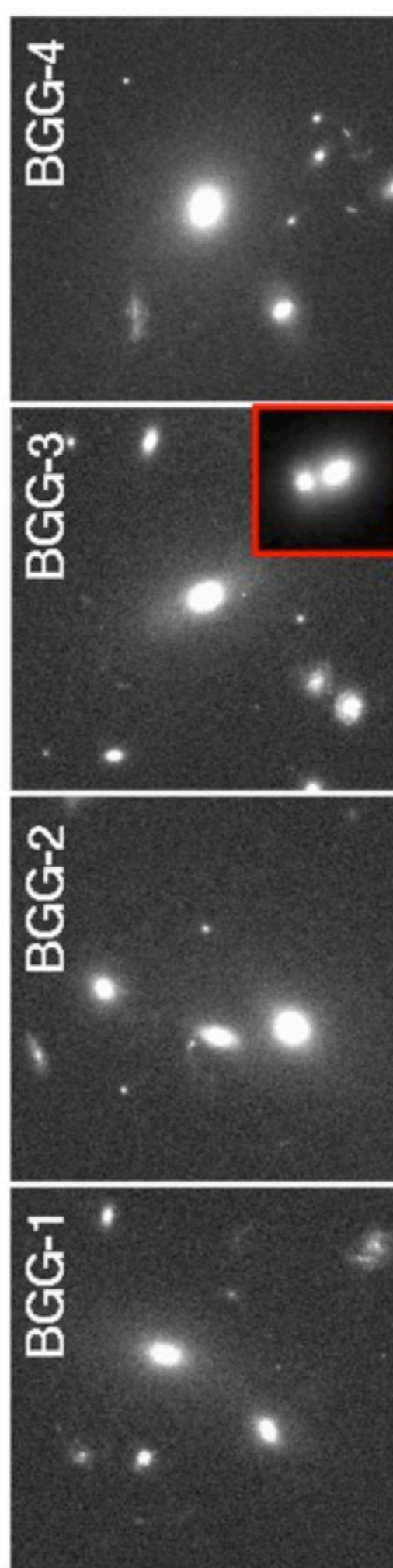
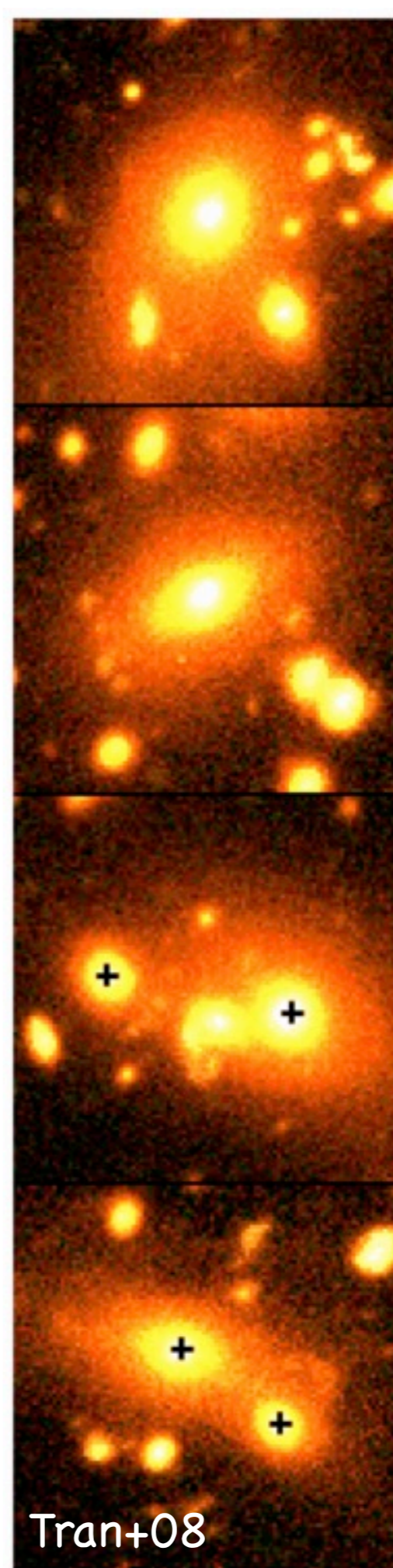
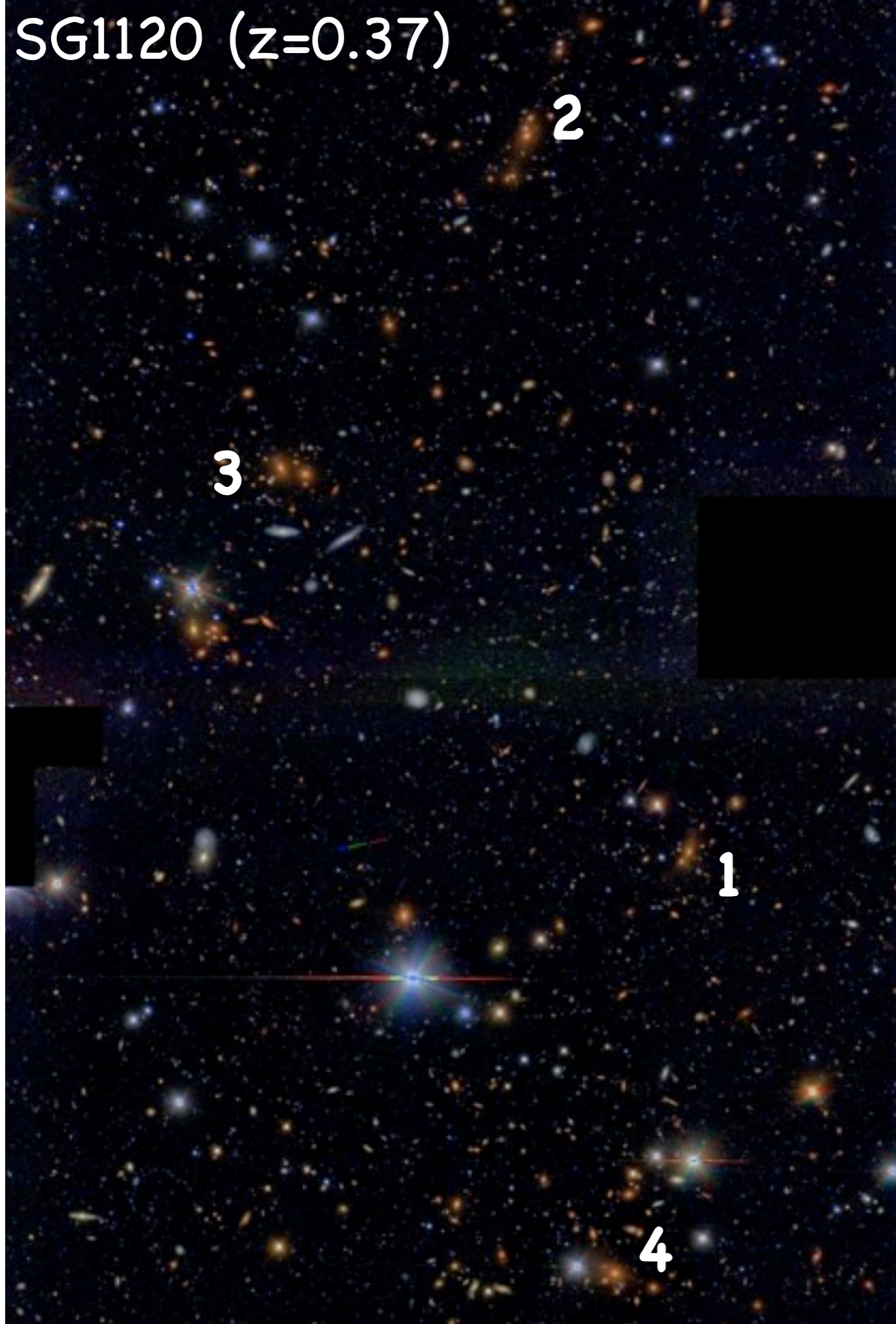
~16% bound galaxy pairs (spectroscopically confirmed)



Tran+05b

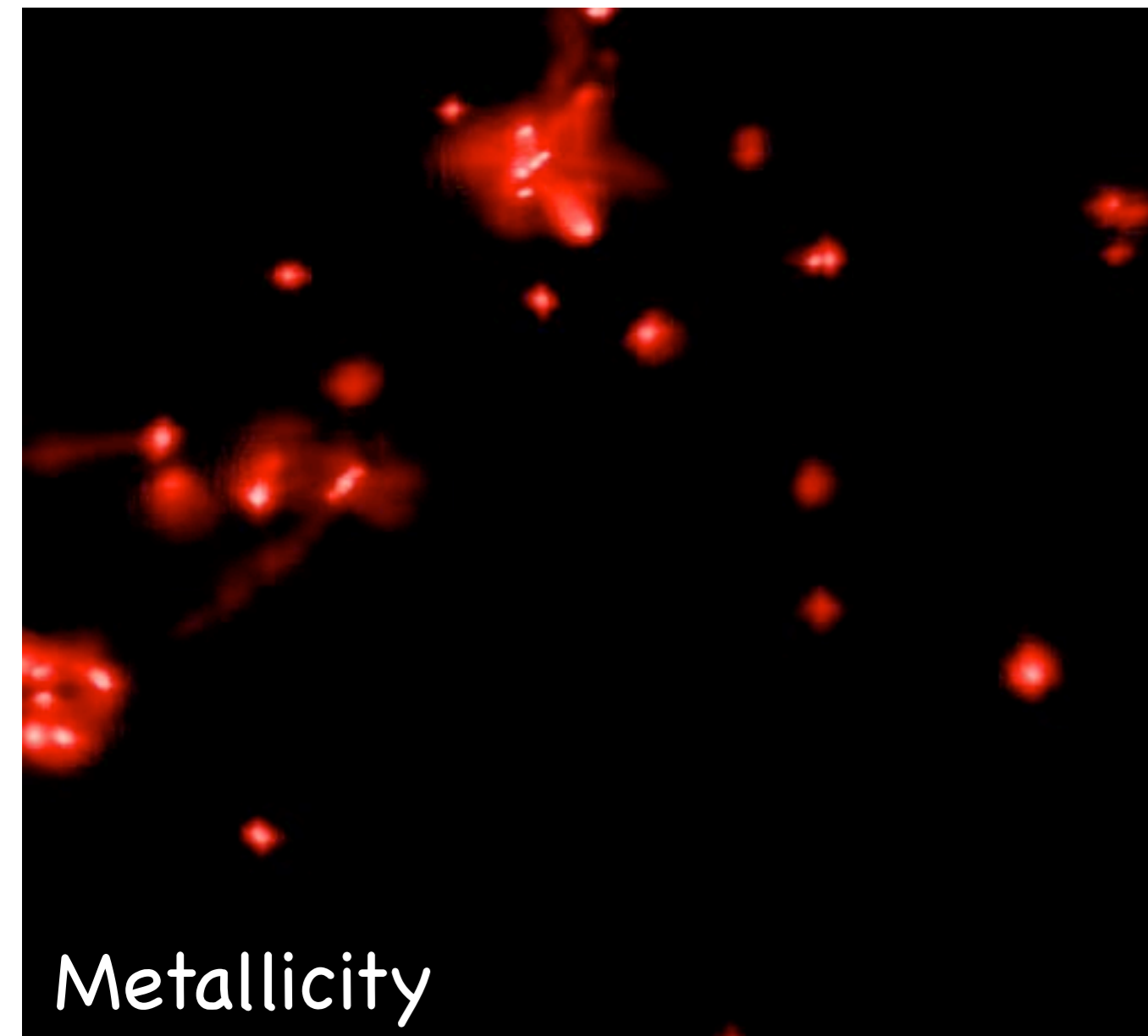
van Dokkum+99

SG1120 ($z=0.37$)

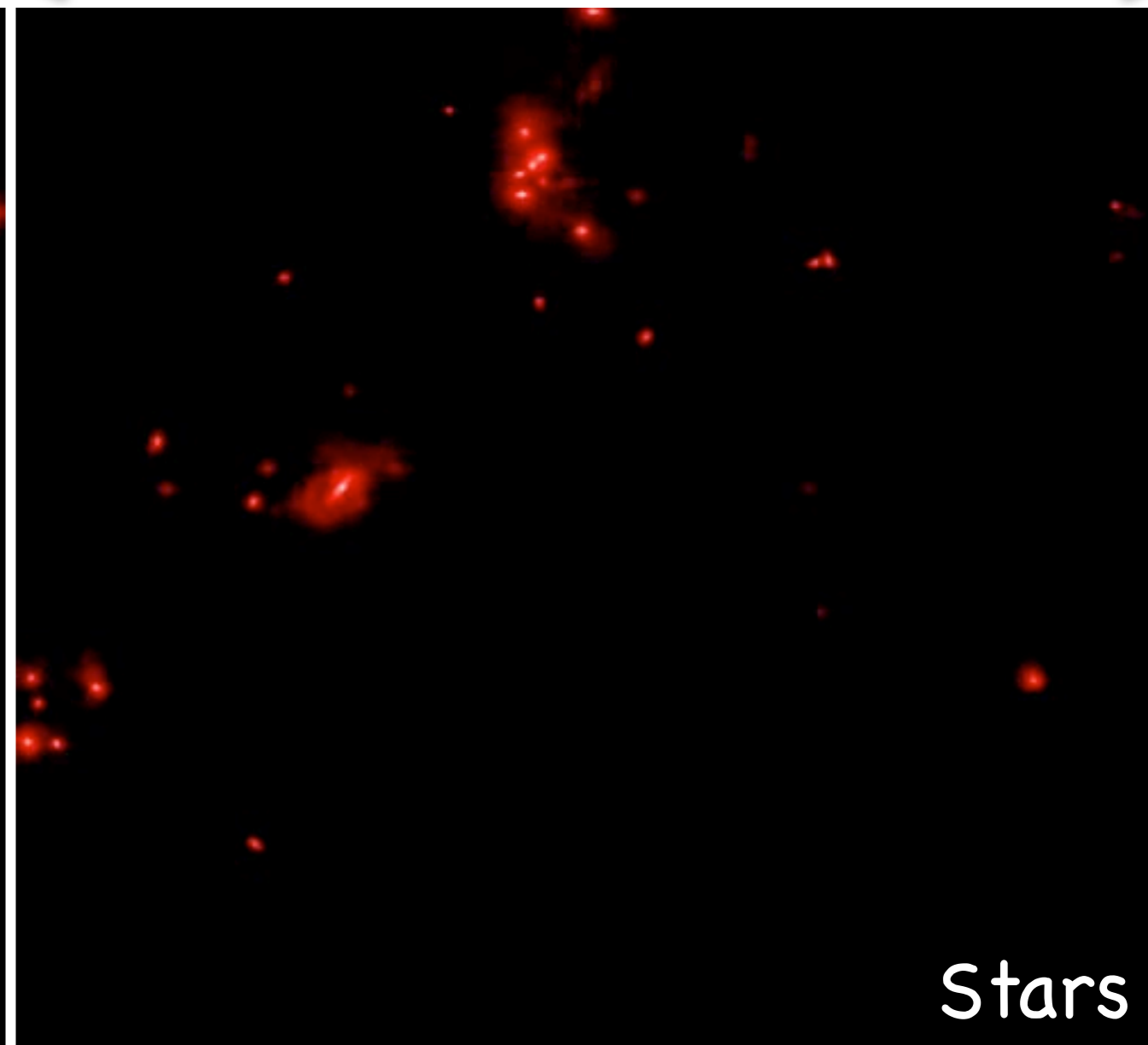


#2: Dynamical Friction & ICL

10 Mpc



Metallicity



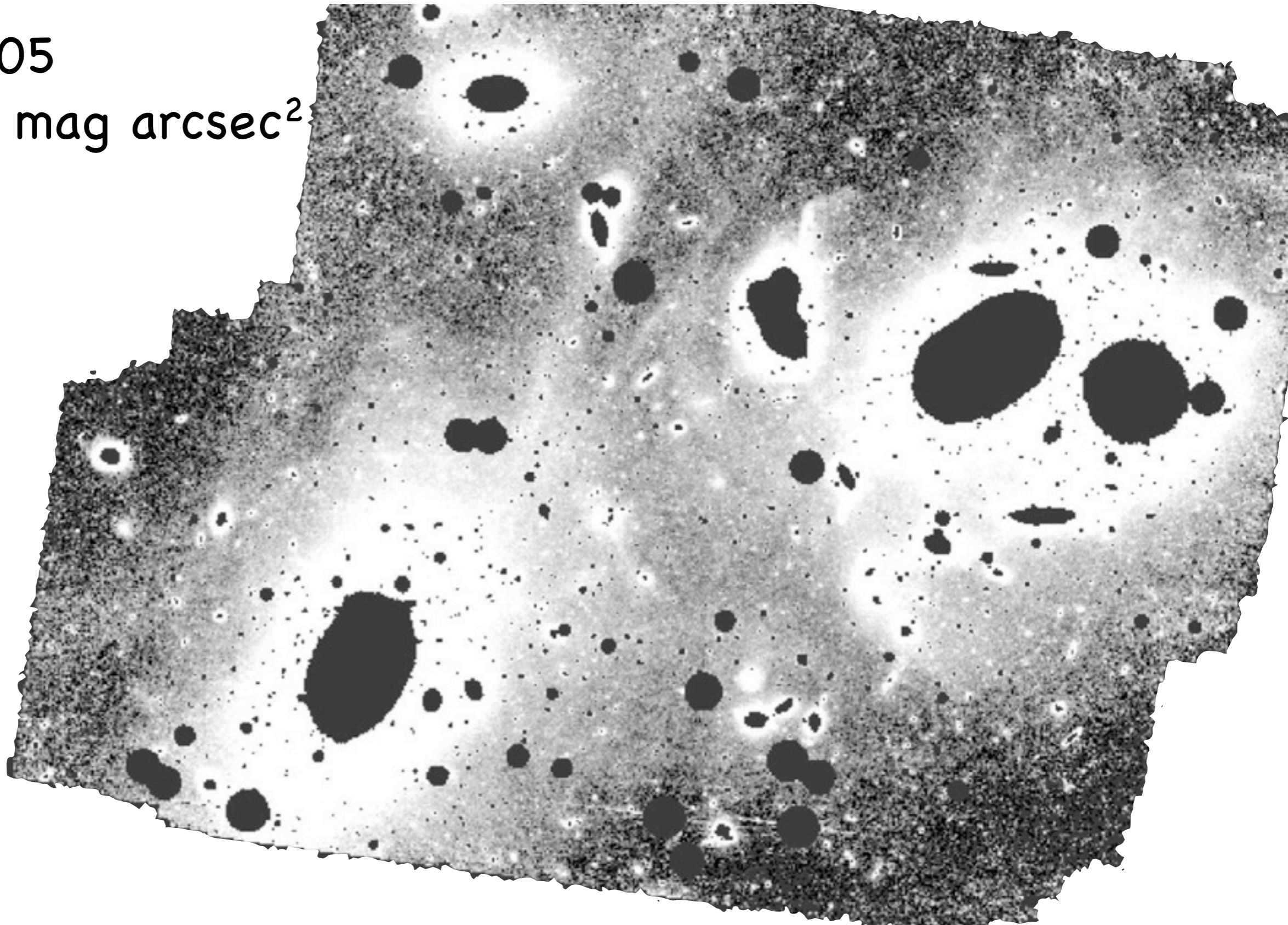
Stars

Bryan+08: ENZO AMR, $10^{15} M_{\text{sun}}$ cluster

Intracluster Light: Virgo

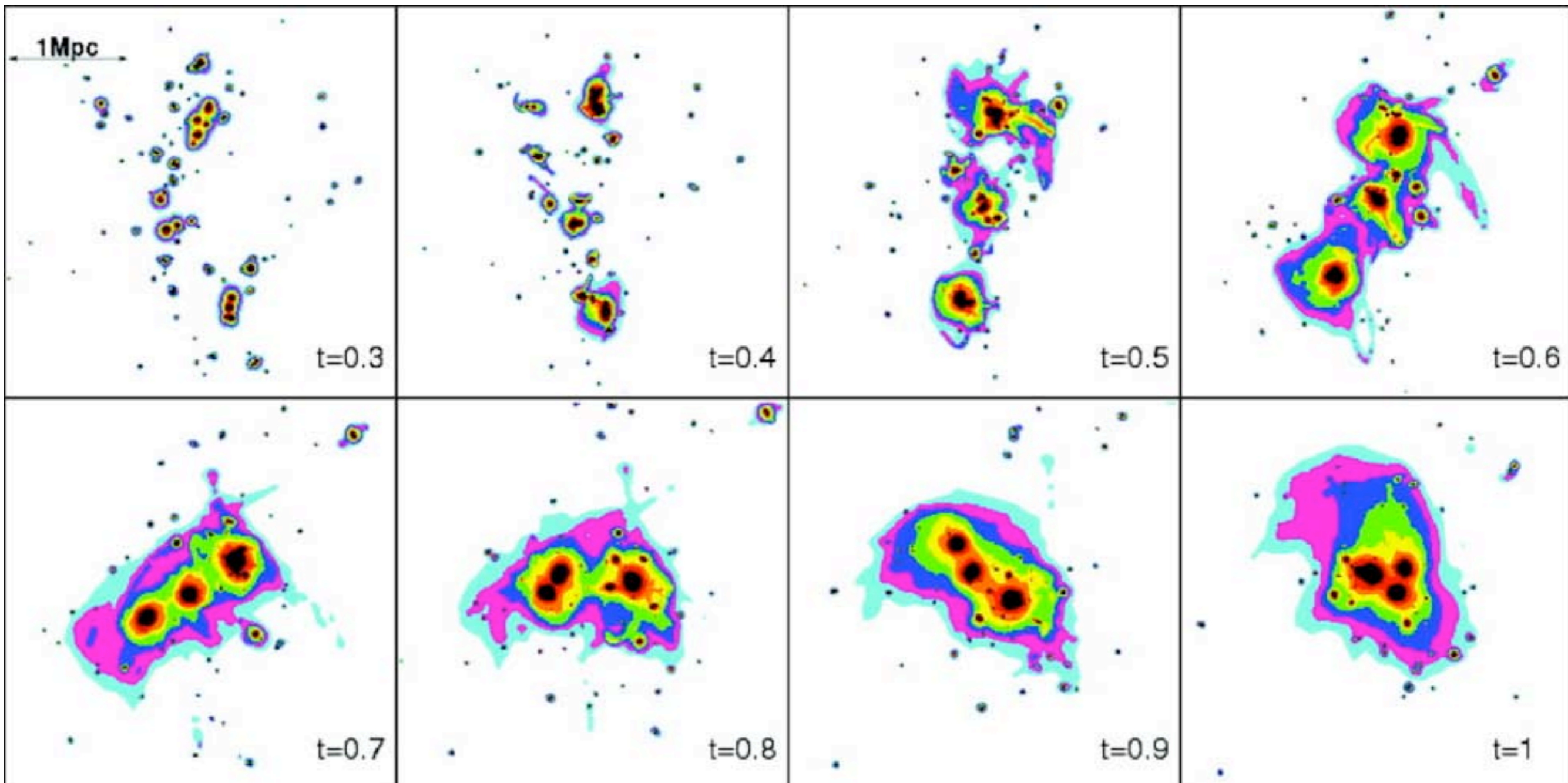
Mihos+05

$\mu > 26.5 \text{ mag arcsec}^2$



Intracluster/group Light

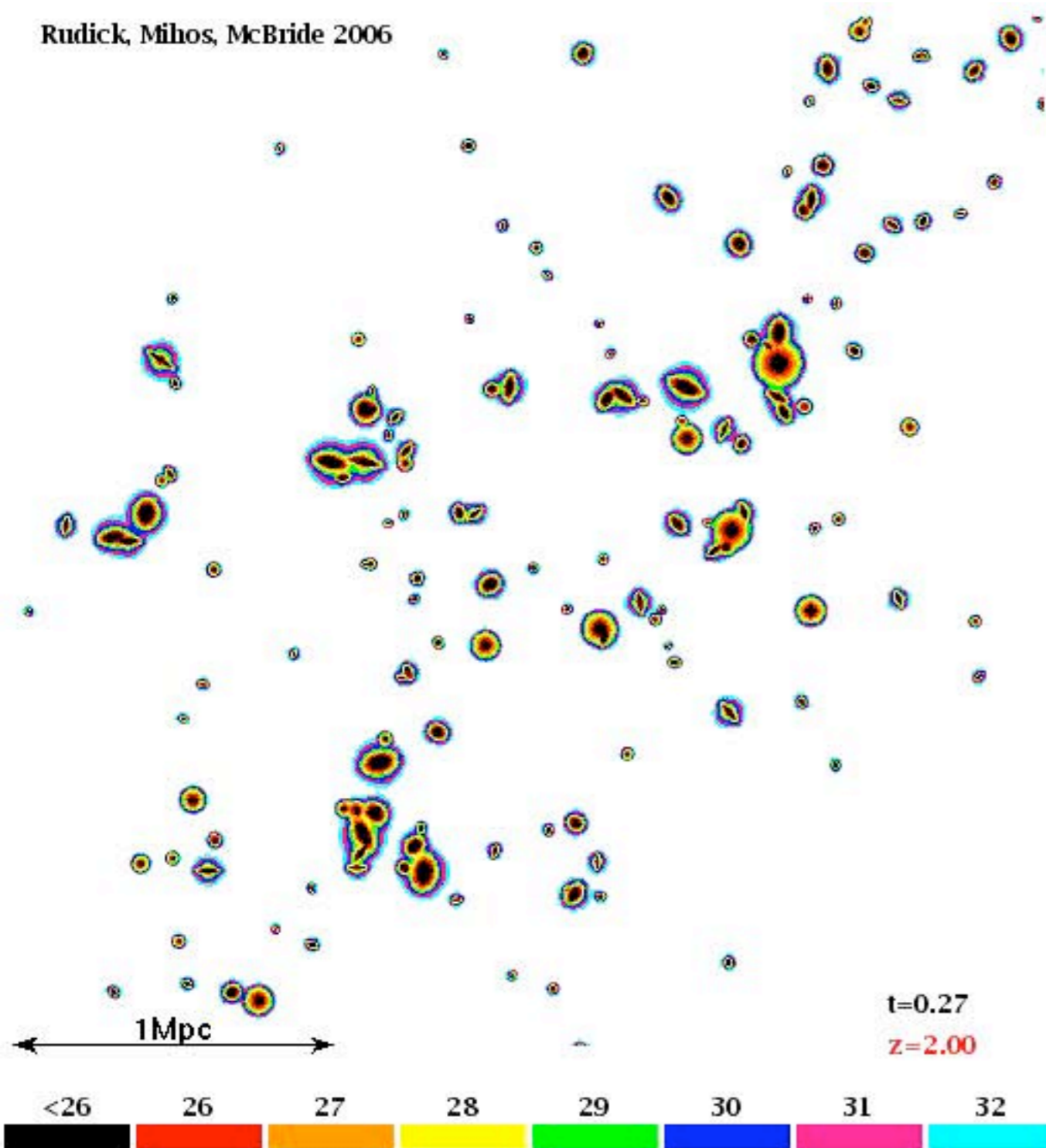
Rudick+06 (Models): ICL structure evolves
→ fossil record of cluster assembly



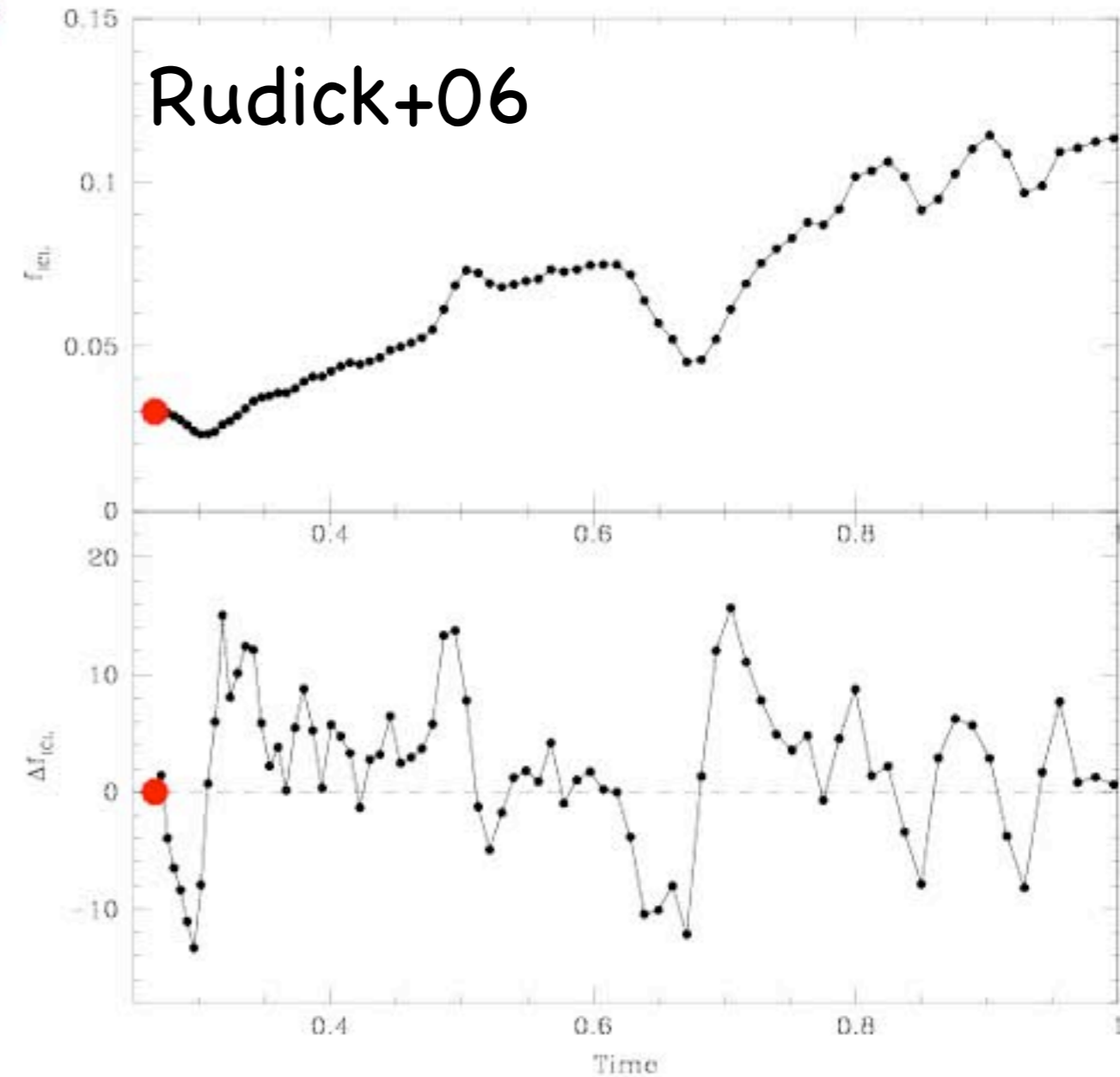
Intracluster/group Light

Build-up of ICM linked to accretion of galaxy groups

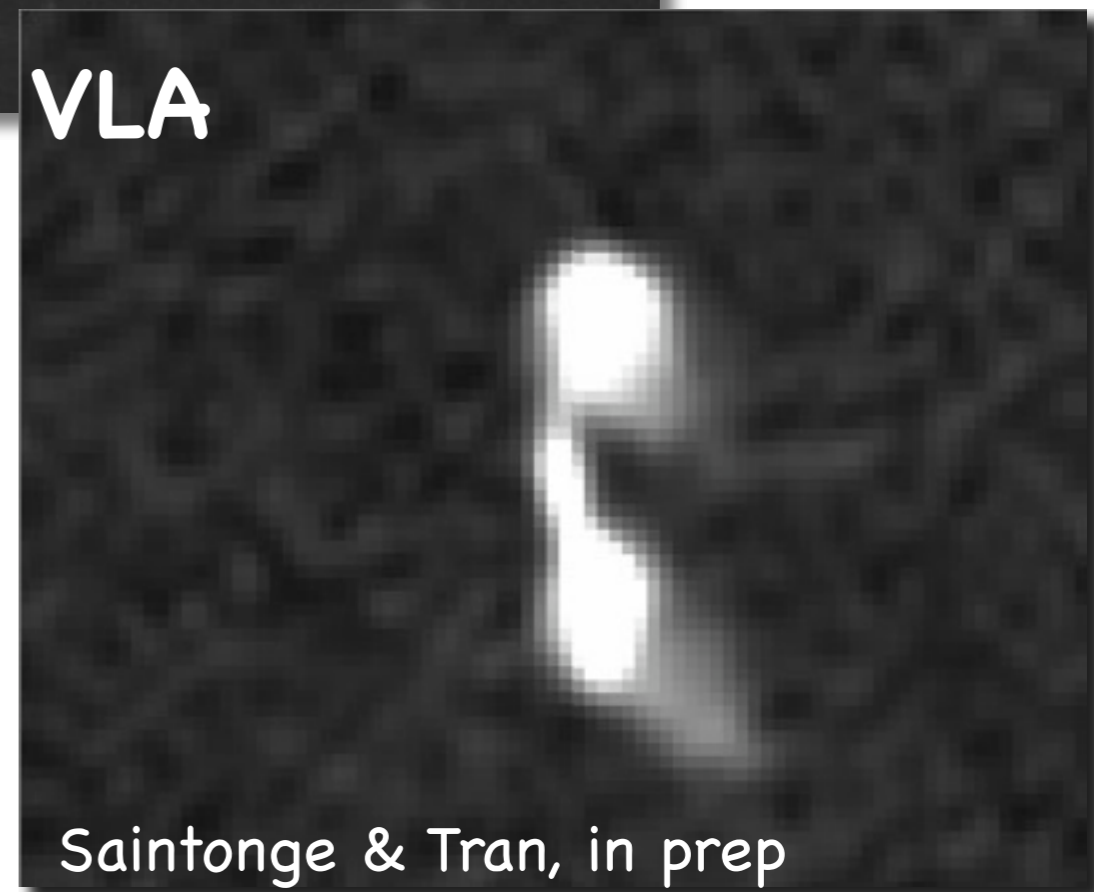
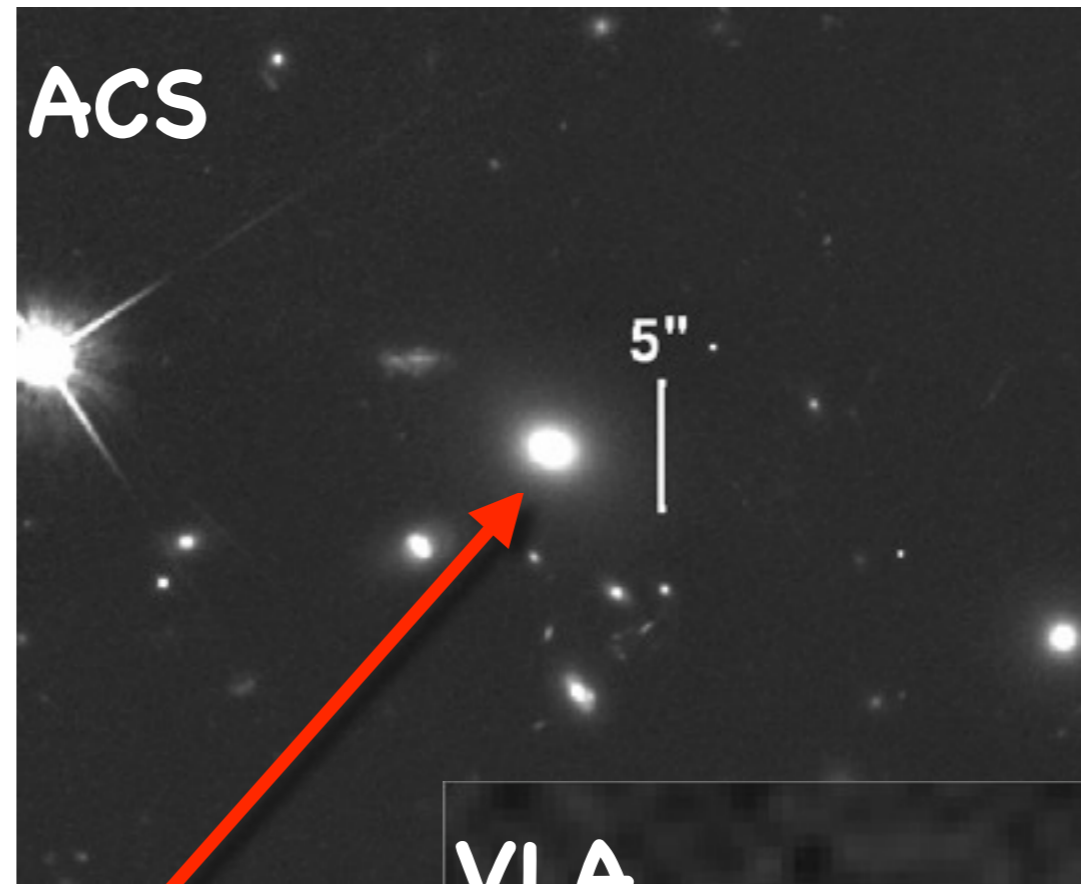
Rudick, Mihos, McBride 2006



Changes in ICL Luminosity, Cluster 3



AGN & Intra-group Medium



Summary

Rise of the galaxy group environment
(big shift from even 5 years ago)

Holistic view of galaxy evolution:
Galaxies & Intra-Halo Light/Medium

Synergy between observations & theory
(better translate b/w theory observations,
e.g. satellites & centrals)