Why Does Environment Matter?

An Incomplete & Biased Guide

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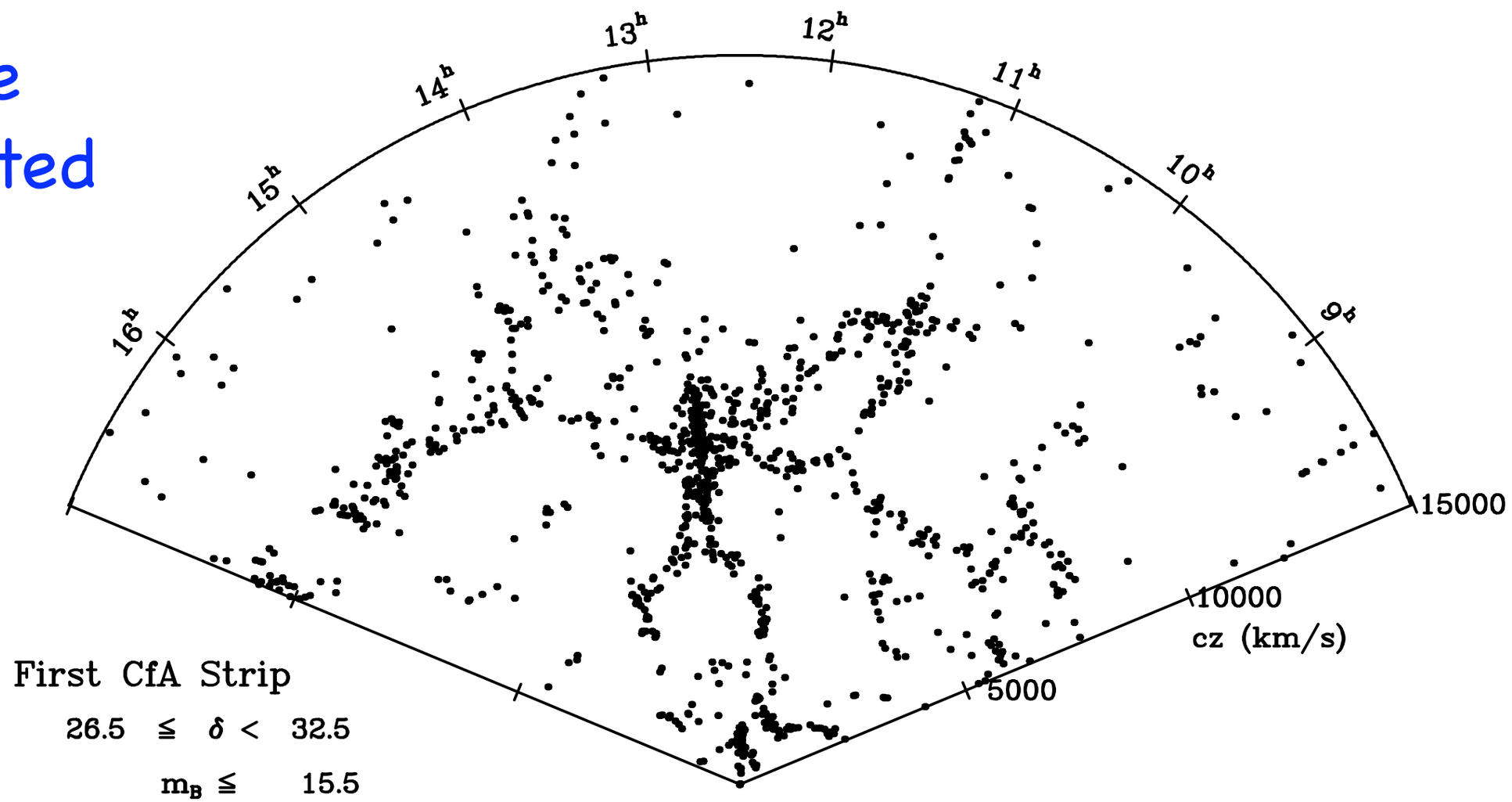
Redshift Surveys

Center for Astrophysics Redshift Survey (1980s)

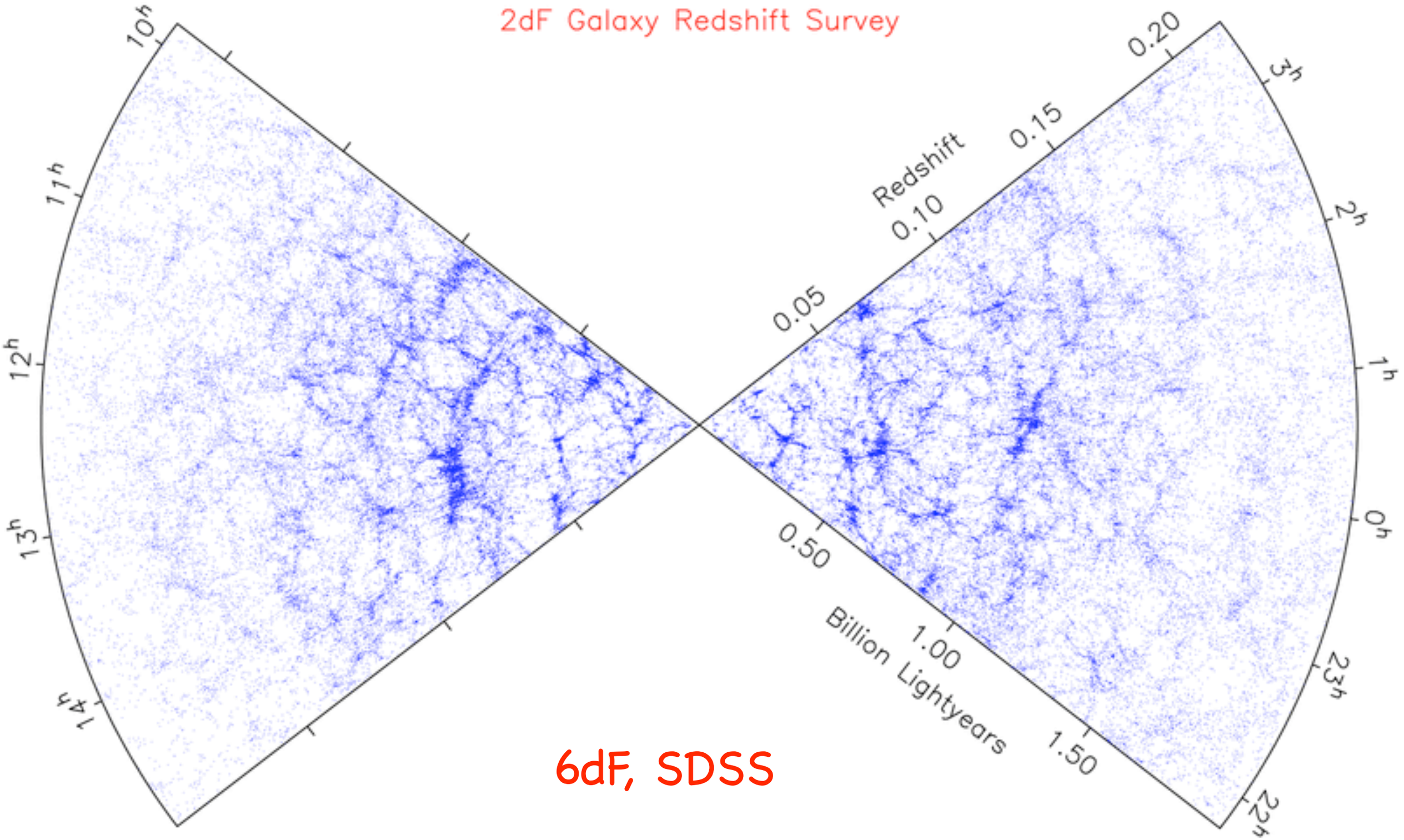
First observational evidence of Large-Scale Structure

Davis, Huchra, Geller, Latham, Tonry

Galaxies are not distributed randomly

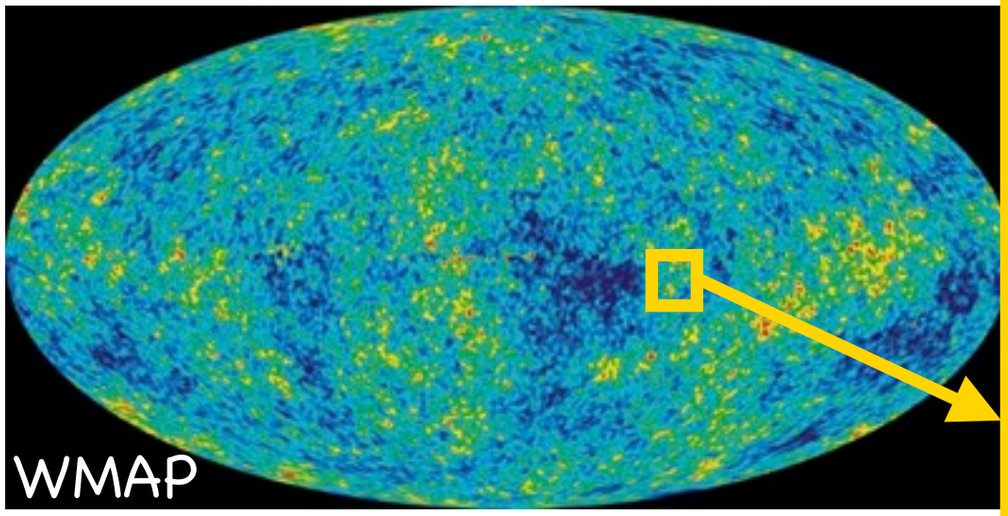


LSS: Local Universe

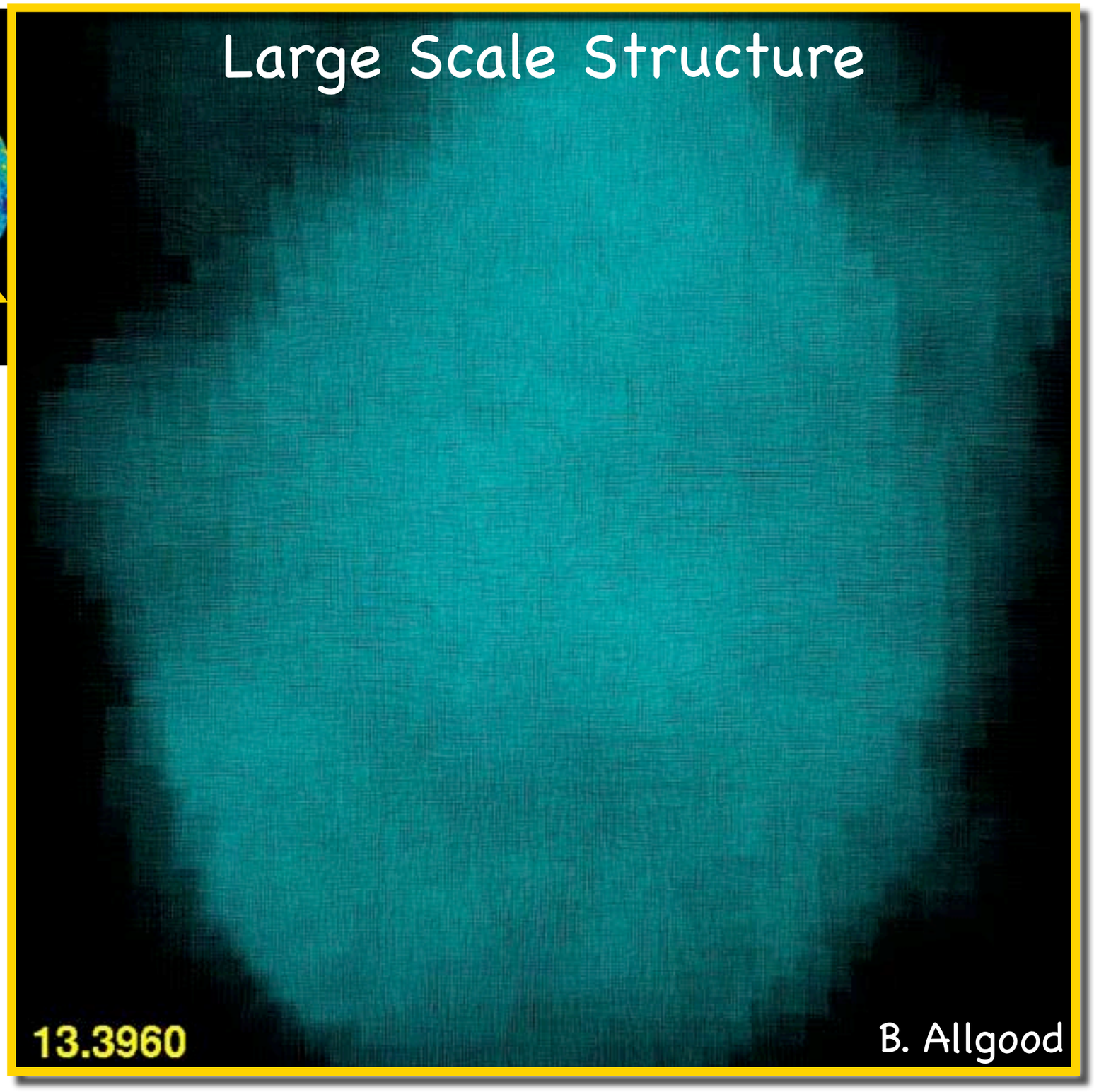


6dF, SDSS

Hierarchical Formation



Primordial fluctuations to collapsed, bound structures (Peebles 1972):
Galaxies,
Galaxy Groups,
Galaxy Clusters

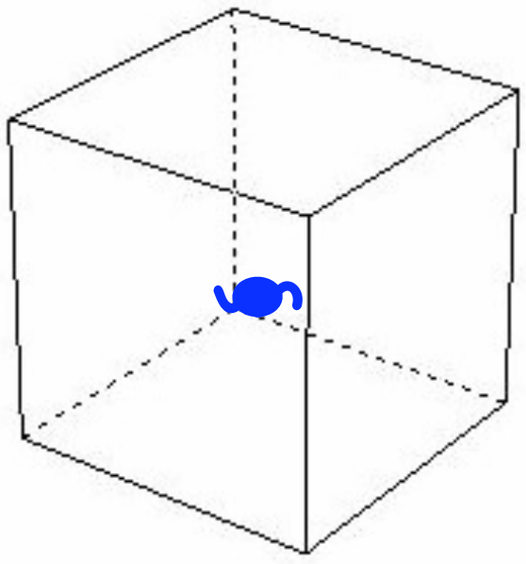


Defining Environment

Group:

~10 L* Galaxy/Mpc^3

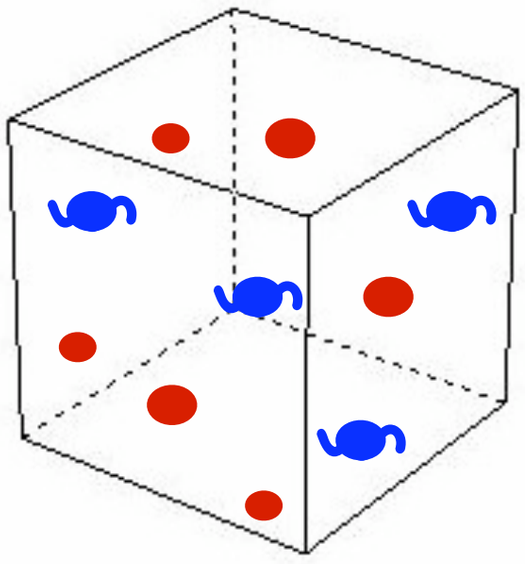
δ(velocity)~200-300 km/s

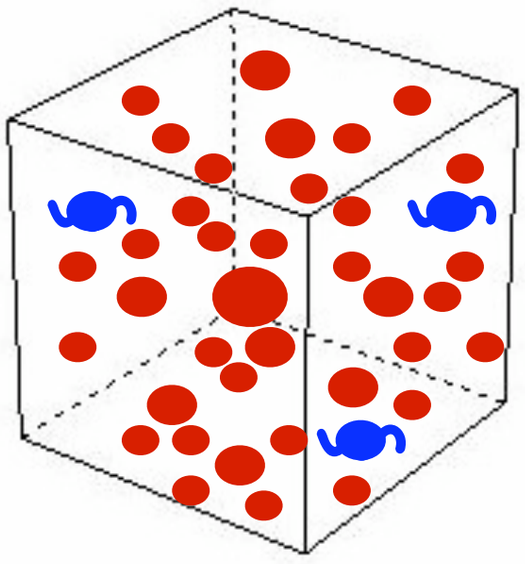


Field:

~1 L* Galaxy/Mpc^3

cz=Hubble Expansion



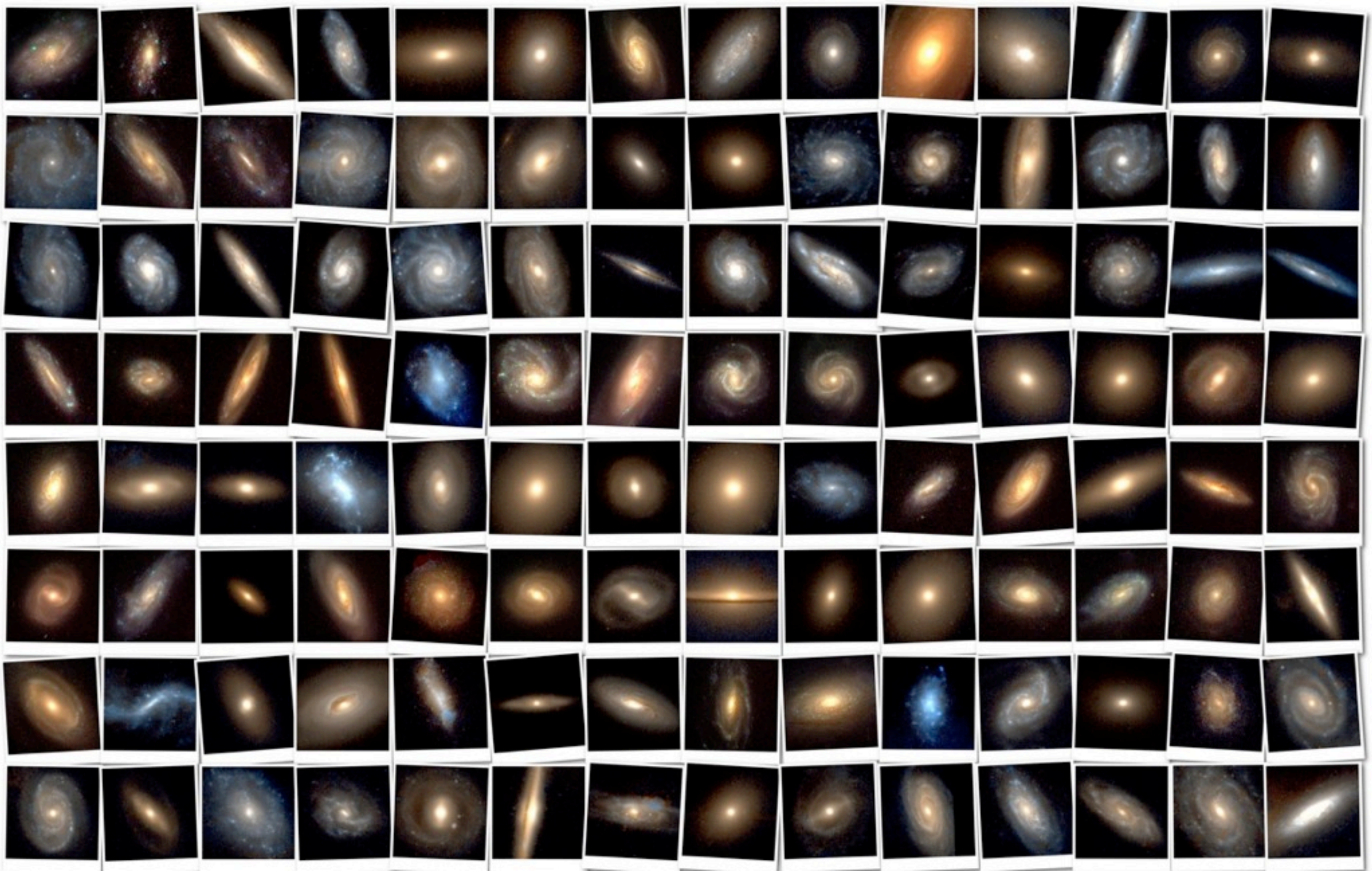


Cluster:

~10^2-10^3 L* Galaxy/Mpc^3

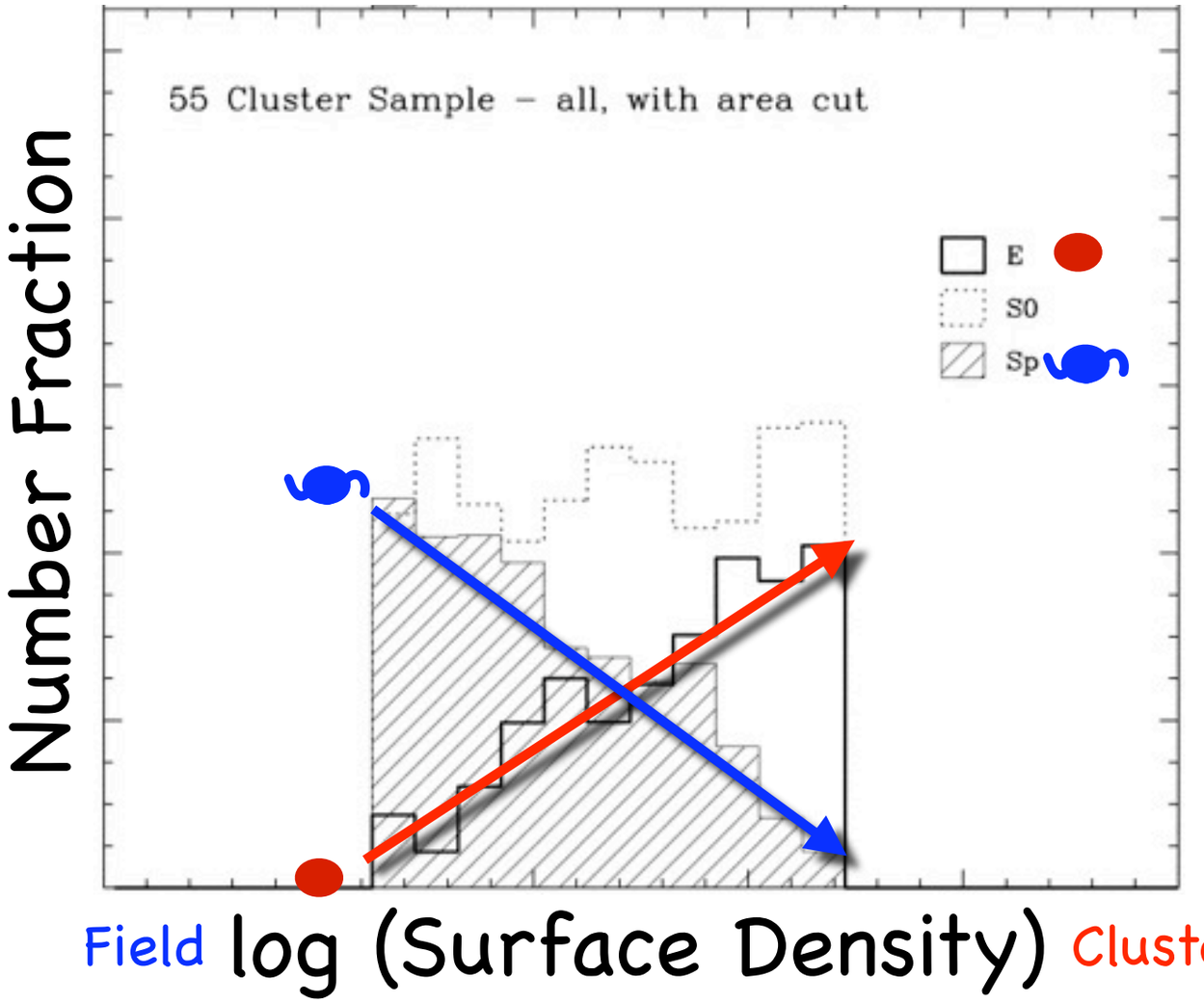
δ(velocity)~1000 km/s

Frei Catalog of Local Galaxies



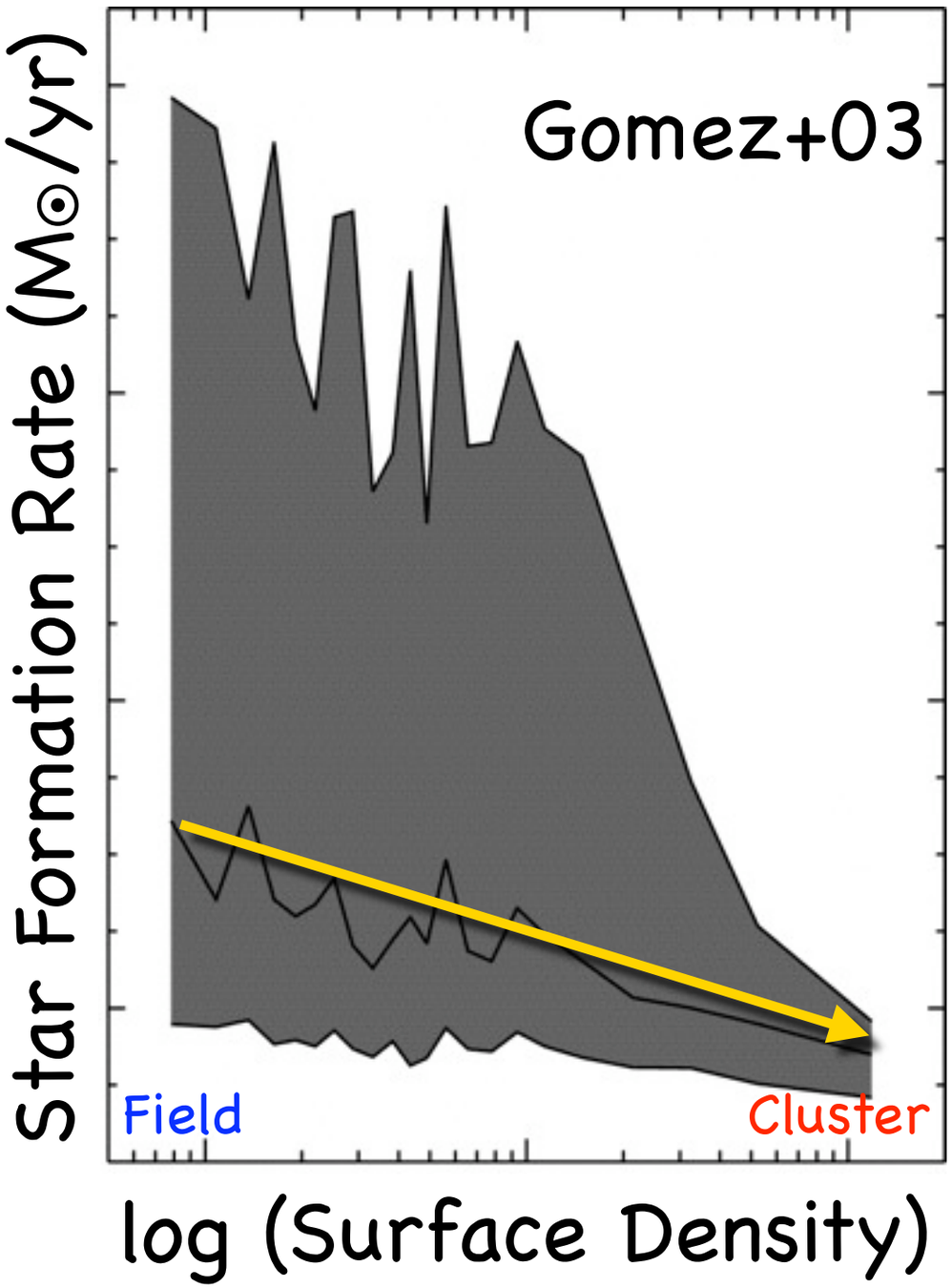
Observed Environmental Trends

Changes in Morphology



Dressler+1997

Changes in Star Formation



Observables

Galaxies:

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

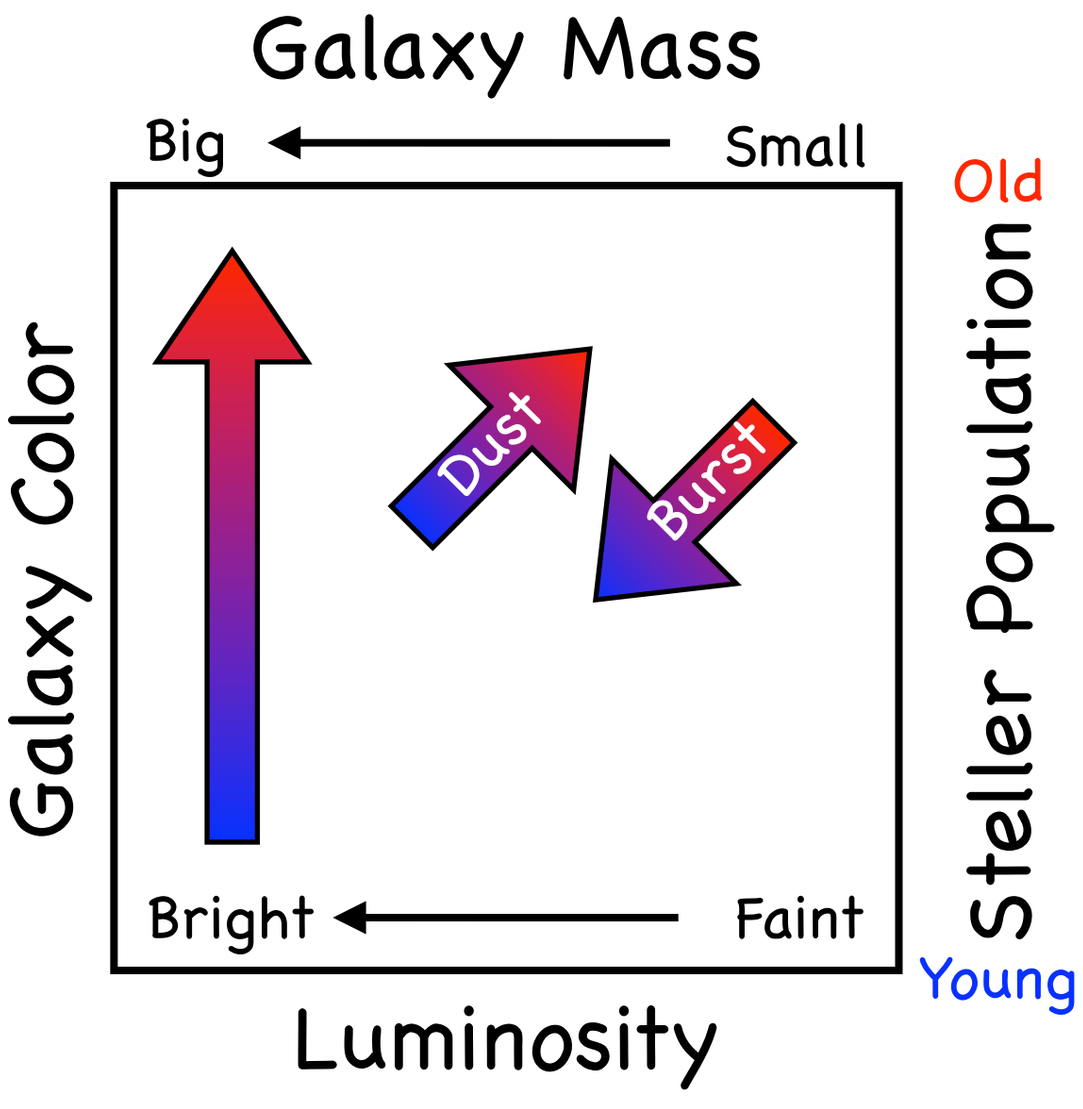
Intra-cluster/group medium:

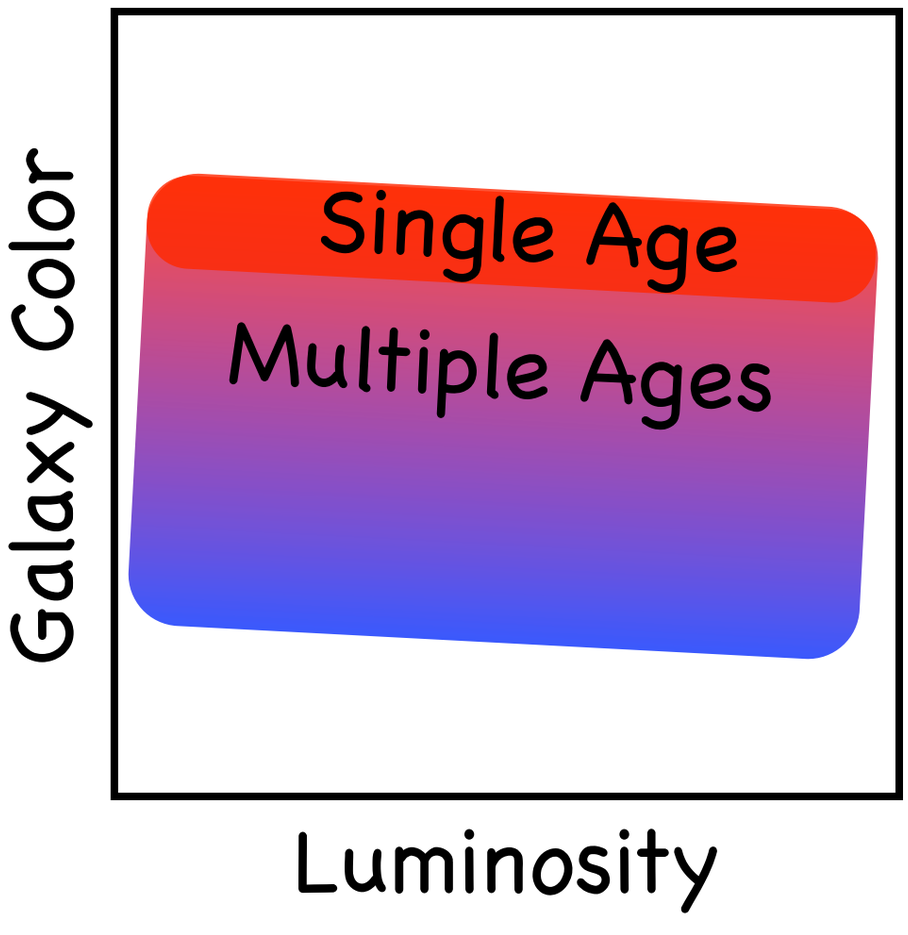
masses (stellar & gas), sizes, luminosities, metallicities, star formation histories (ages), kinematics, temperatures (X-ray)

Dark Matter:

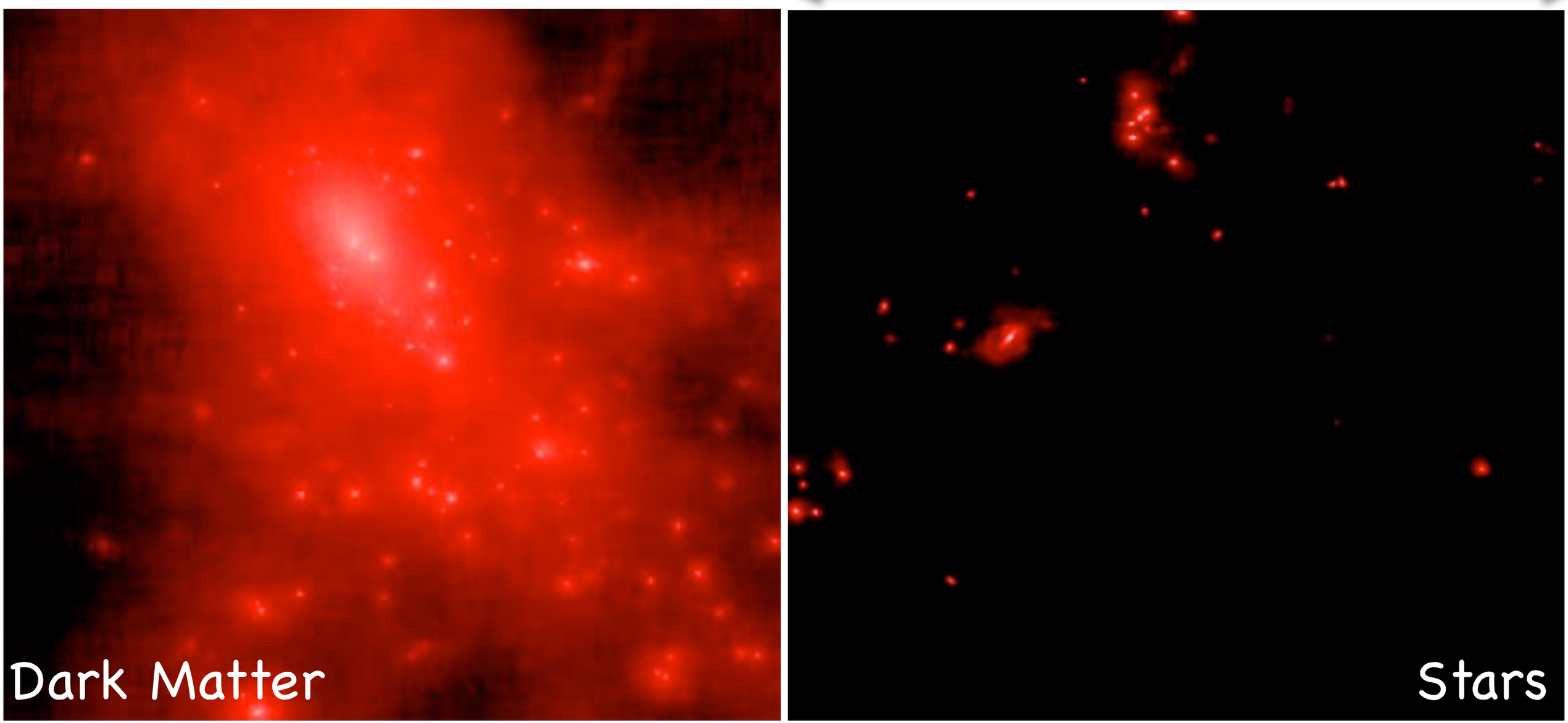
mass & distribution via lensing & galaxy kinematics

Color-Magnitude Diagram





#1: Merging & Massive Galaxies

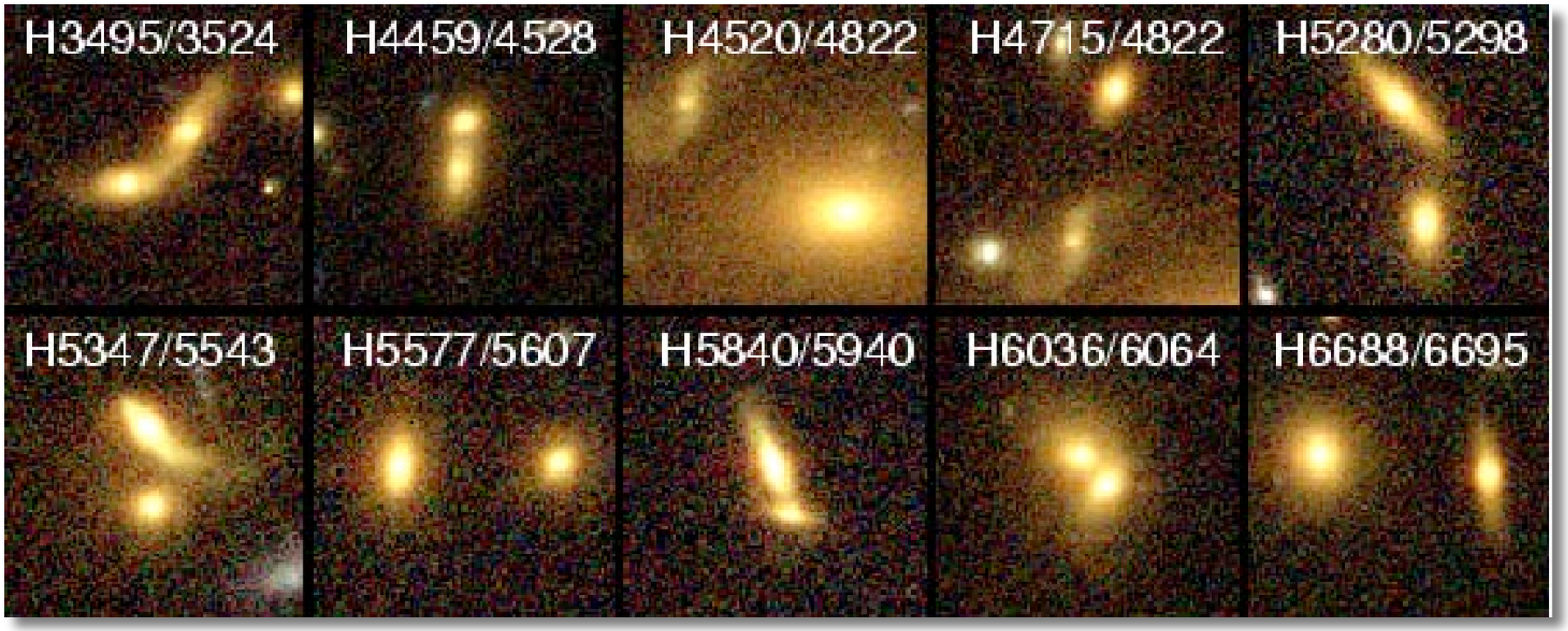


Bryan+08: ENZO AMR, 10^{15} M_{sun} cluster

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

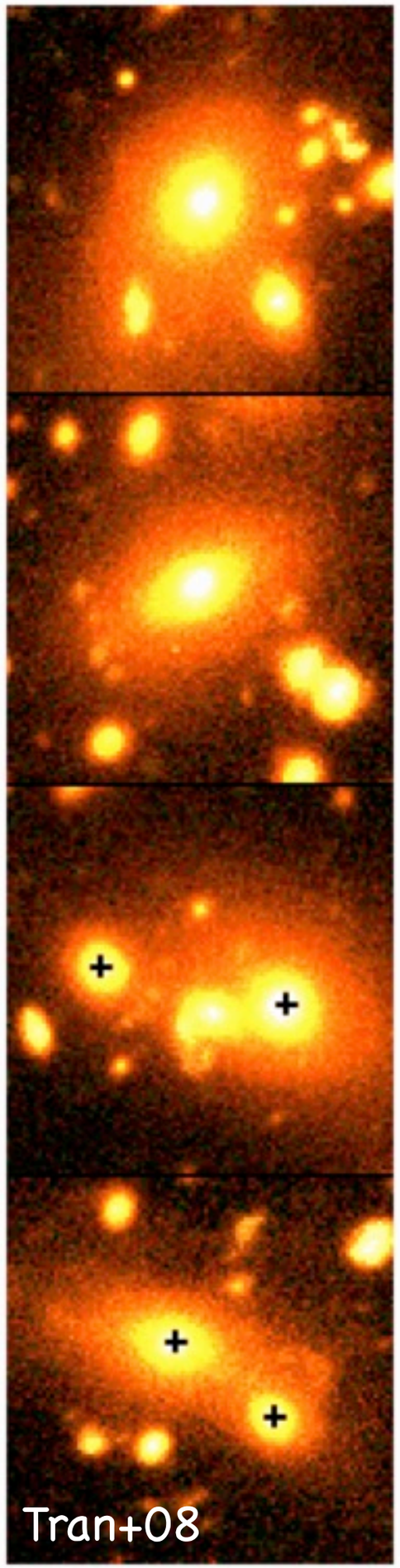
SG1120 (z=0.37)

2

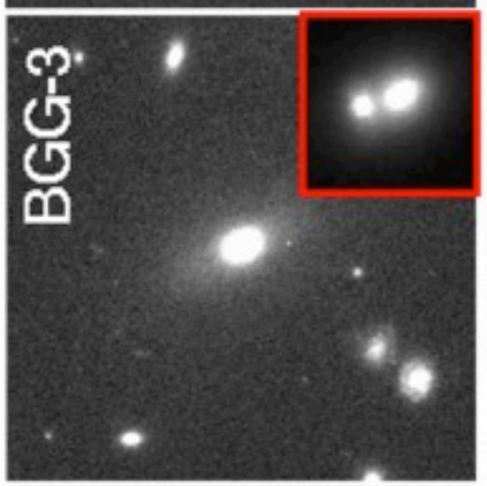
3

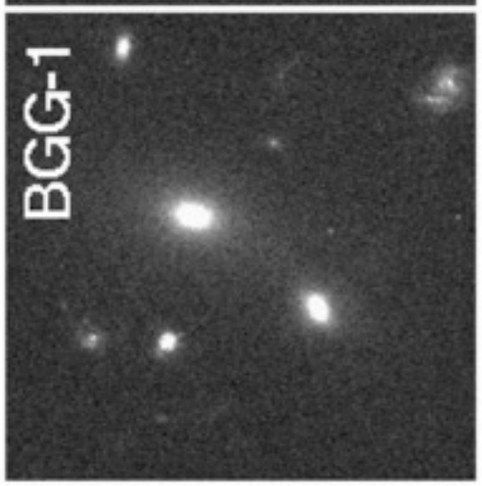
1

4

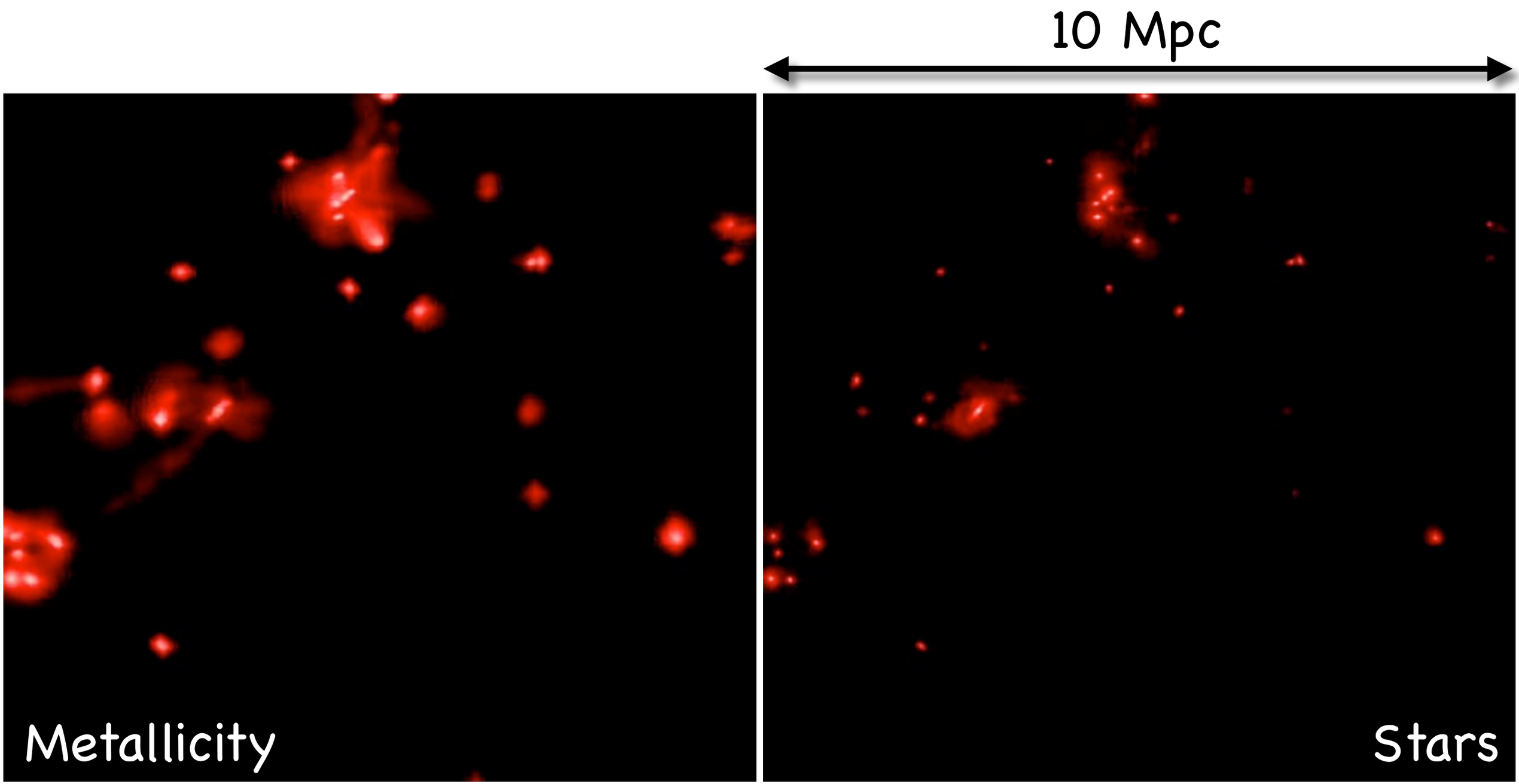


Tran+08





#2: Dynamical Friction & ICL

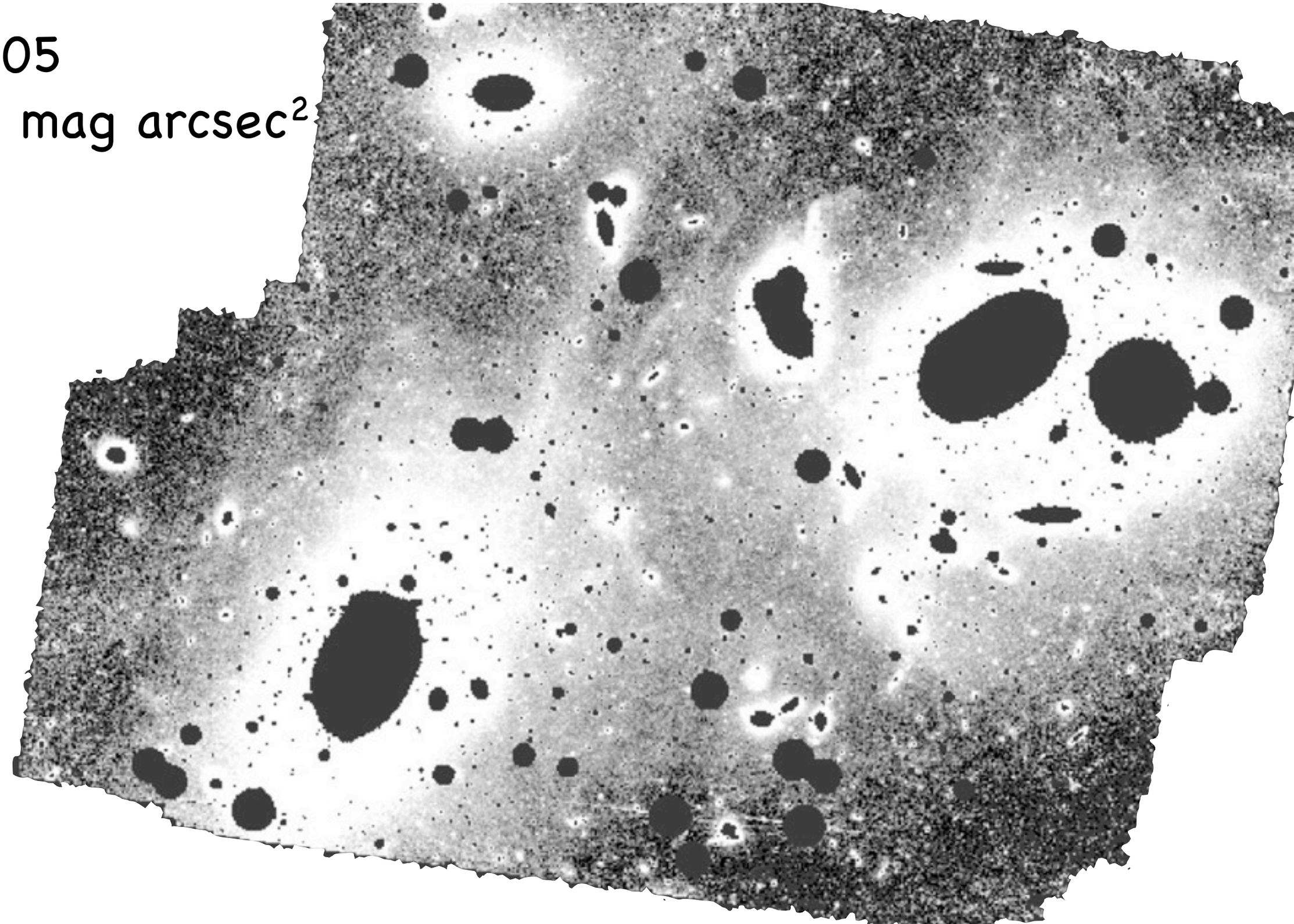


Bryan+08: ENZO AMR, 10^{15} M_{sun} cluster

Intracluster Light: Virgo

Mihos+05

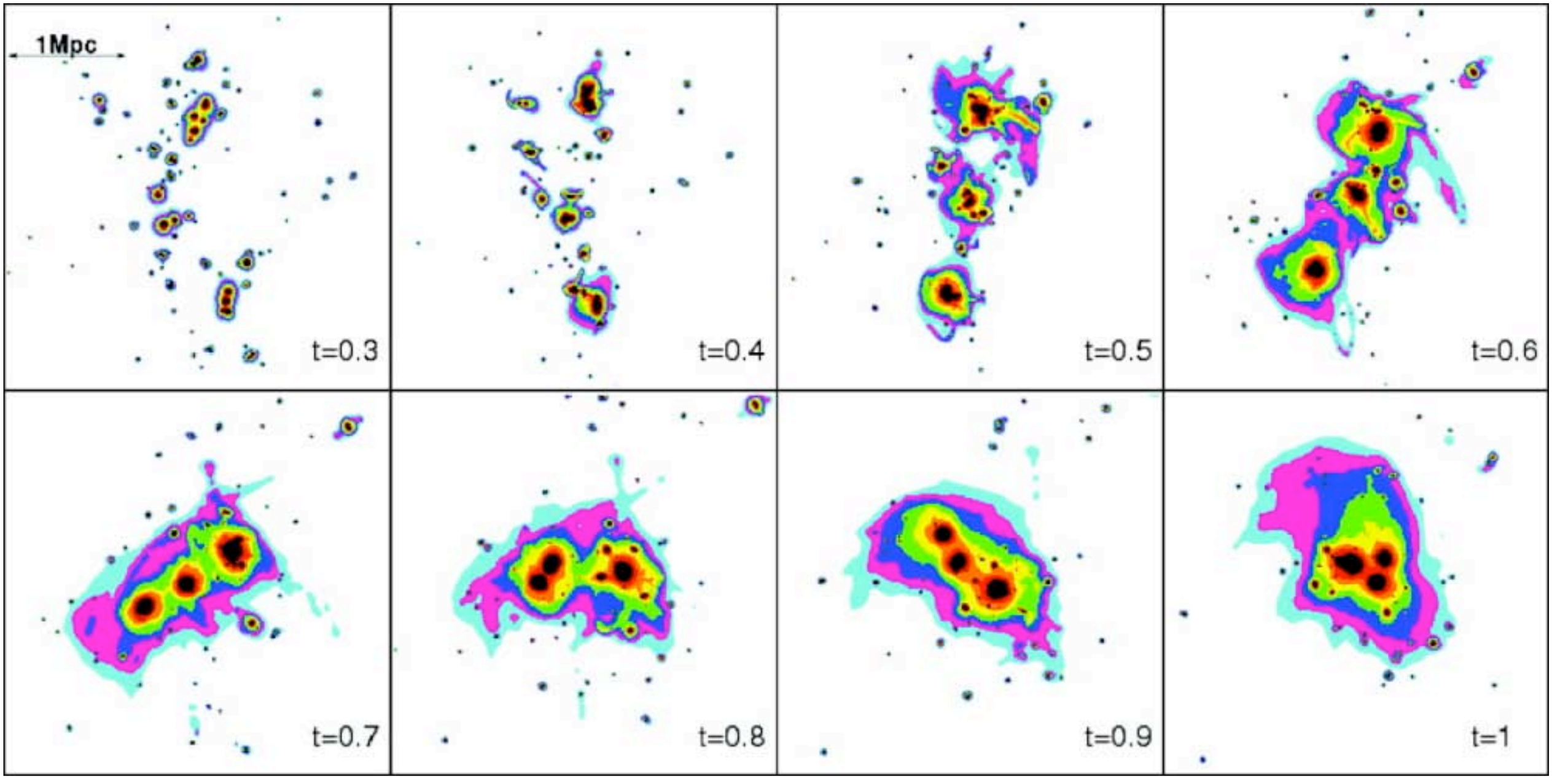
μ>26.5 mag arcsec^2



Intracluster/group Light

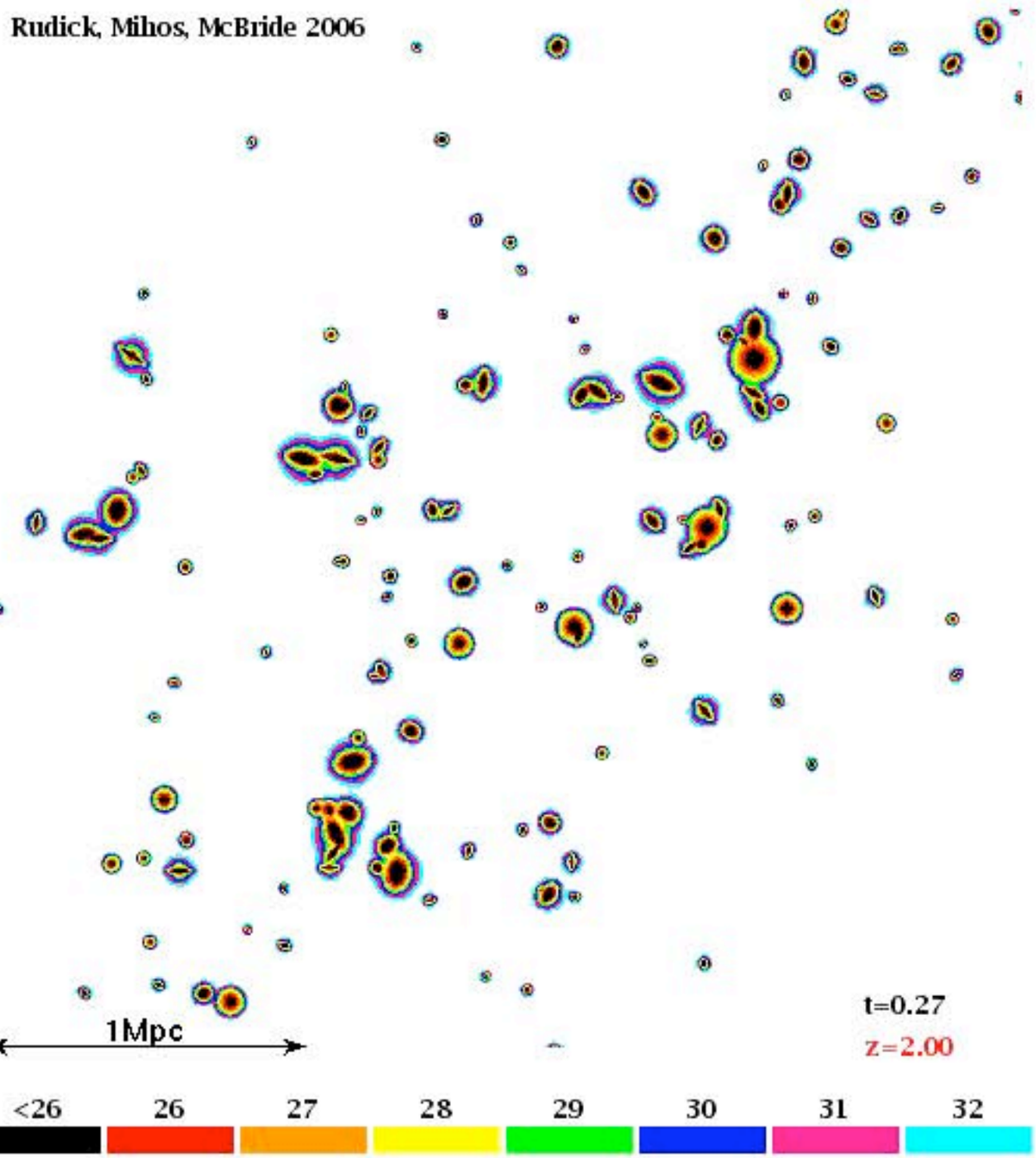
Rudick+06 (Models): ICL structure evolves

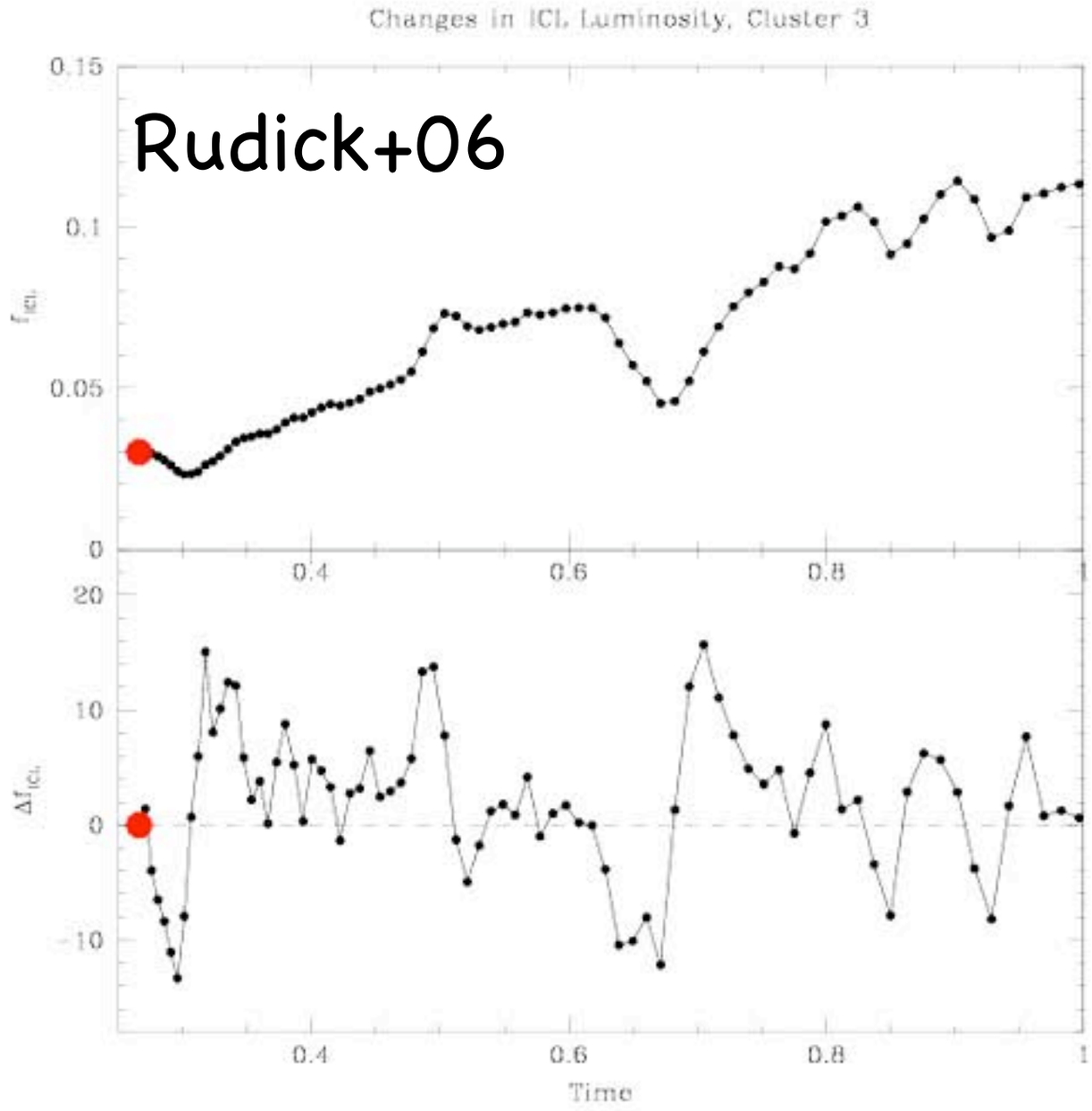
➜ fossil record of cluster assembly



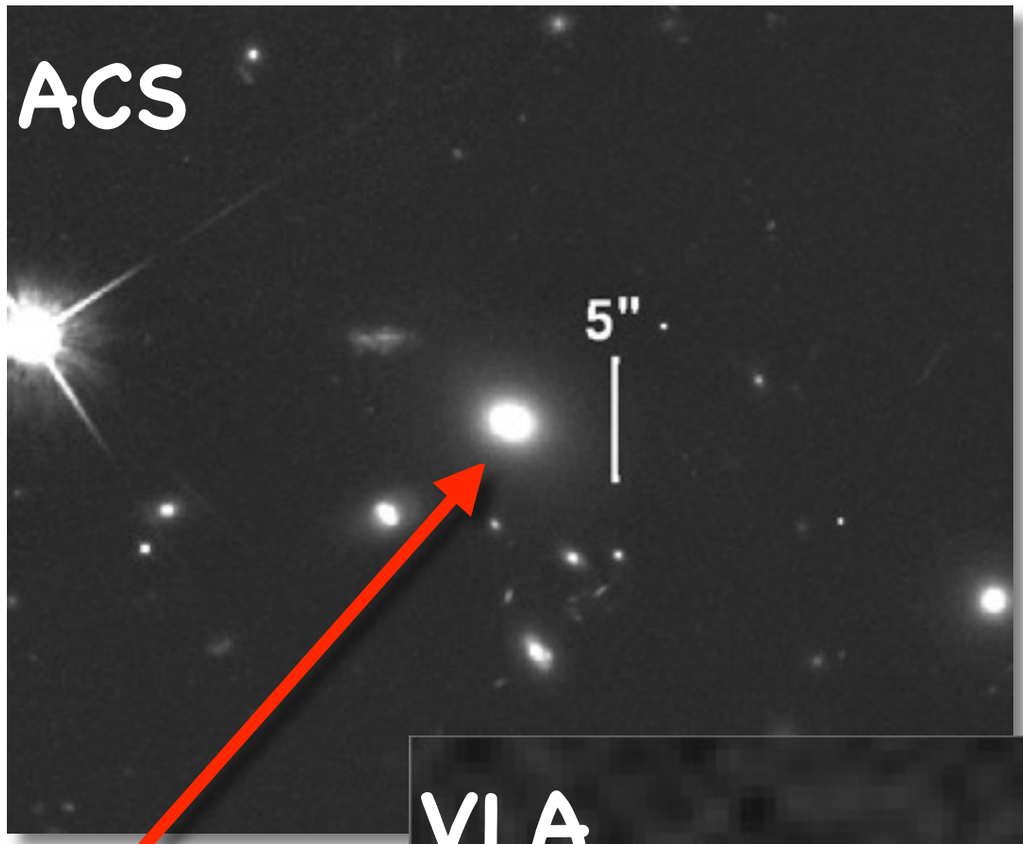
Intracluster/group Light

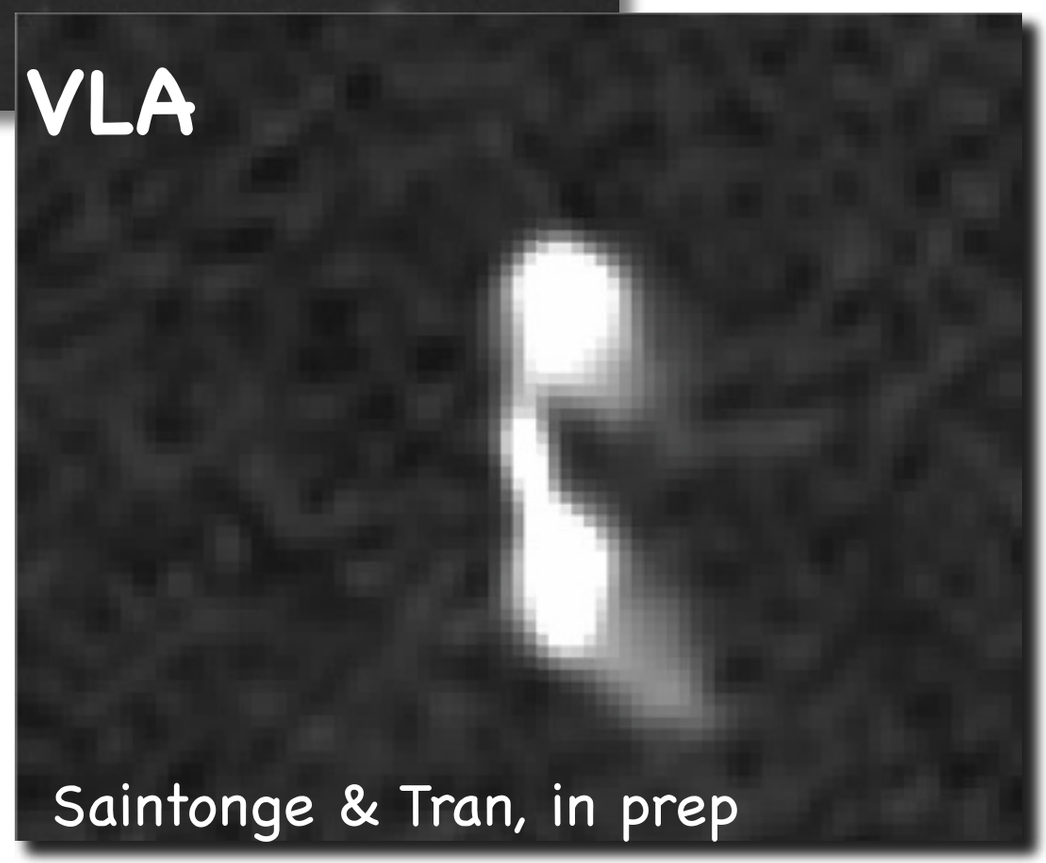
Build-up of ICM linked to accretion of galaxy groups





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)