The University of Nottingham

The *subtle* effect of the cluster environment on the structure and star-formation history of galaxies

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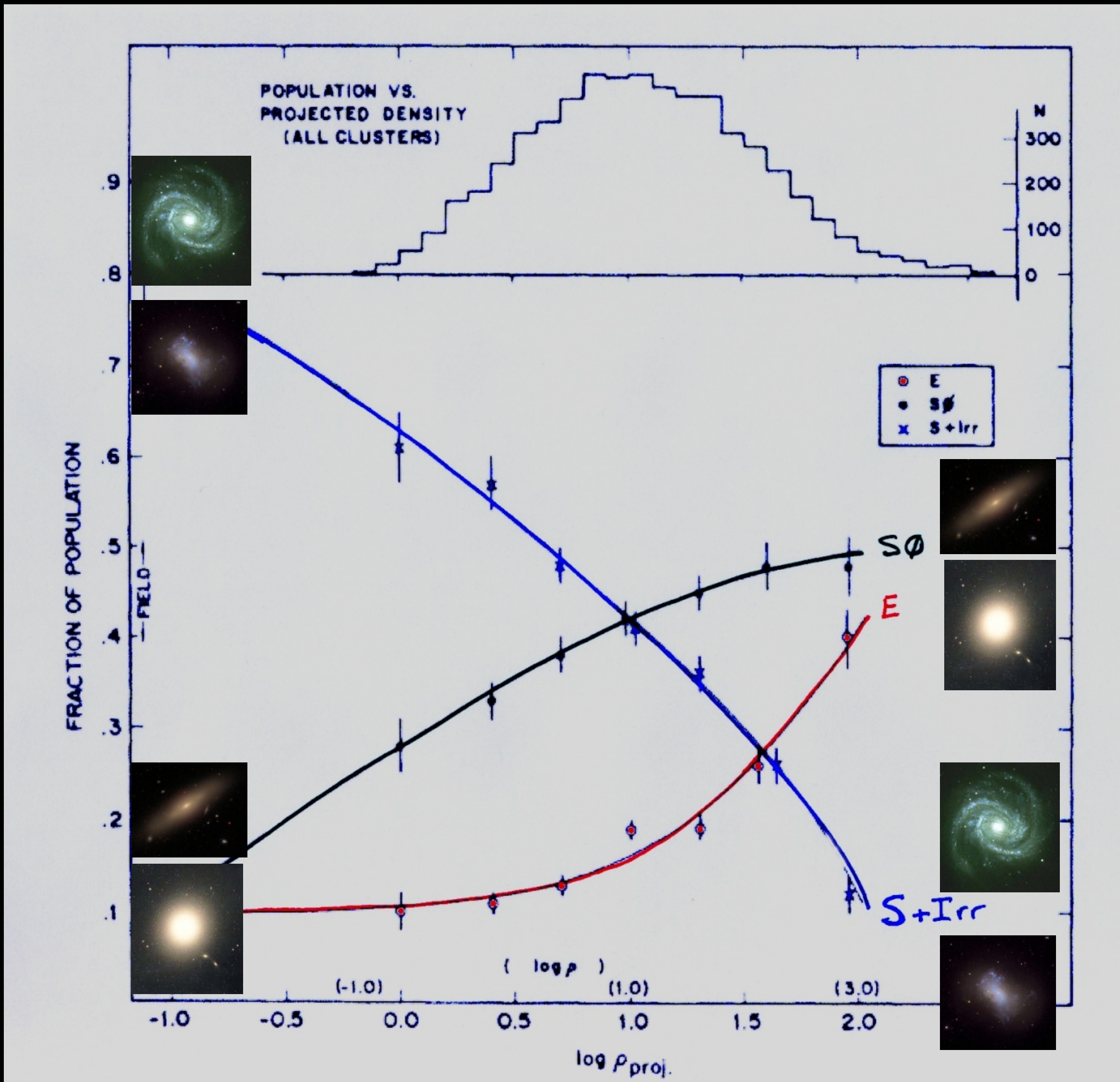
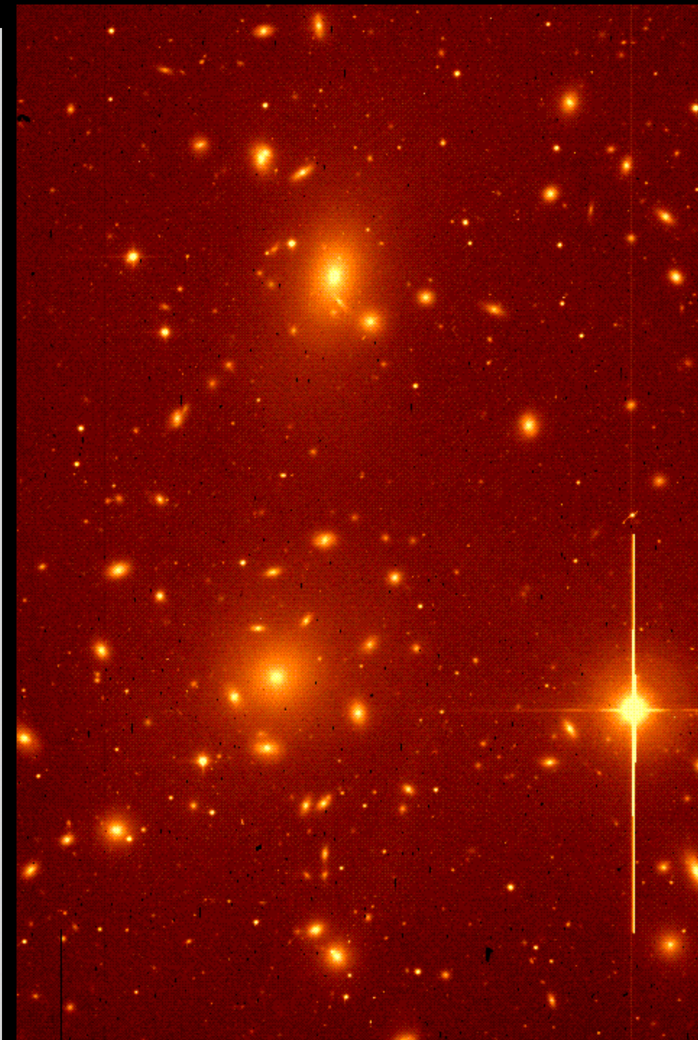
& the EDisCS collaboration

Morphology–Density Relation at z~0

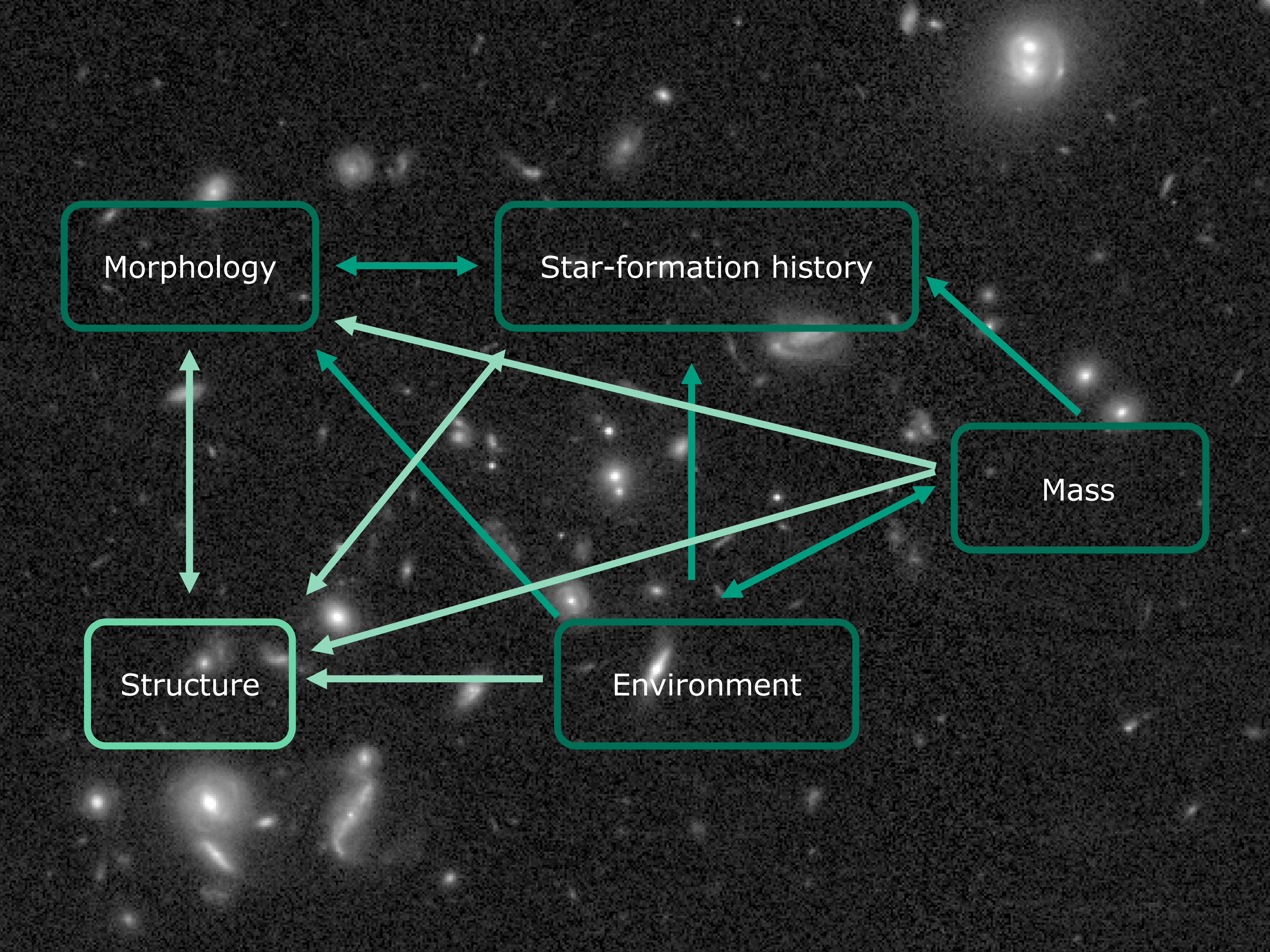


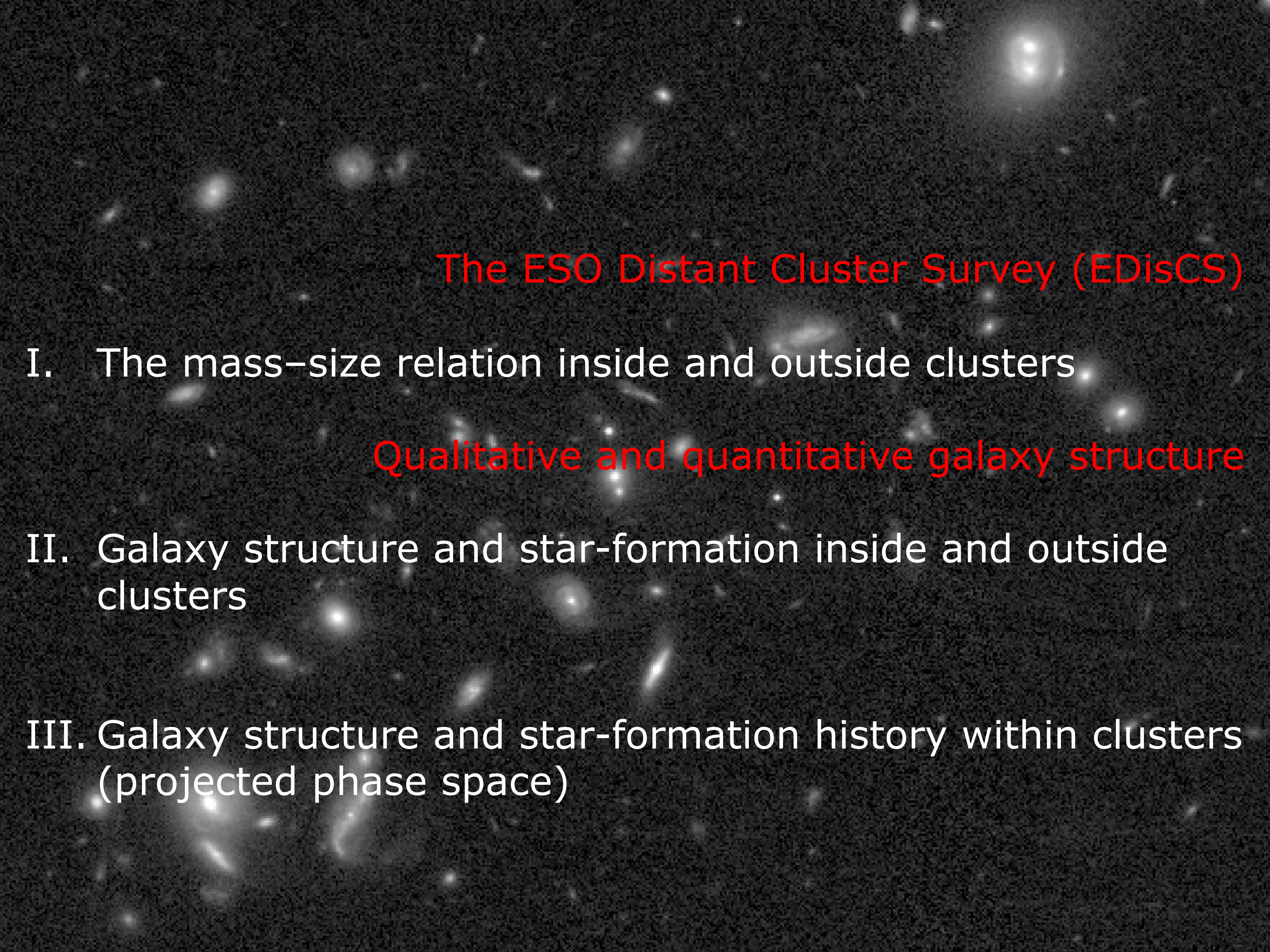
Density



Hubble & Humason (1931)

Dressler (1980)


Morphology
Star-formation history
Mass
Structure
Environment



The ESO Distant Cluster Survey (EDisCS)

I. The mass–size relation inside and outside clusters

Qualitative and quantitative galaxy structure

II. Galaxy structure and star-formation inside and outside clusters

III. Galaxy structure and star-formation history within clusters (projected phase space)

The ESO Distant Cluster Survey

Rudnick et al. 2003, The Messenger, 112

White et al., 2005, A&A, 444, 365

The Cast and Crew

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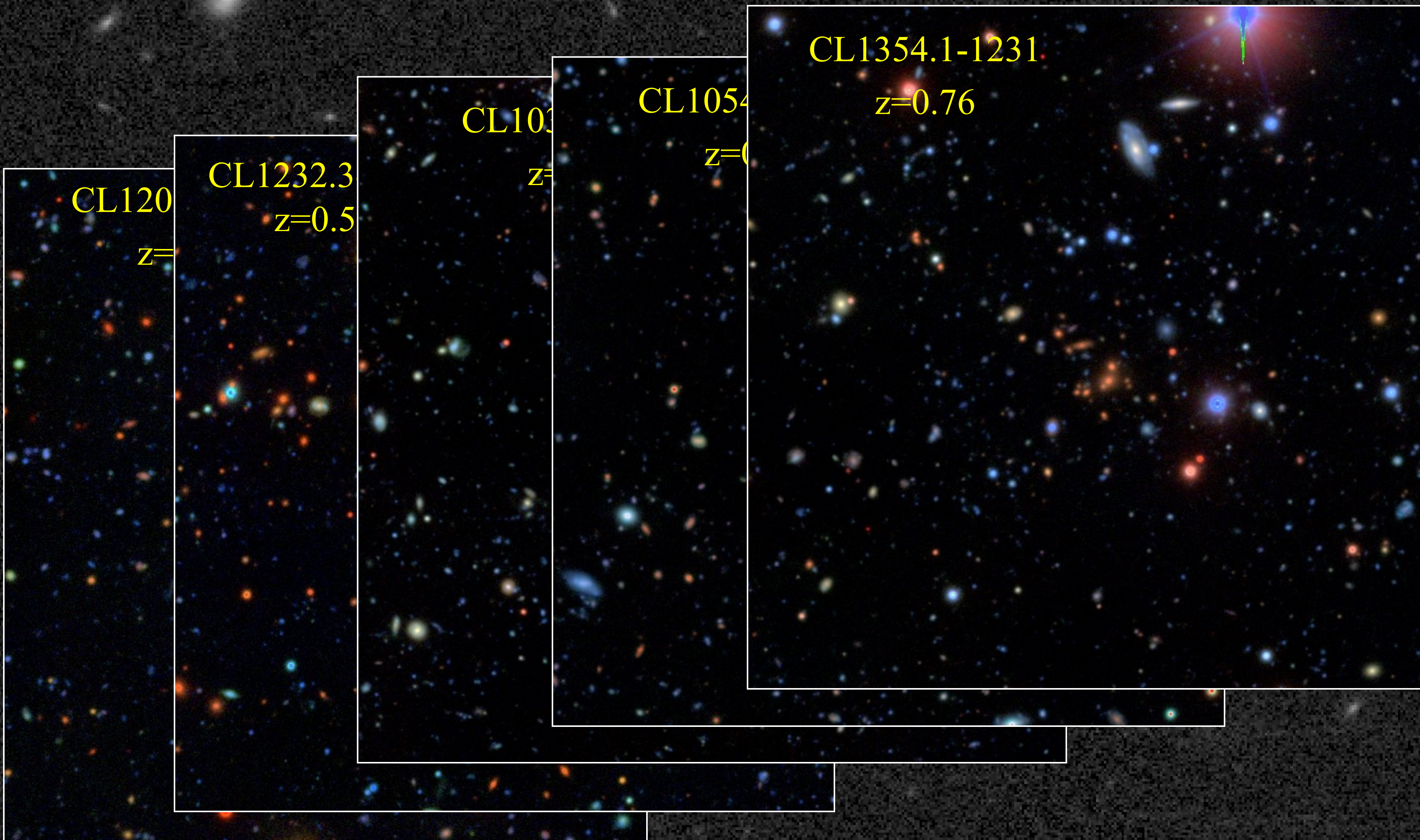
A. Aragón-Salamanca (Nottingham, UK)
R. Bender (Munich, D)
P. Best (ROE, Scotland)
M. Bremer (Bristol, UK)
S. Charlot (MPA, D & IAP, F)
D. Clowe (Bonn, D)
J. Dalcanton (U.Washington, USA)
B. Fort (IAP, F)
P. Jablonka (OPM, F)
G. Kauffmann (MPA, D)
Y. Mellier (IAP, F)
R. Pello (OMP, F)
B. Poggianti (Padova, I)
H. Rottgering (Leiden, NL)
P. Schneider (Bonn, D)
D. Zaritsky (U. Arizona, USA)

G. De Lucia (MPA, D)
V. Desai (Caltech, USA)
C. Halliday (Goettingen, D)
B. Milvang-Jensen (Copenhagen, Denmark
G. Rudnick (NOAO, USA)
R. Saglia (Munich, D)
L. Simard (U. Victoria, C)
S. Bamford (Nottingham, UK)
A. v.d. Linden (MPA, D)
I. Whiley (Nottingham, UK)
O. Johnson (ROE, Scotland)
J. Moustakas (U. Arizona, USA)
R. Finn (Siena College, USA)
Y. Jaffe (Nottingham, UK)
D. Maltby (Nottingham, UK)
K. Kelkar (Nottingham, UK)

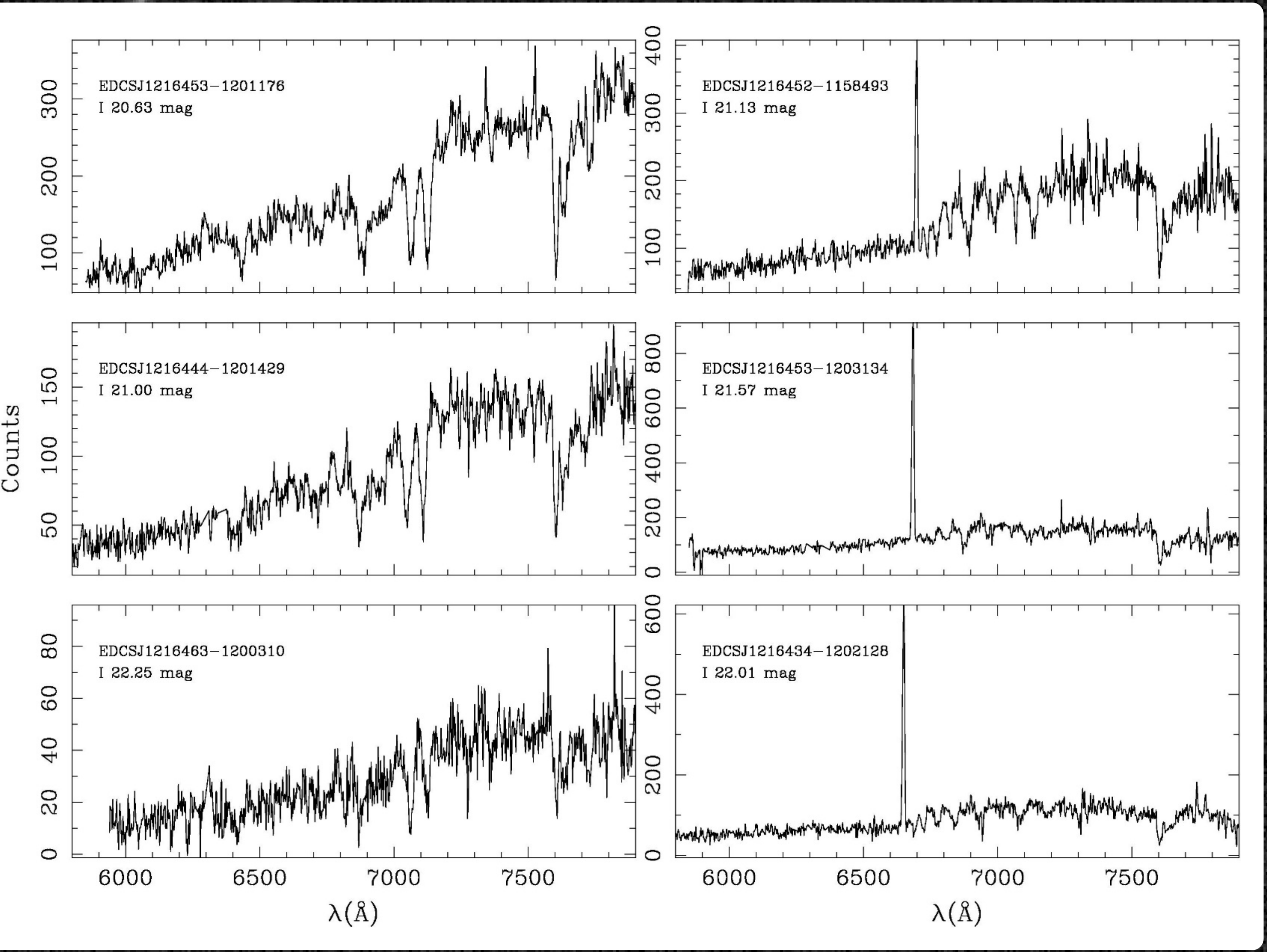
Imaging

10 "high-z" fields in VRIJK, 10 "low-z" fields in BVIK



Spectroscopy

22 nights of FORS2 MXU spectroscopy ⇒ ~50 members/cluster



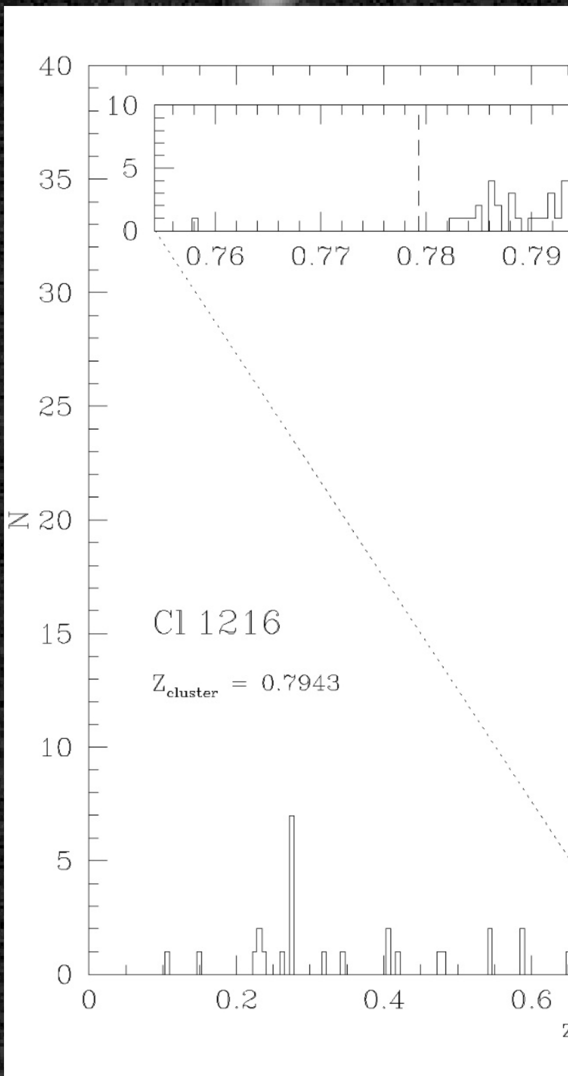
z's to I~23

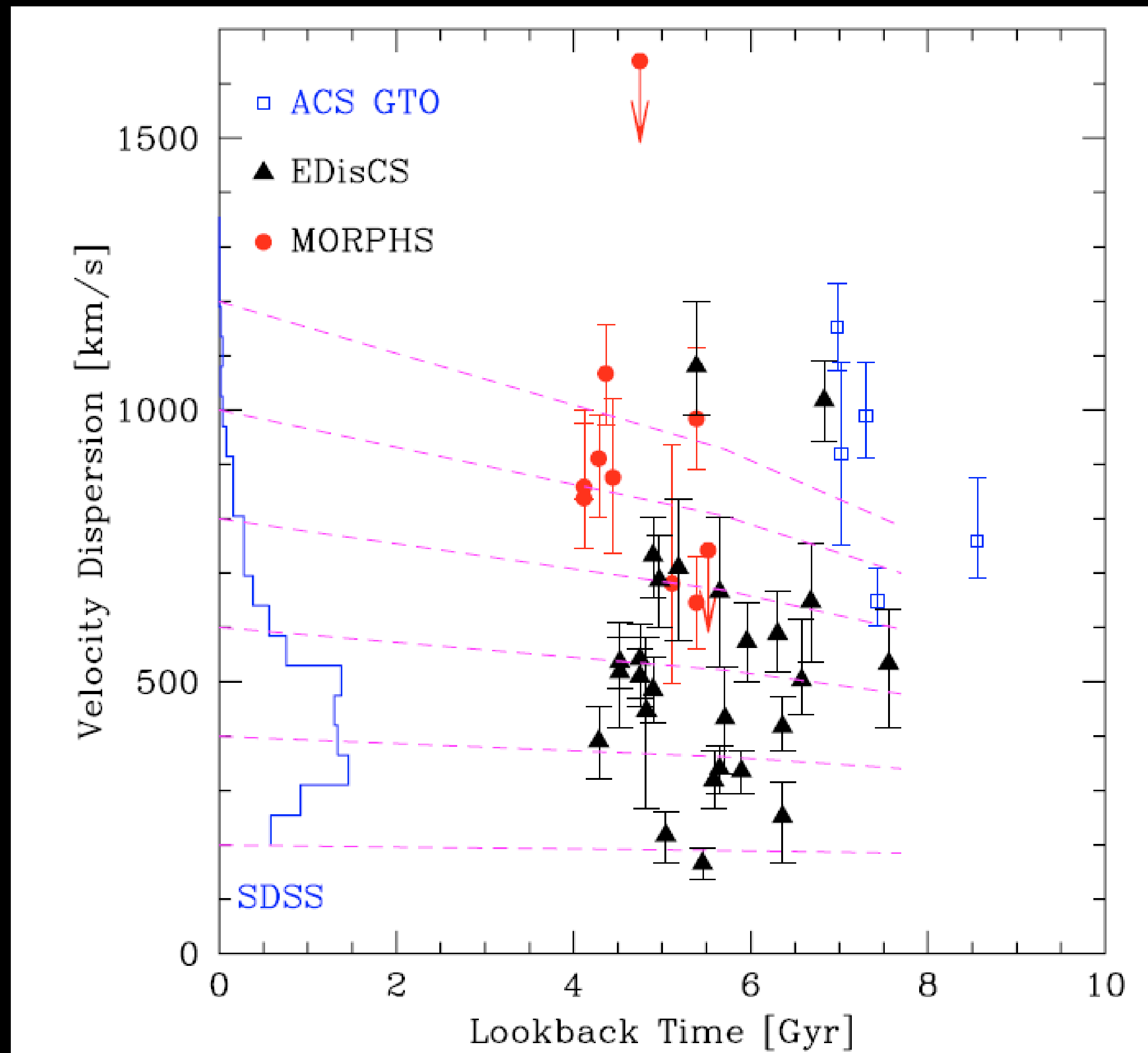
Line indices to I~22.5

σ's to I~21.5

Redshifts and Velocities

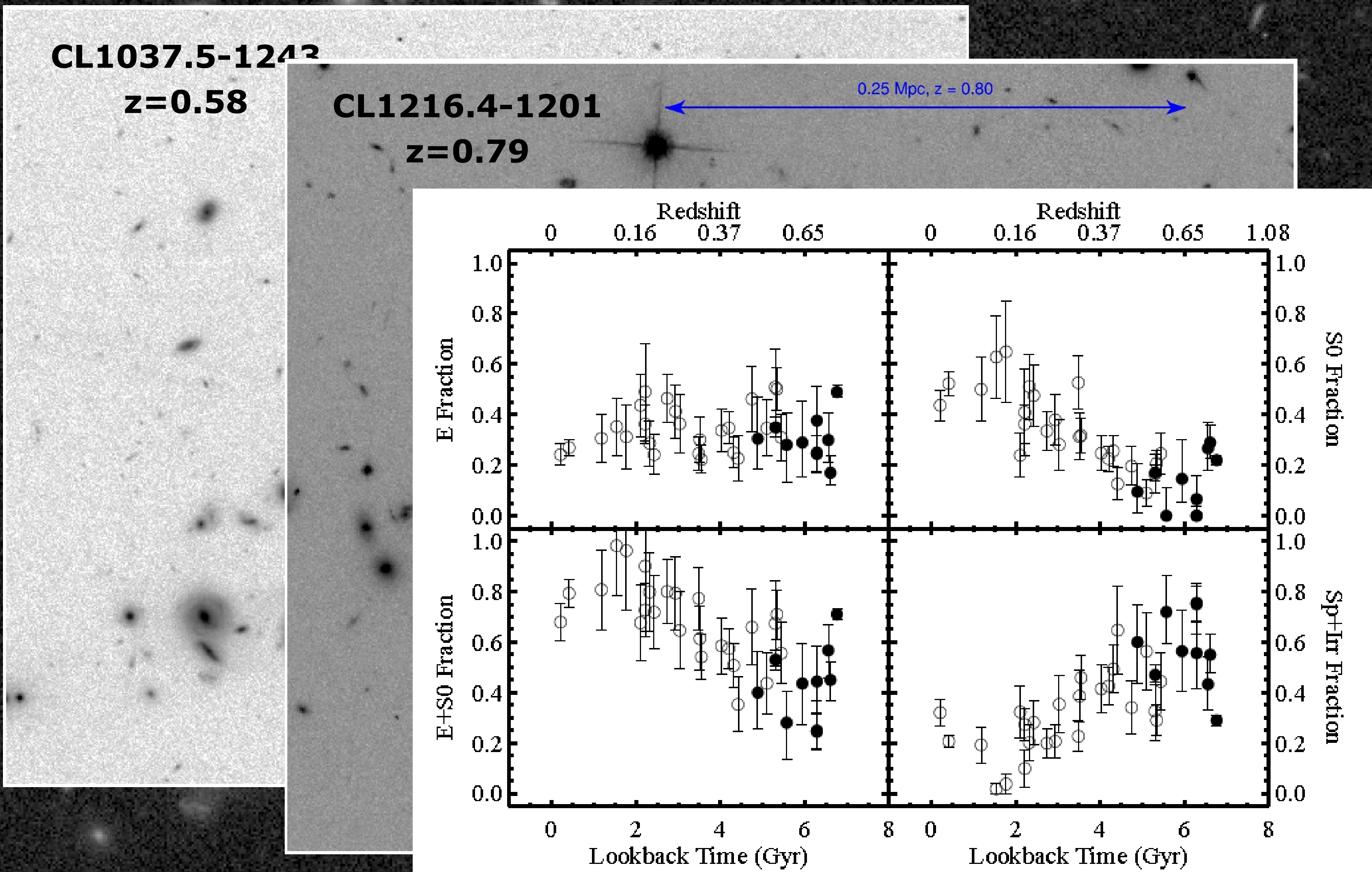
Claire Halliday, Bo Milvang-Jensen et al., 2004, 2008



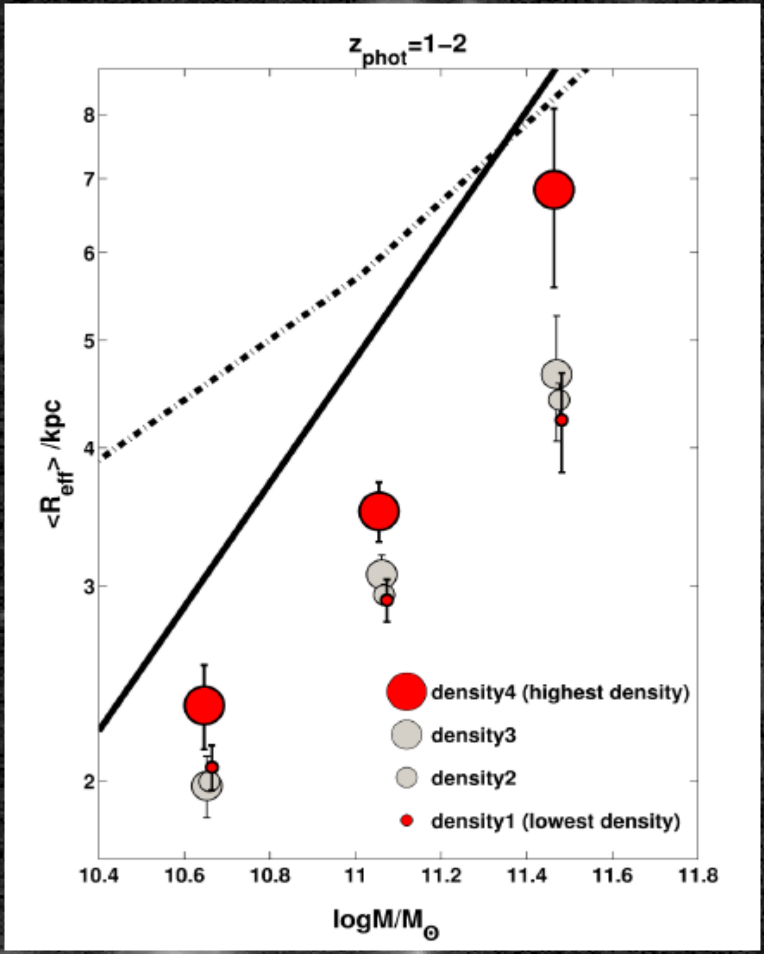


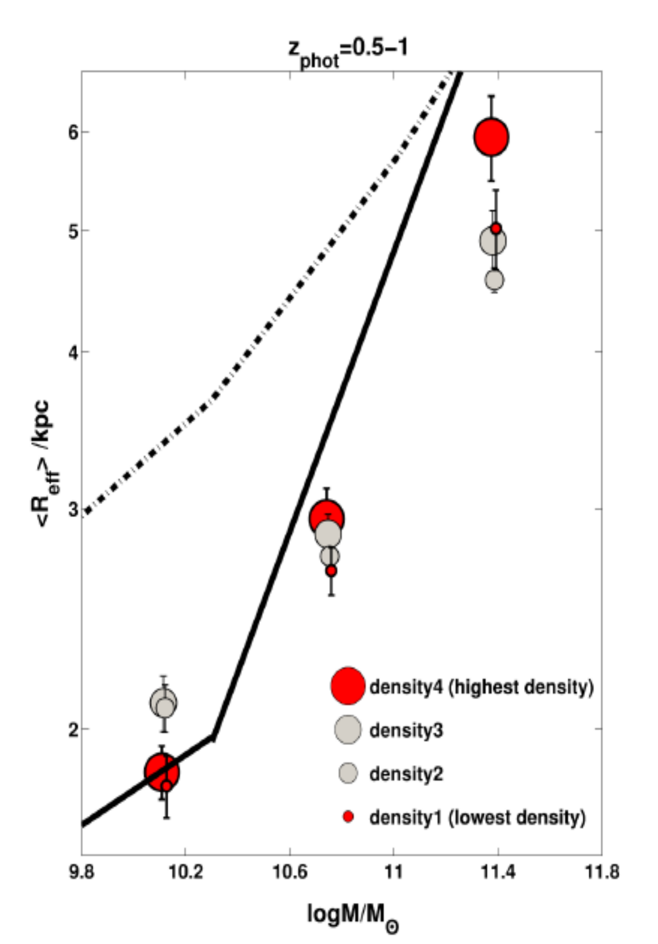
HST Imaging and Morphology

Vandana Desai et al. (2007)



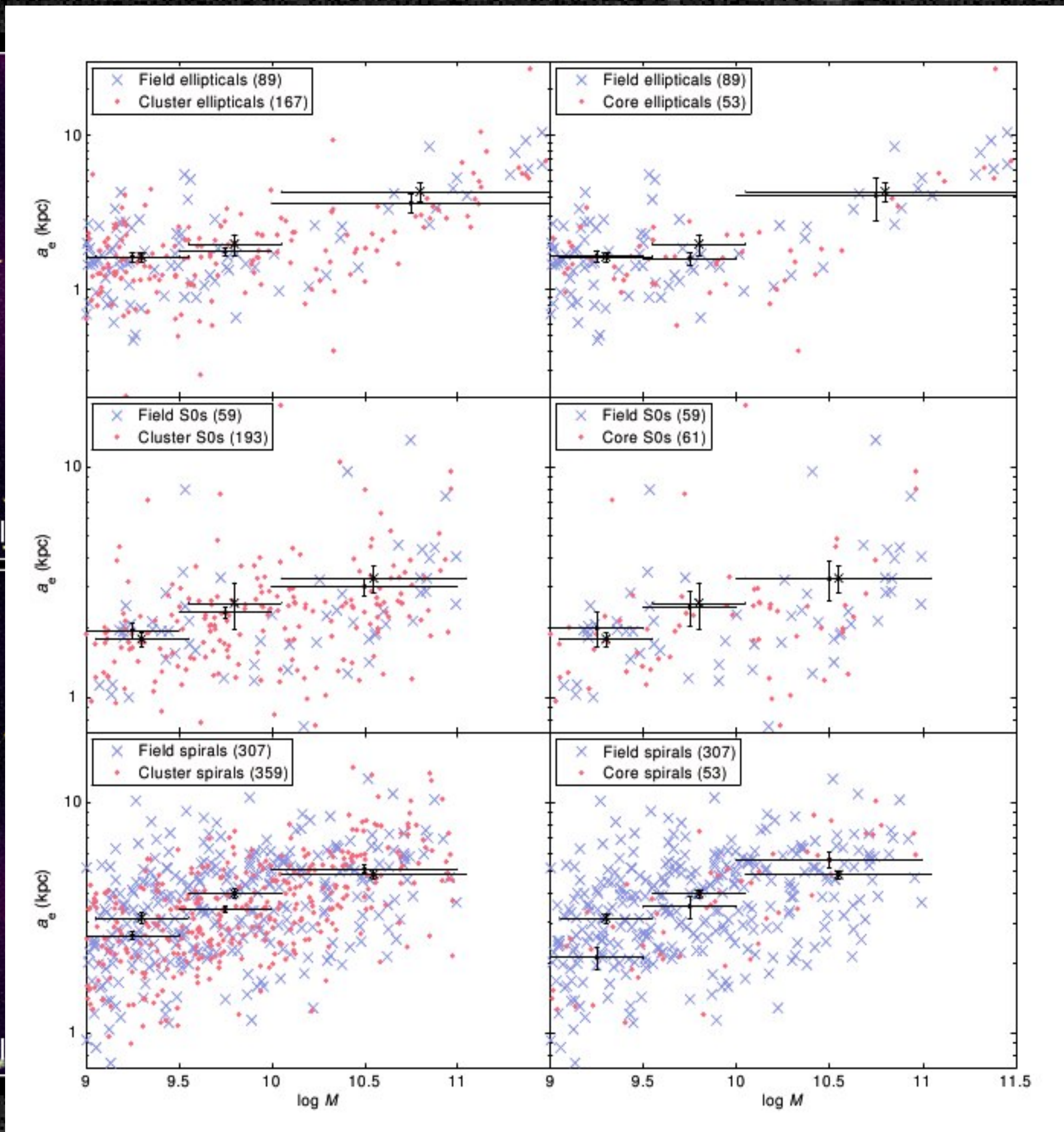
M*–size relation at high *z*

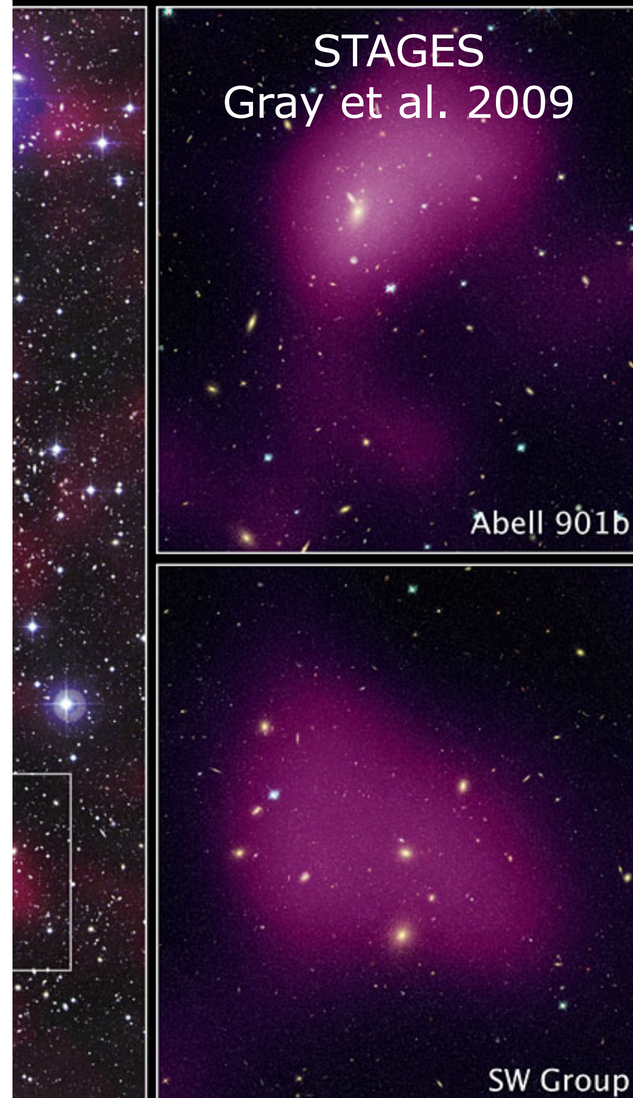




Lani et al. 2013

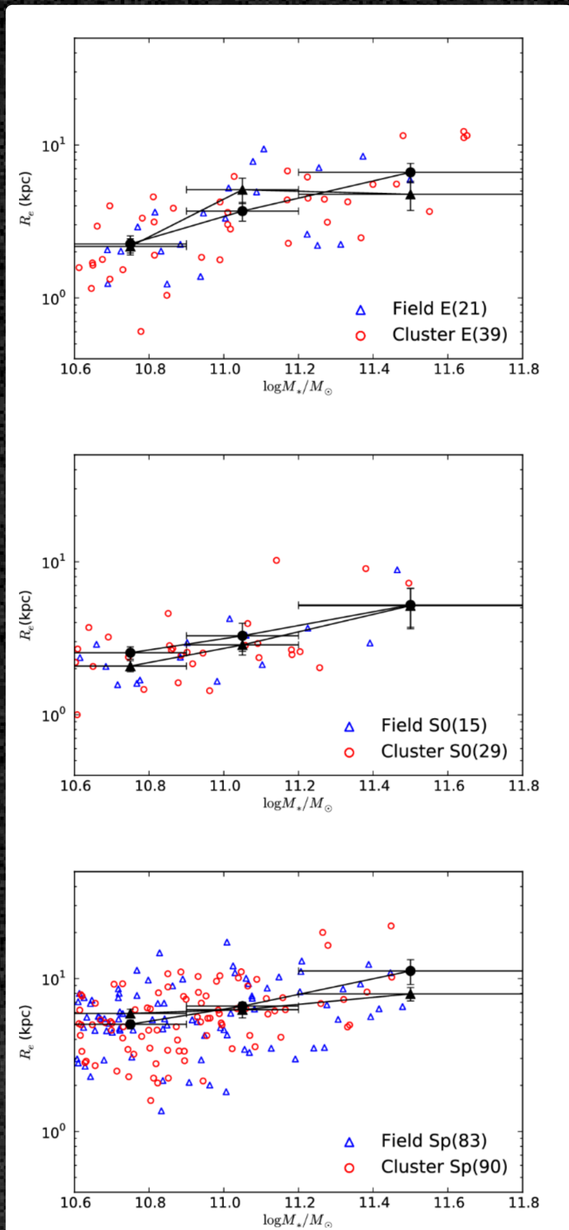
M*–size relation low z





Maltby et al. 2010

M*–size relation at intermediate z



Spectroscopic sample

Ellipticals

S0s

Spirals

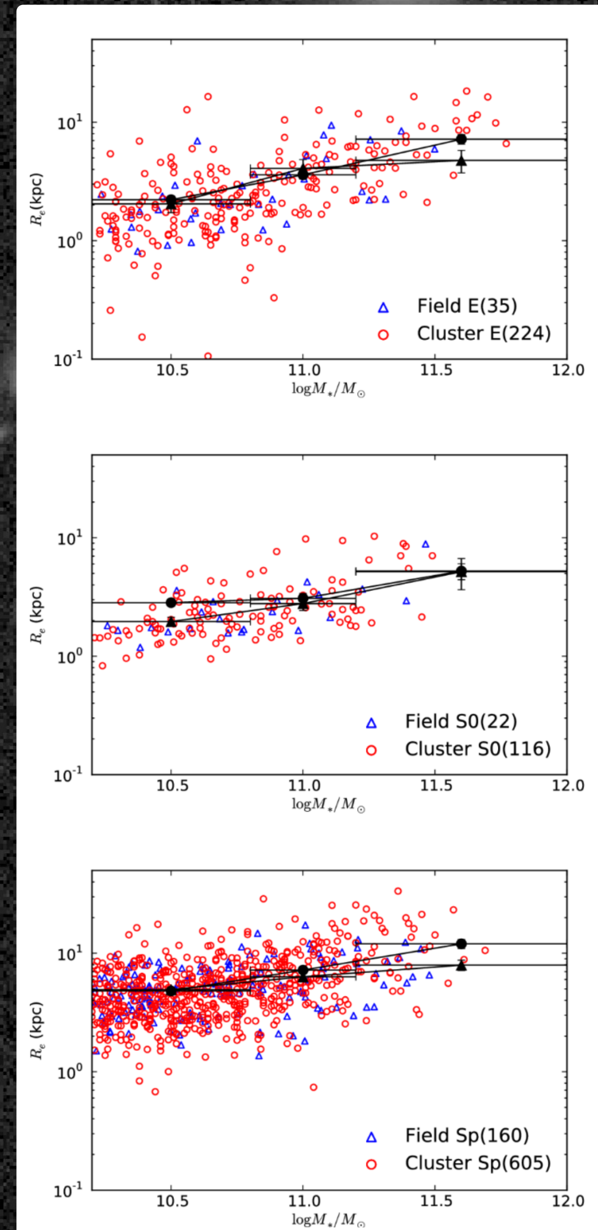
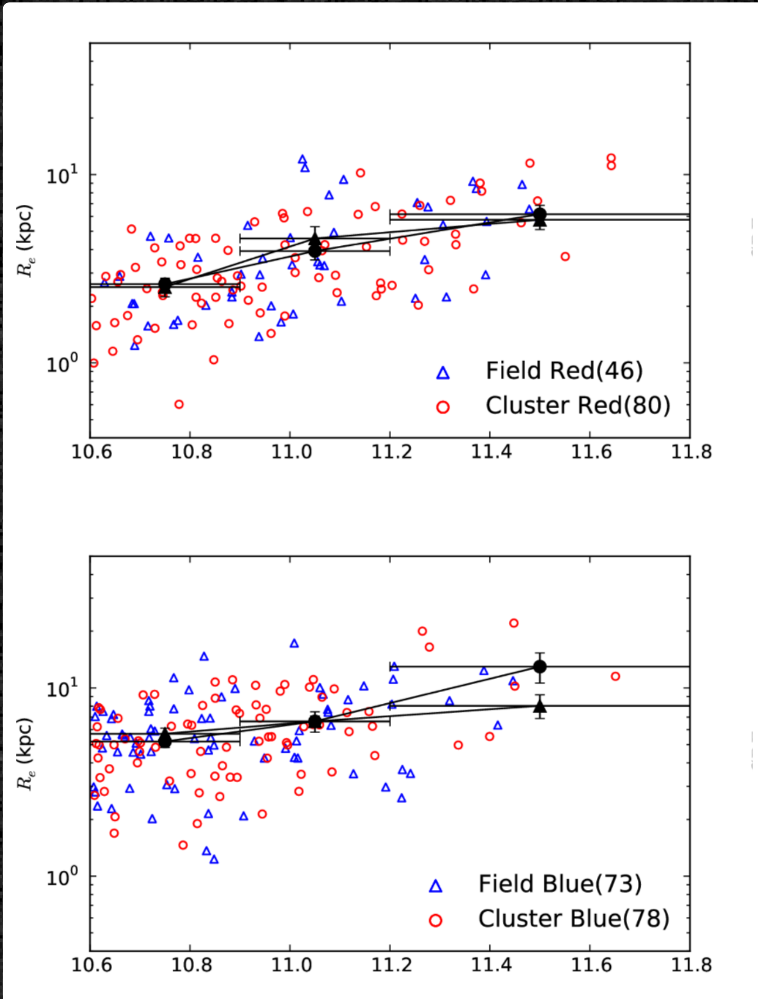


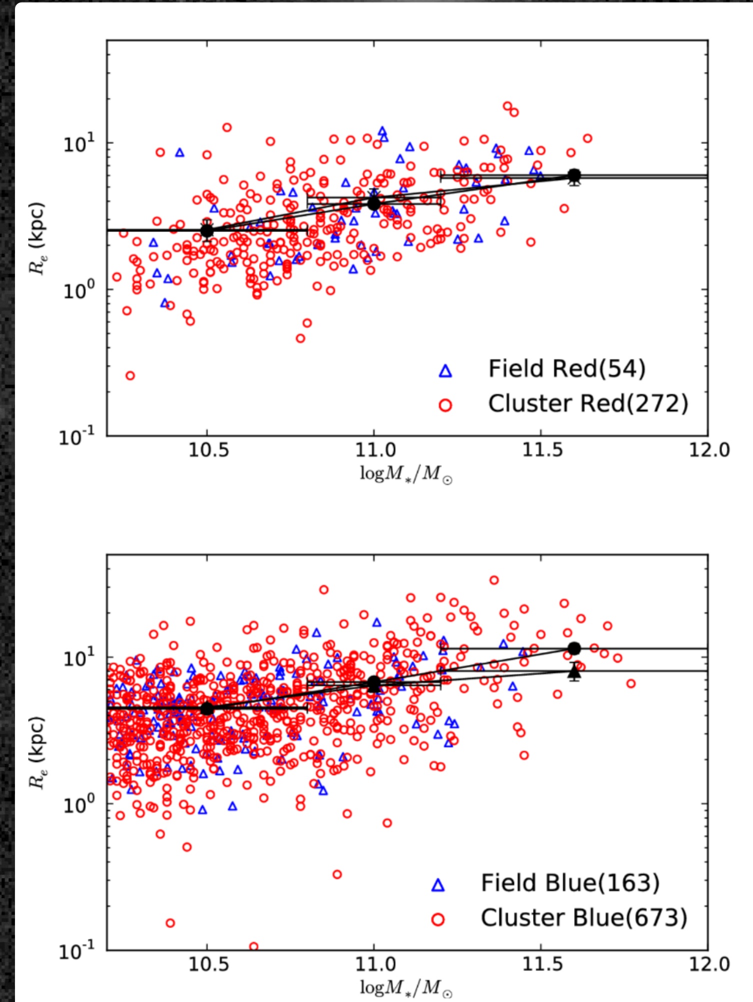
Photo-z sample

M*–size relation at intermediate z



Red

Blue



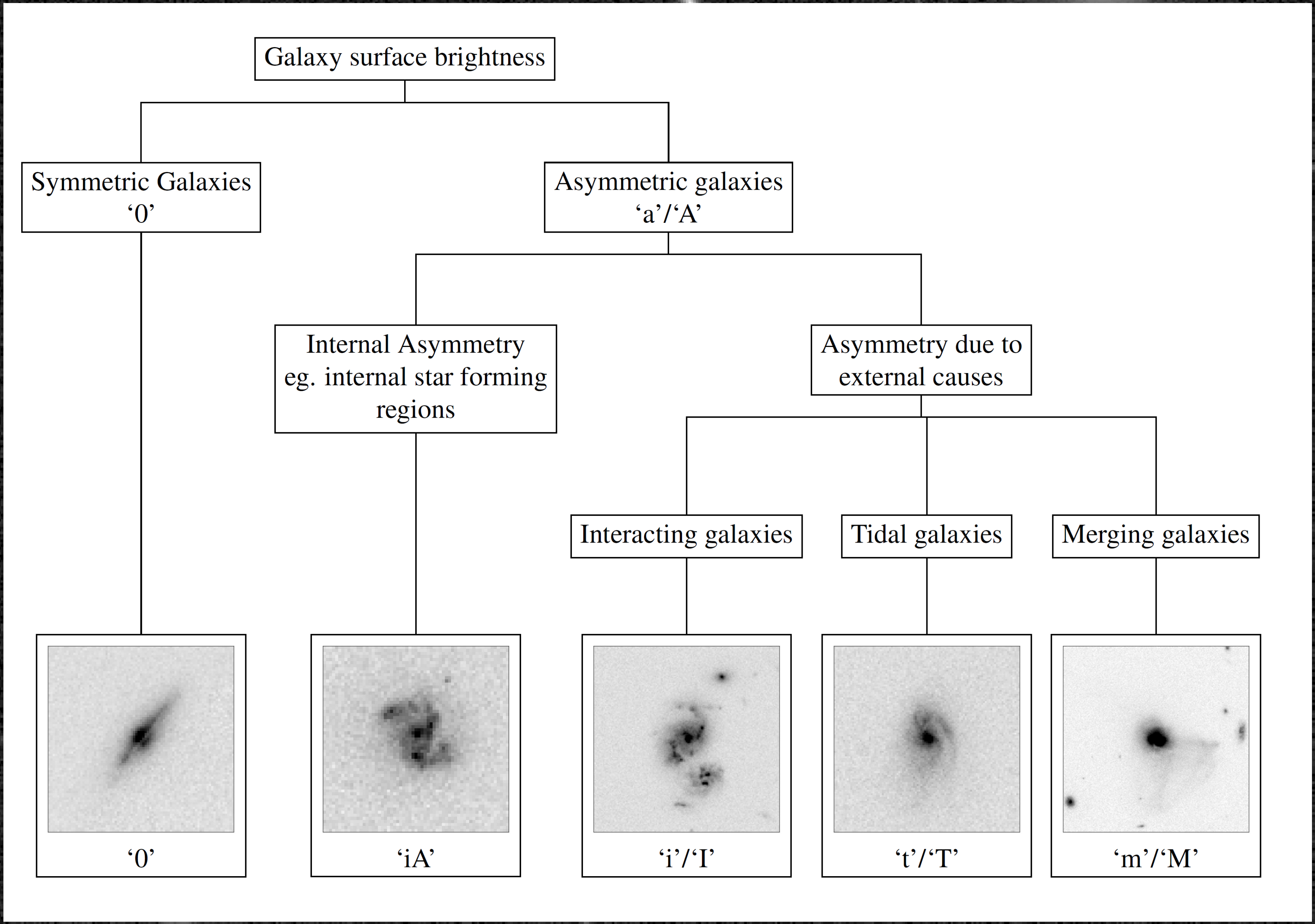
Spectroscopic sample

Photo-z sample

Size changes <10% at fixed mass, colour and morphology

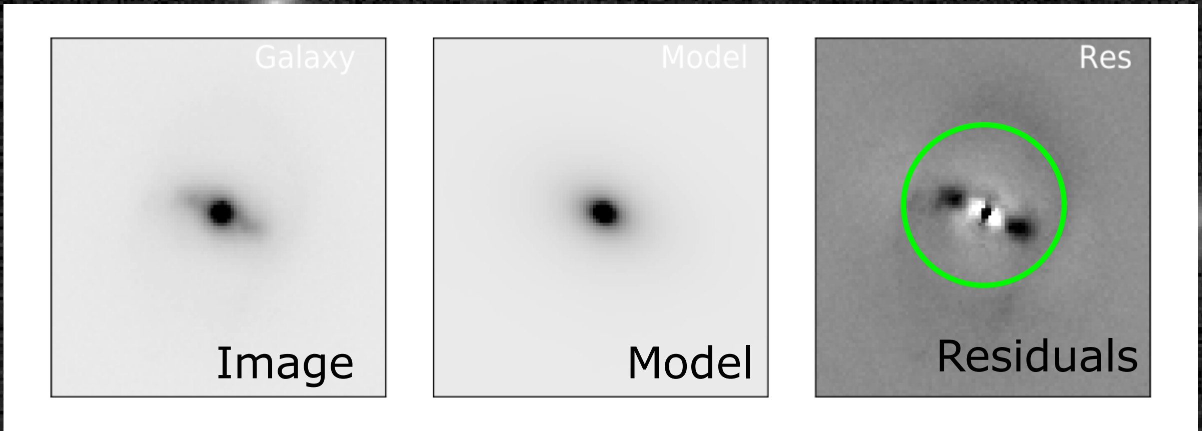
Kelkar et al. 2015

Qualitative galaxy structure

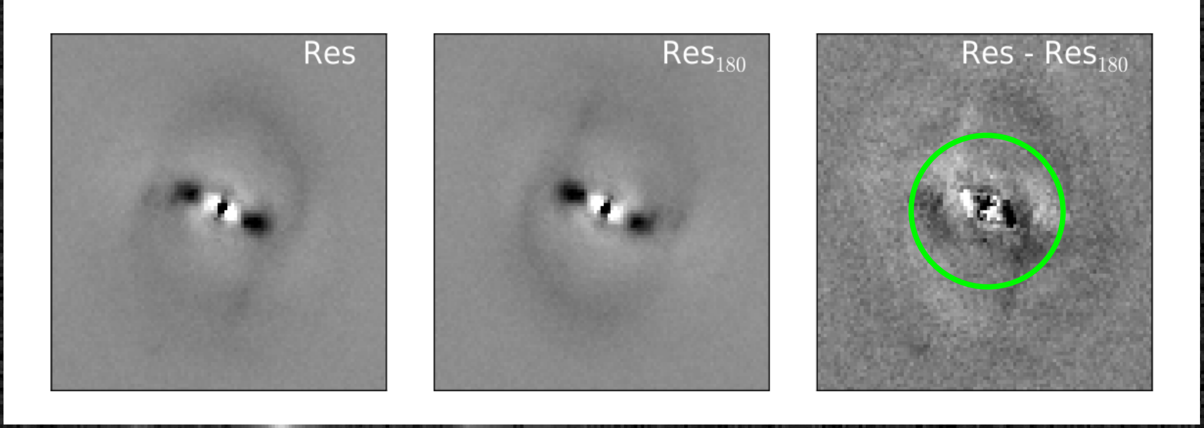


Kelkar et al. 2017

Quantitative galaxy structure



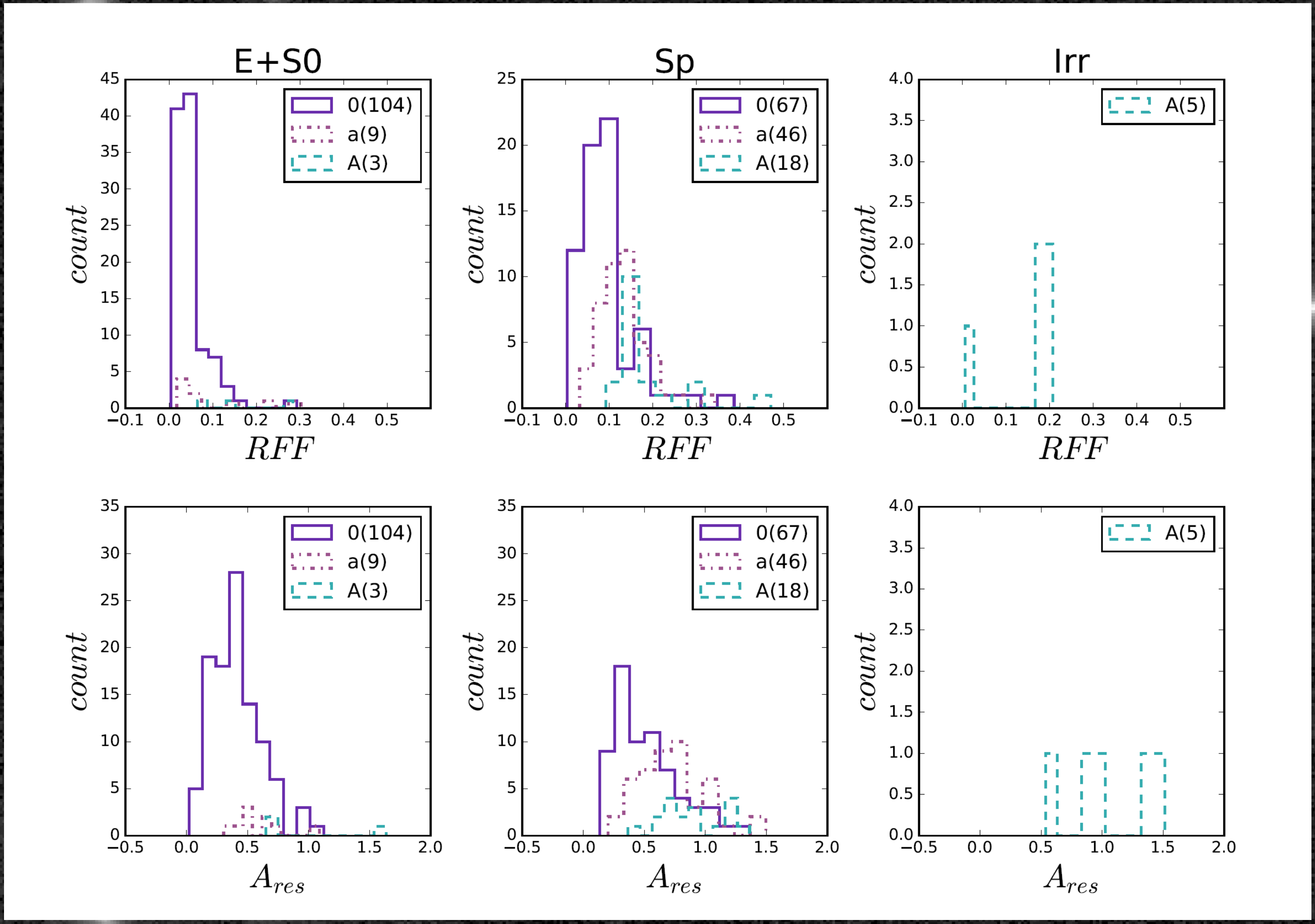
Residual Flux Fraction
RFF



Asymmetry of residuals
A_{res}

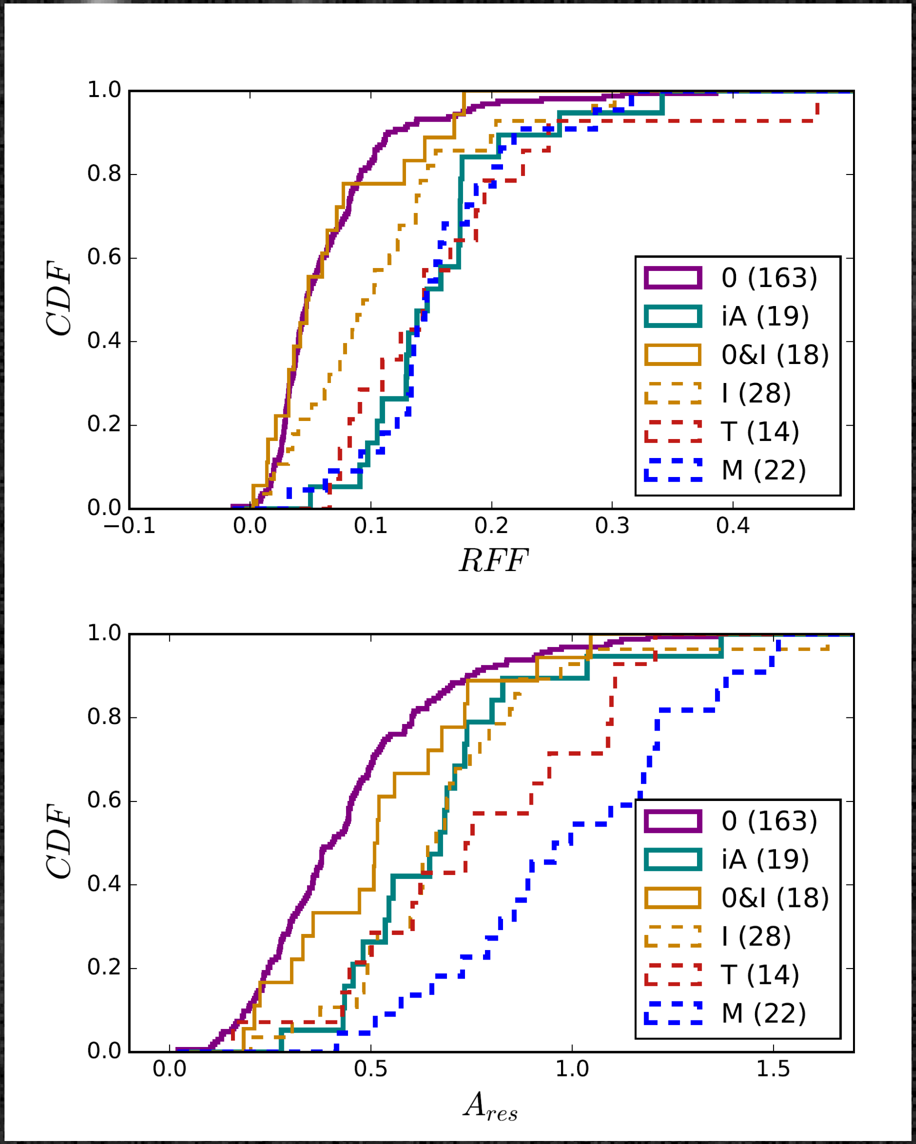
Kelkar et al. 2017

Quantitative vs. quantitative galaxy structure



Kelkar et al. 2017

Quantitative vs. quantitative galaxy structure

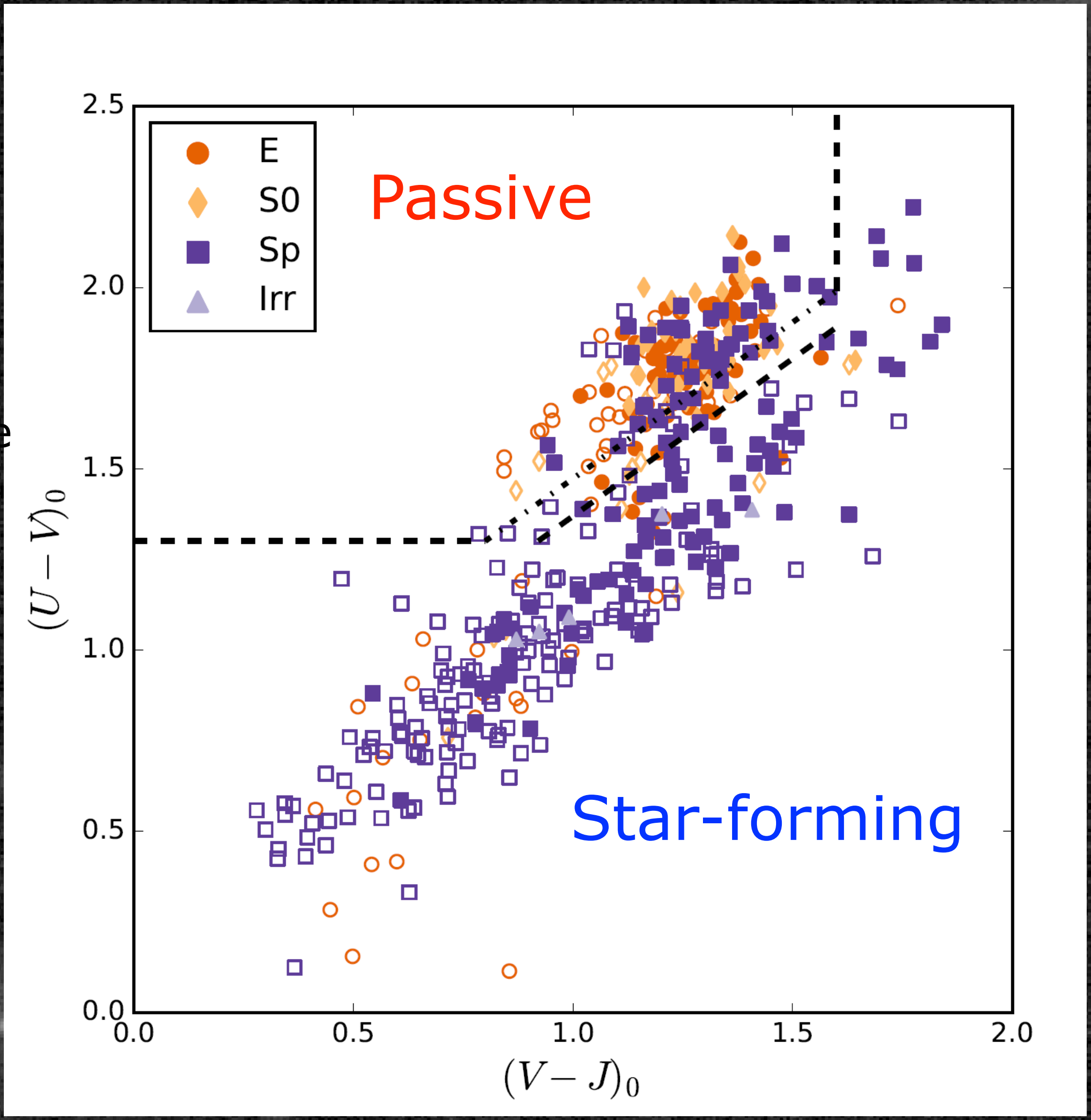


RFF is sensitive to the degree of structural disturbance while A_{res} is more sensitive to its cause.

Kelkar et al. 2017

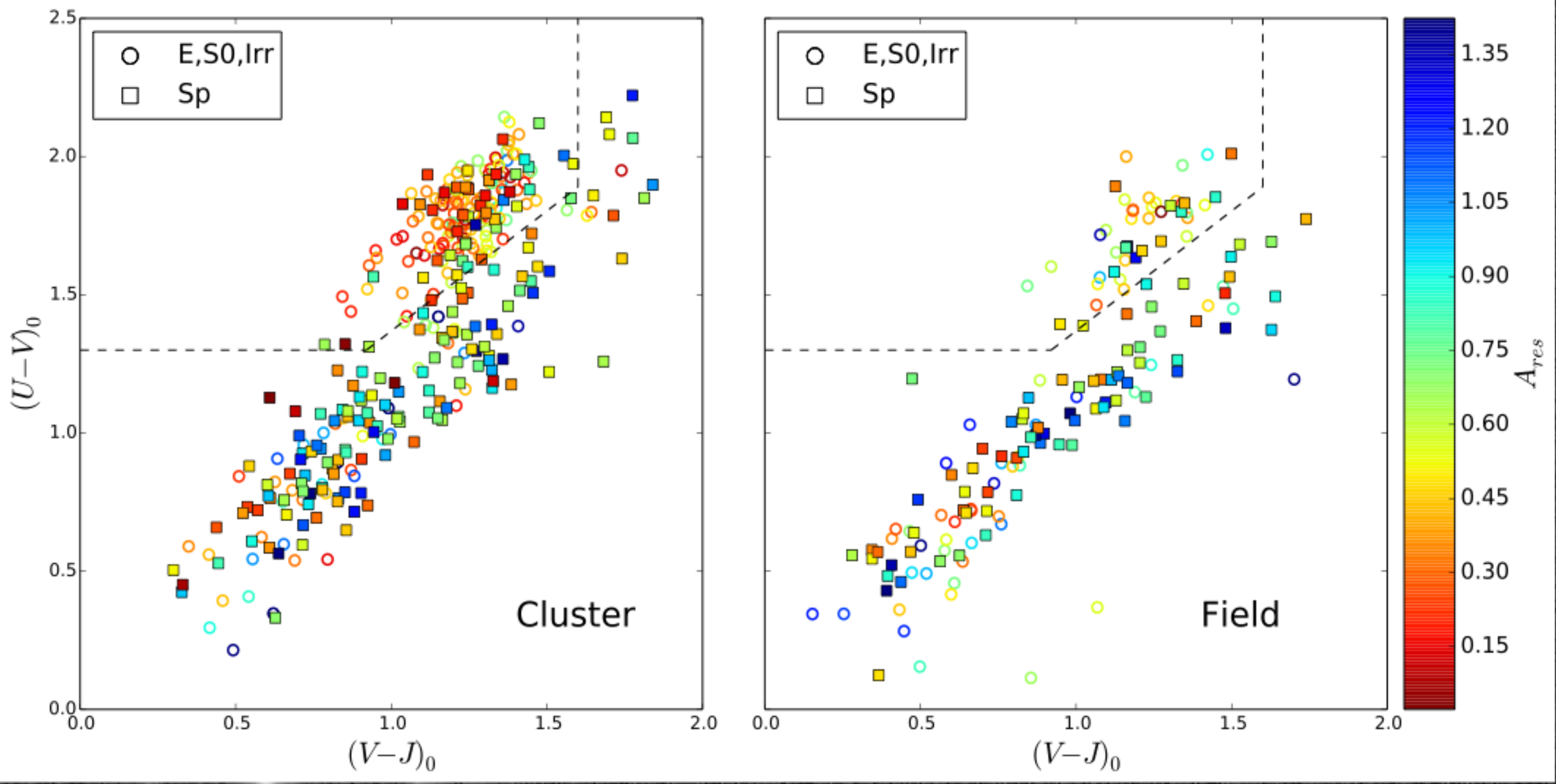
Star formation

Image



Kelkar et al. 2017

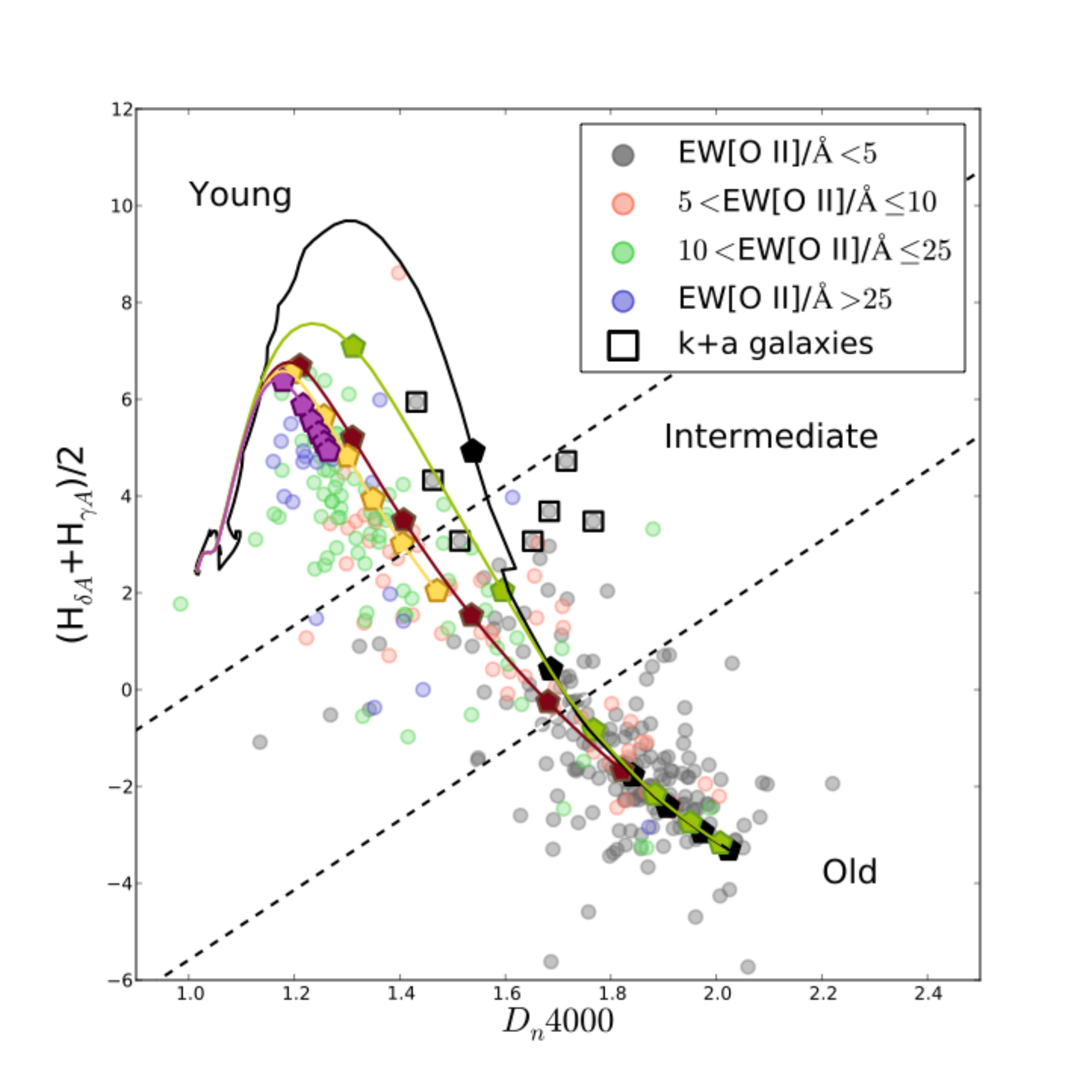
Quantitative structure, star formation, and environment



Kelkar et al. 2017

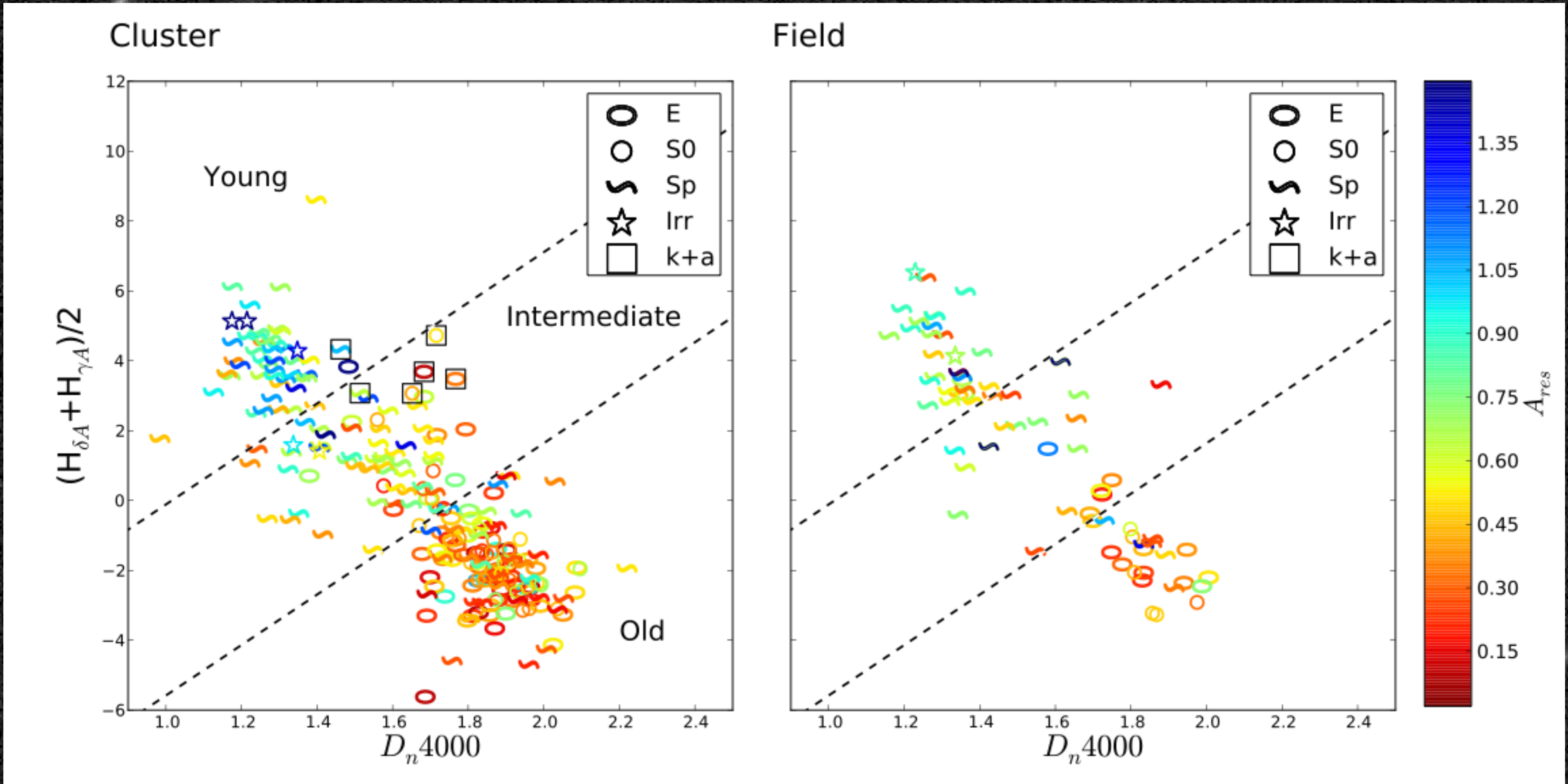
Star-formation history

Image



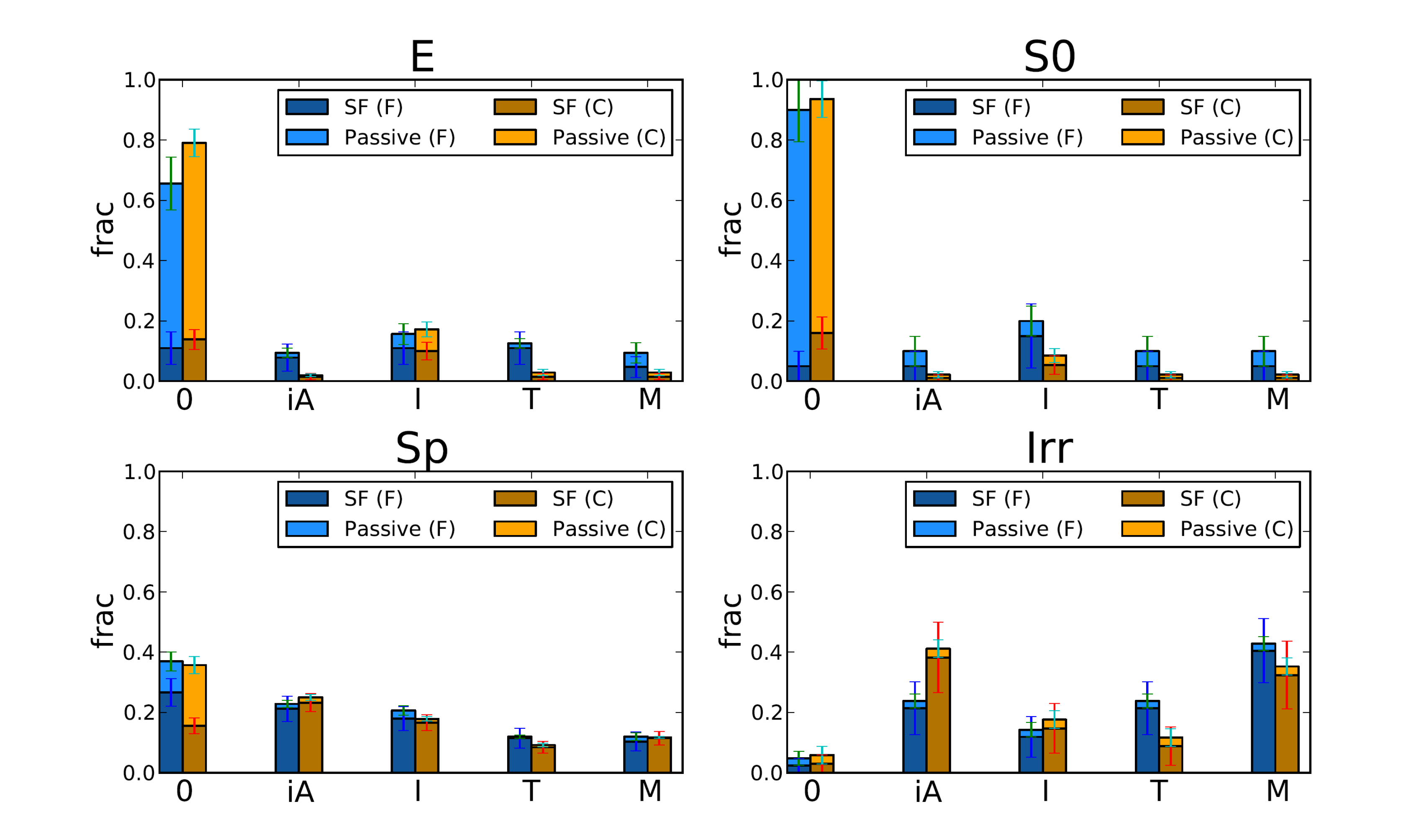
Kelkar et al. 2017

Quantitative structure, star-formation history, and environment



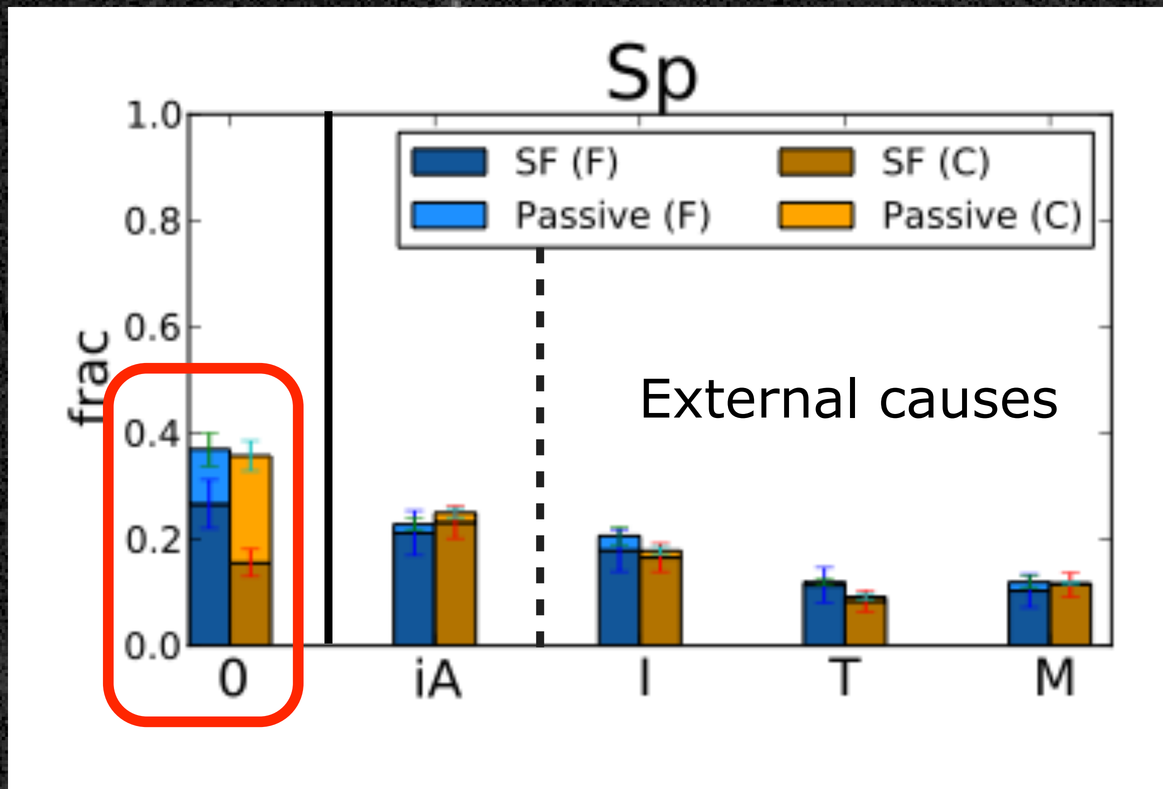
Kelkar et al. 2017

Morphology, structure, star formation, and environment



Kelkar et al. 2017

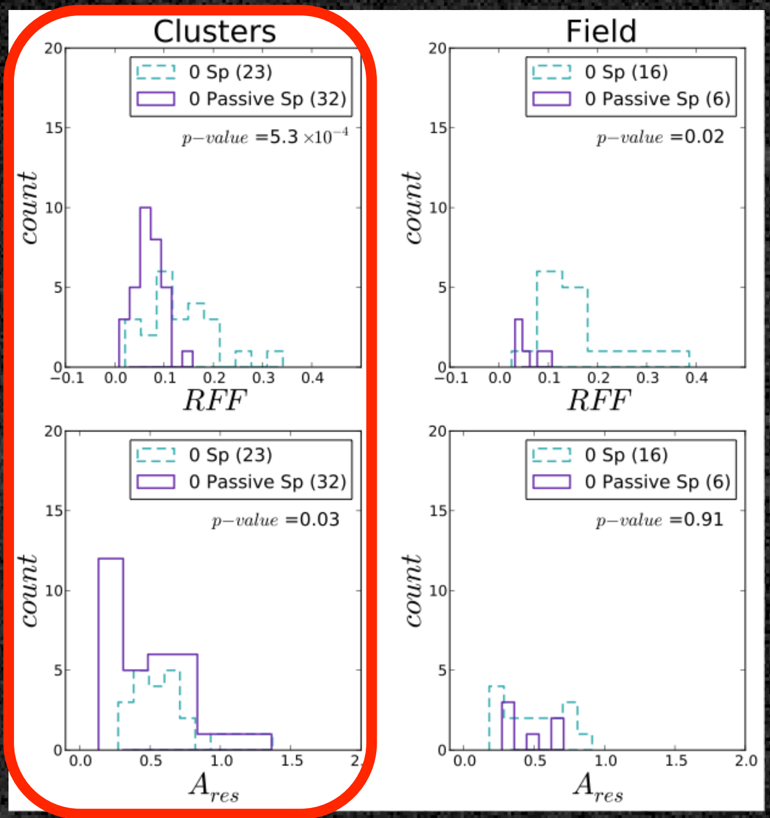
Morphology, structure, star formation, and environment



Smooth passive spirals in clusters

Kelkar et al. 2017

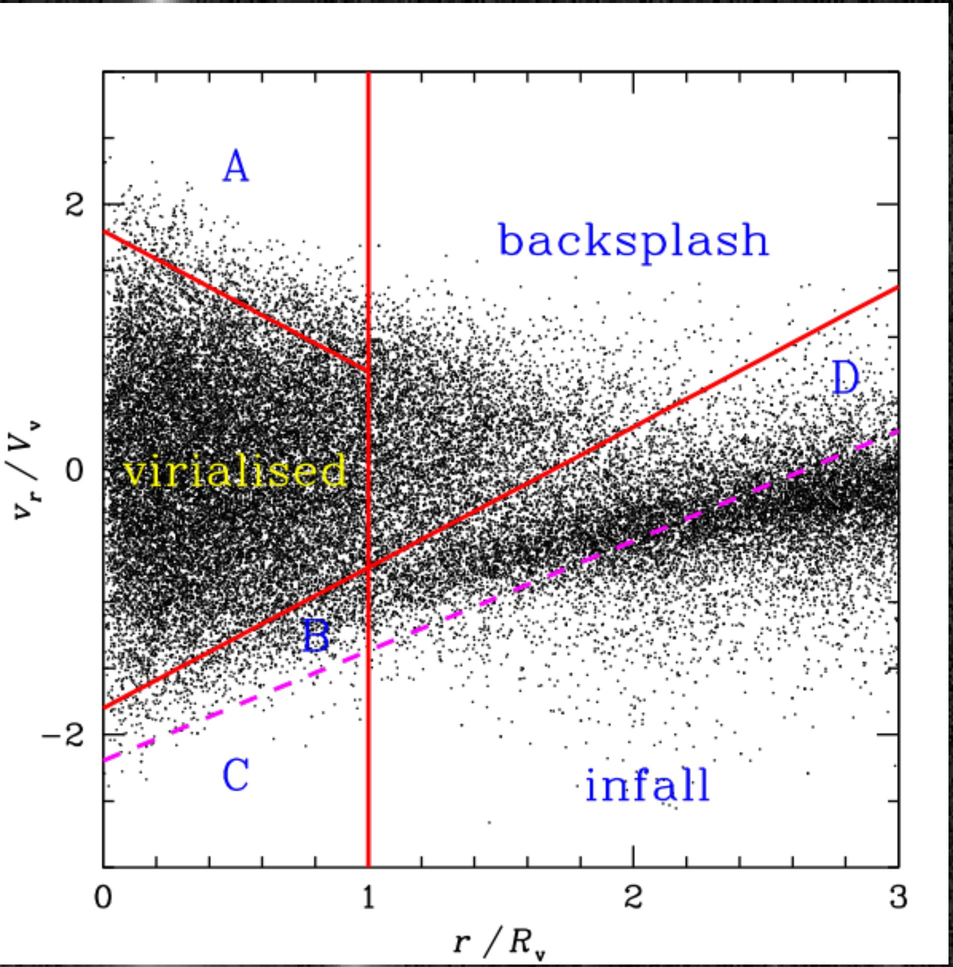
Morphology, structure, star formation, and environment



In addition to being visually symmetric and passive, cluster spirals are quantitatively smoother

Kelkar et al. 2017

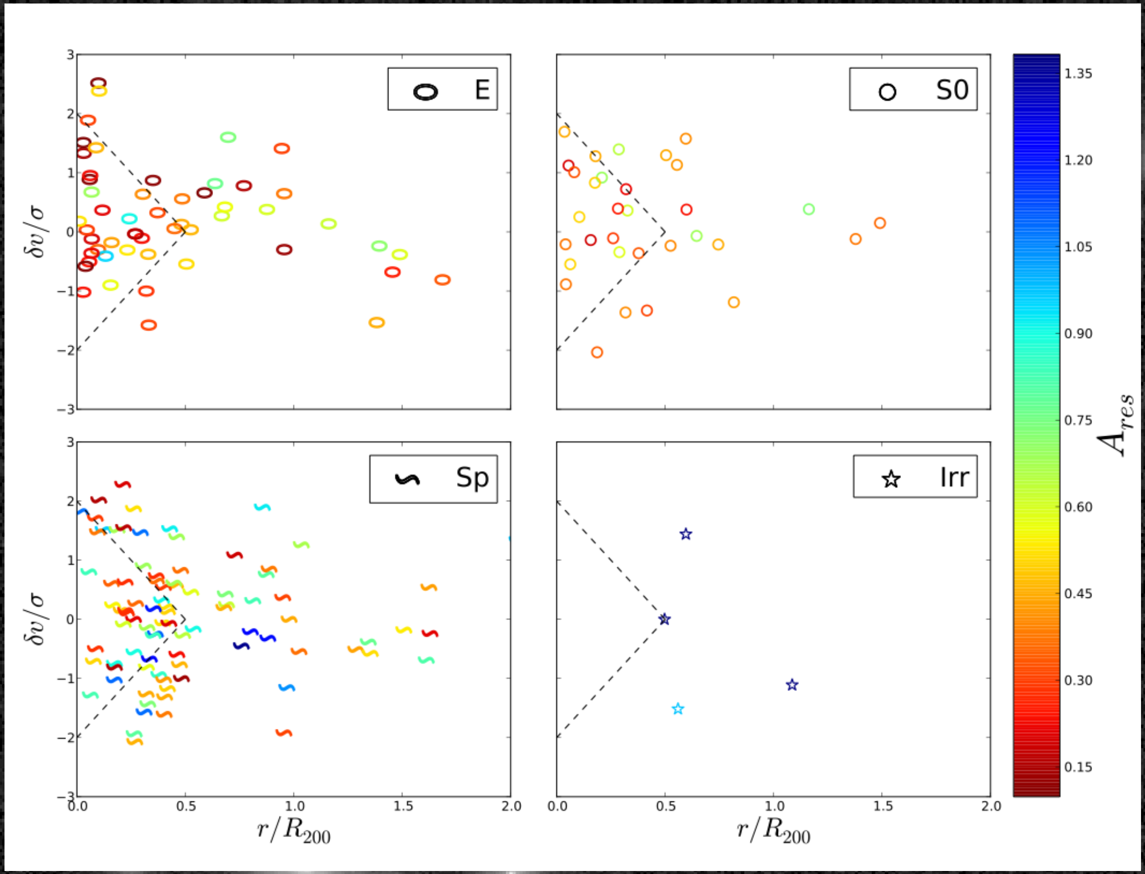
Galaxy structure and star-formation history within clusters



Internal cluster environment using orbital histories of galaxies on the **Projected Phase–Space**

Mahajan et al. 2011

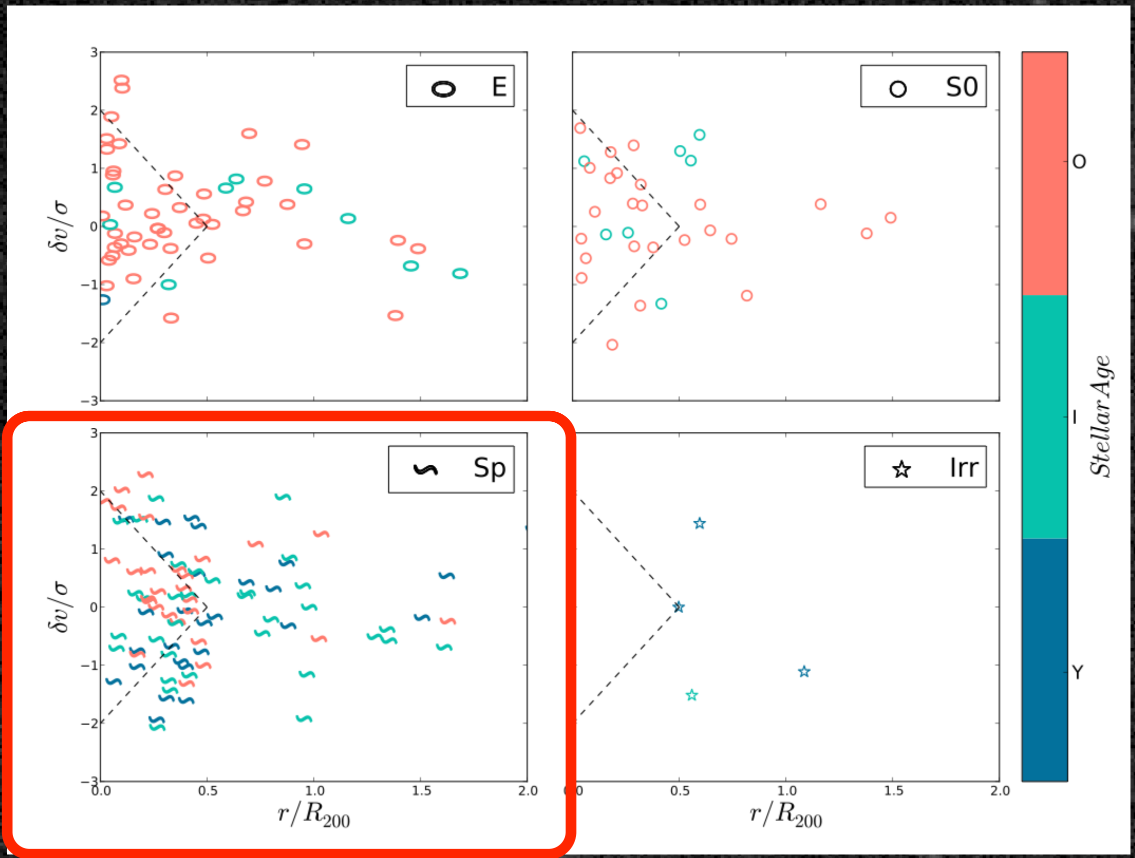
Galaxy structure within clusters at fixed morphology



No trends in *RFF* or *A*res across different cluster regions at fixed morphology

Kelkar et al. 2017b, in prep.

Stellar population ages within clusters at fixed morphology



Higher fraction of old spirals in cluster core

Kelkar et al. 2017b, in prep.

Take-home message:

- Spirals entering clusters become structurally smooth (and red) due to the quenching of their star formation, but retain their spiral morphology for a while (before becoming S0s).
- In clusters, we observe the end result of the build up of the old passive population in the cluster core with smooth and symmetric intrinsic structure.
- The effect of the environment must be reasonably gentle, affecting the star formation of cluster spirals, but leaving their stellar distribution (sizes, disks) largely intact.
- Gas-related (as opposed to gravitationally driven) mechanisms must be at play.