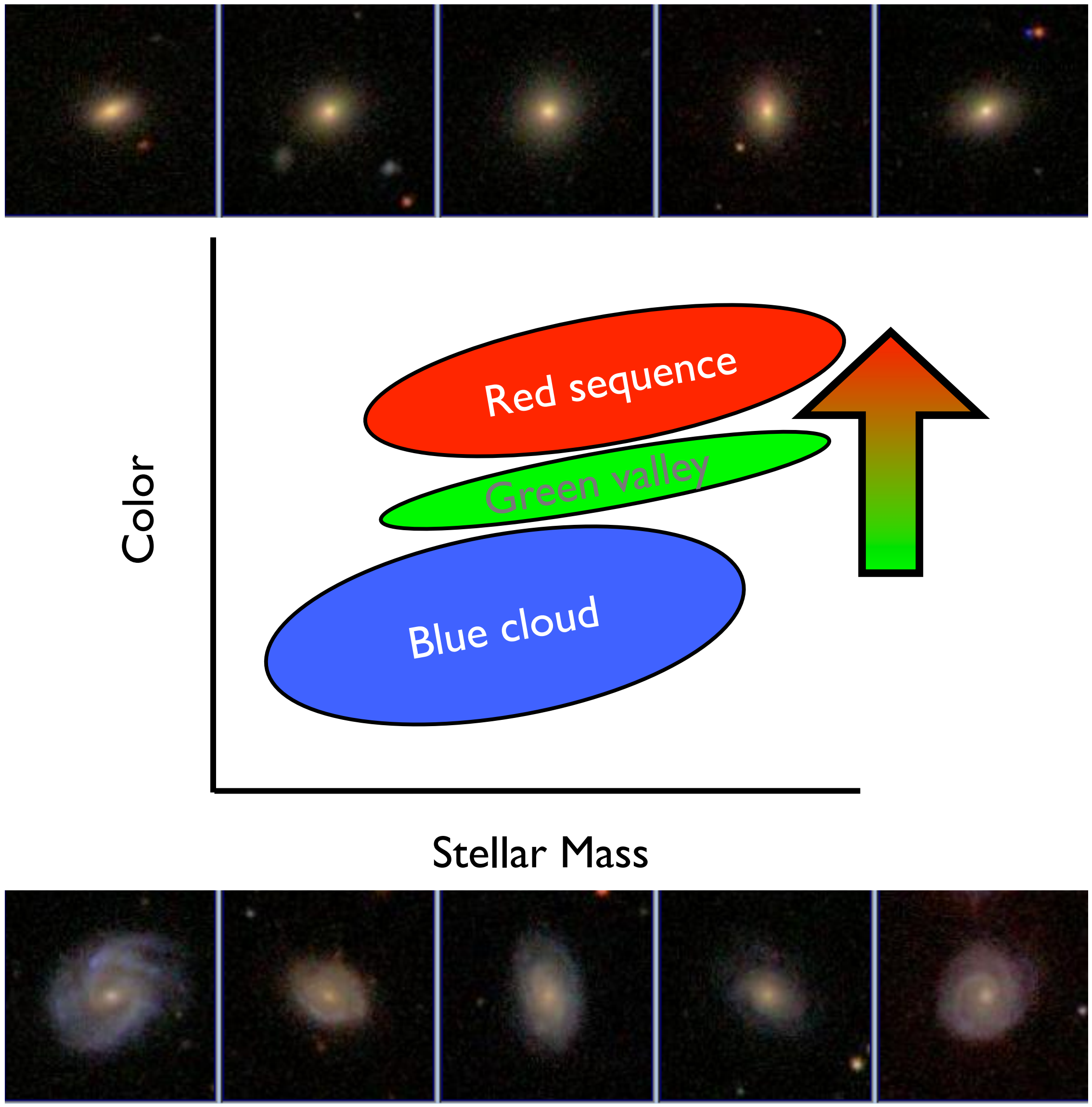
A Link Between Inner Galaxy Structure and Quenching in SDSS Galaxies

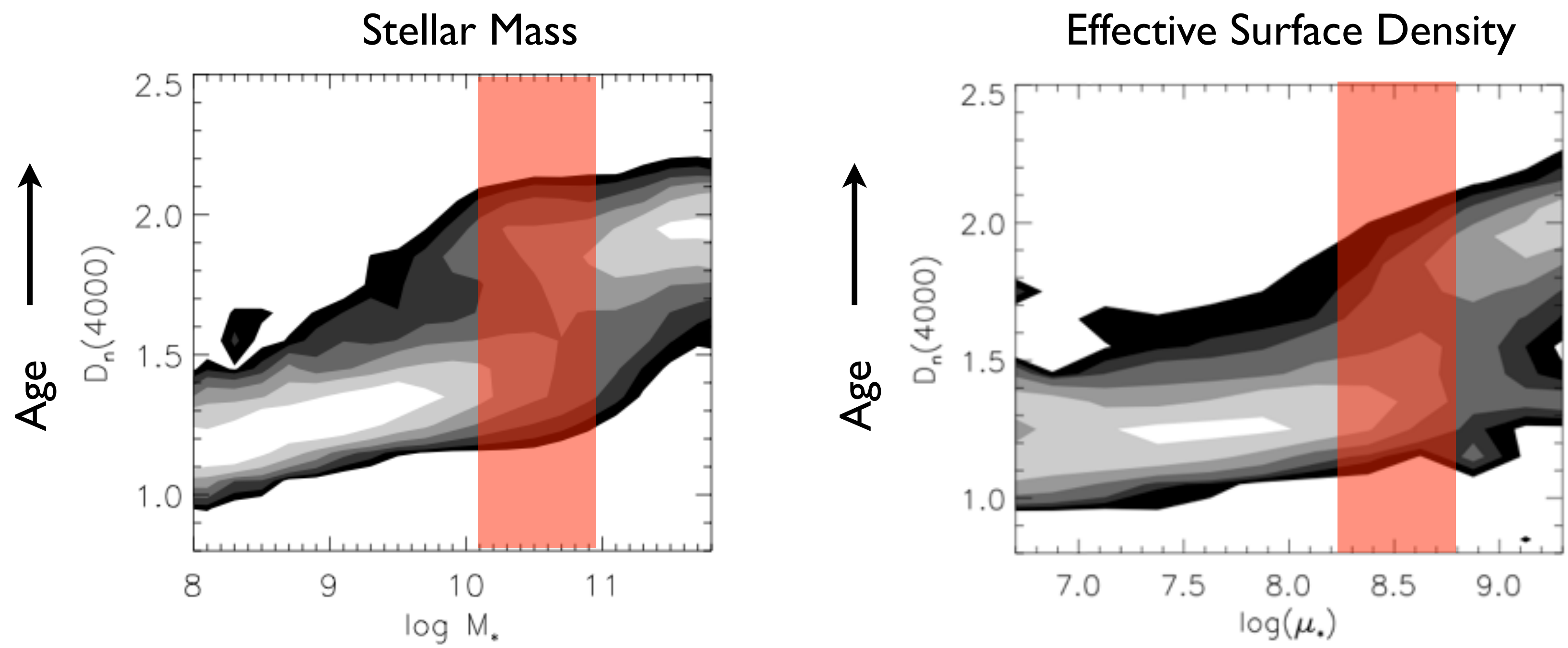
Jerome Fang (UCSC)
Sandy Faber, David Koo,
Avishai Dekel

Santa Cruz Galaxy Workshop
August 12, 2013

Quenching processes imprint themselves on galaxy structure.



Early SDSS work indicated that galaxy age is linked with structure.



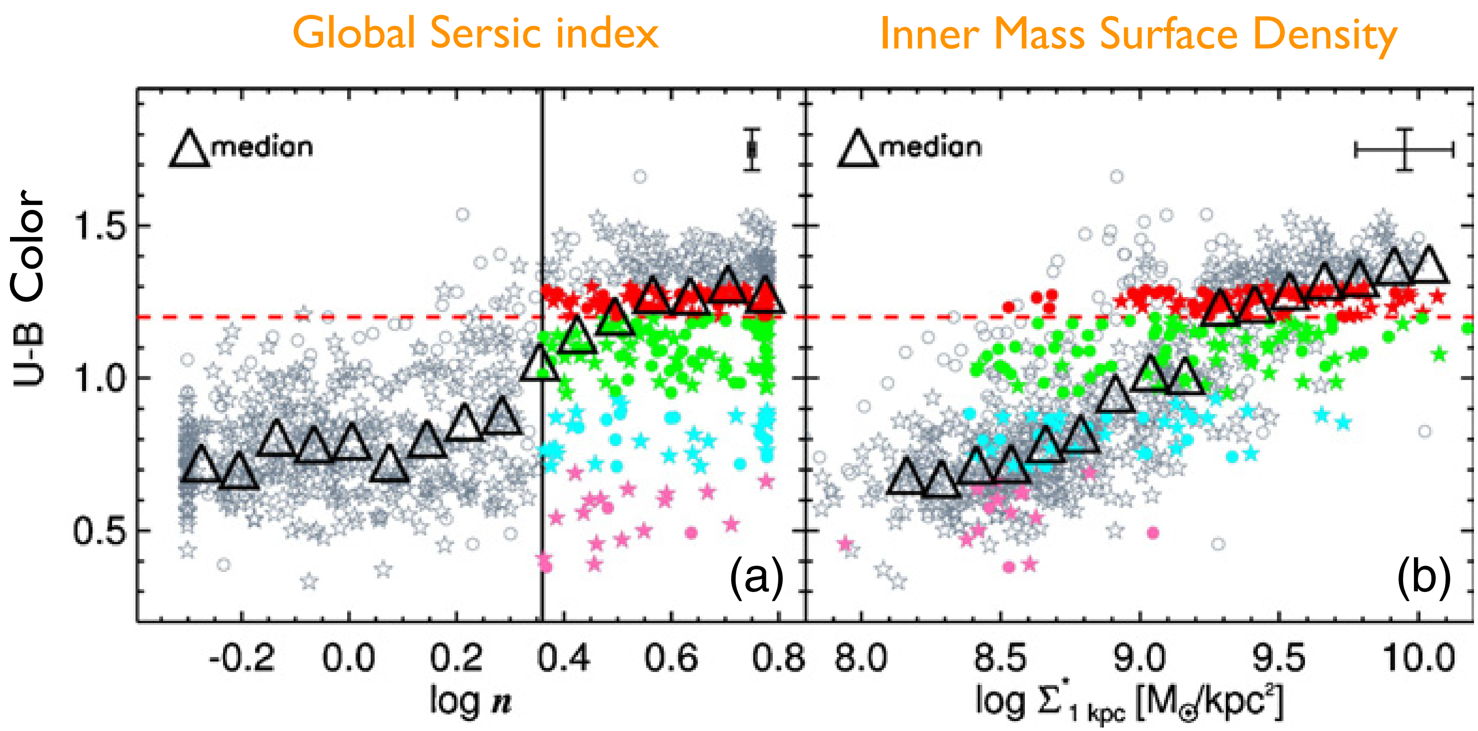
$$\mu_* \propto \frac{M_*}{R_{50}^2}$$

Kauffmann+2003

Galaxies above a (fuzzy) threshold in M_* or μ_* tend to be old.

A tighter relation is found with μ_*.

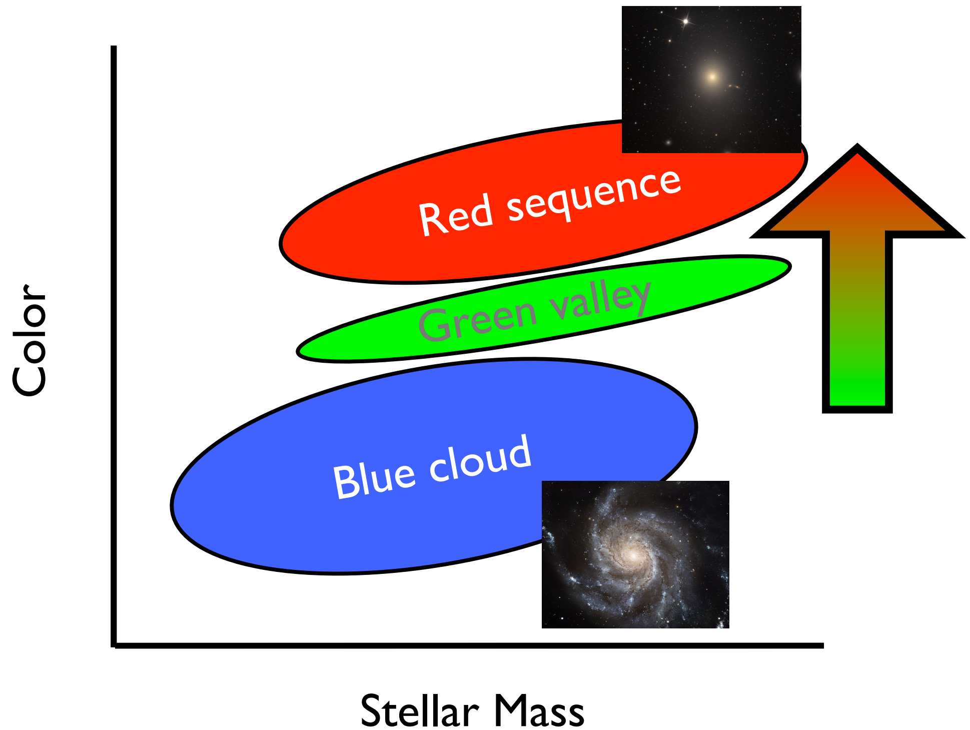
Inner structure appears to be a cleaner predictor of galaxy color.



Cheung+12

Galaxies at z~0.8 (AEGIS survey)

Unresolved issues about quenching and structure persist.



A fundamental parameter?

A fixed threshold value?

Link to physical processes?

Features of our work

Use GALEX UV data to resolve the GV and identify recently quenched galaxies in SDSS.

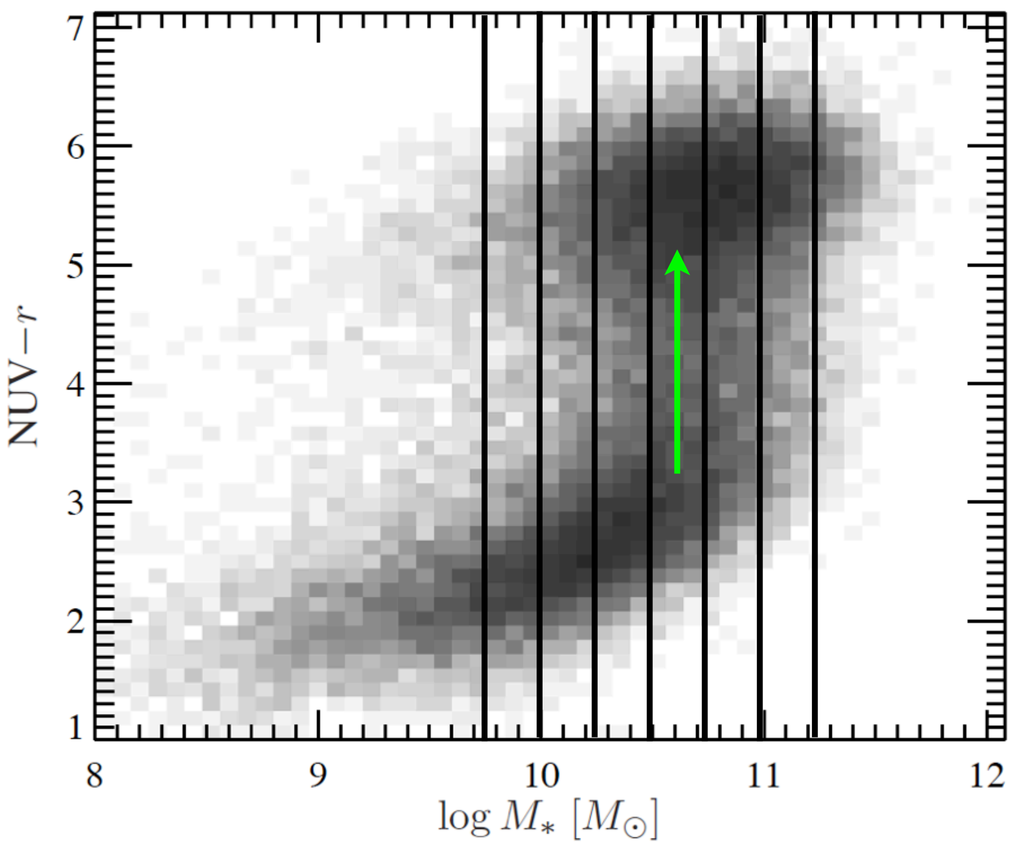
Divide sample into mass bins to remove any global trends and to identify plausible evolutionary tracks.

Use mass density within a radius of 1 kpc, Σ_1, which probes conditions closer to central regions.

Present average mass profiles for a large sample of galaxies divided by mass and color.

Sample galaxies are divided into stellar mass bins.

SDSS galaxies



Sample definition

$$9.75 < \log M_*/M_\odot < 11.25$$

Bins are 0.25 dex wide.

Only face-on, central galaxies with z < 0.075 are included.

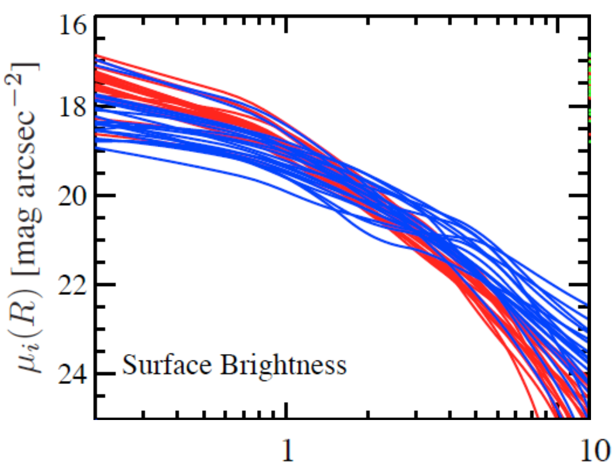
Assume each slice is an evolutionary path.

Mass profiles are computed from aperture photometry.

Surface brightness profile

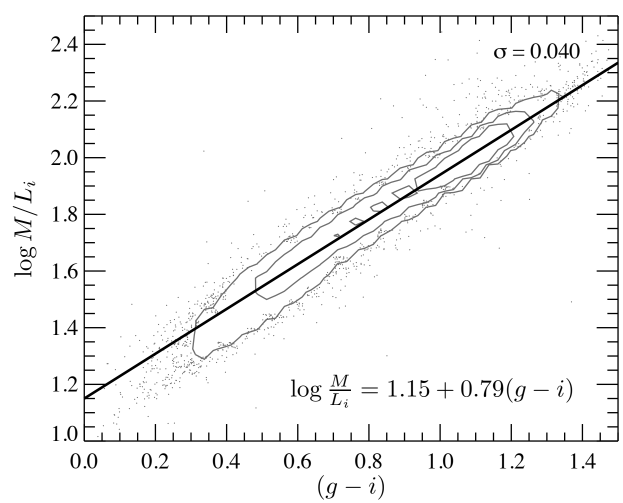
Mass density profile

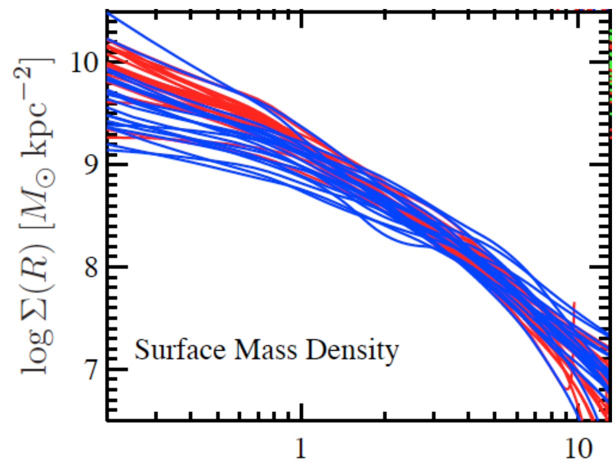
M/*L* conversion



Radius (kpc)

(interpolated catalog aperture photometry)

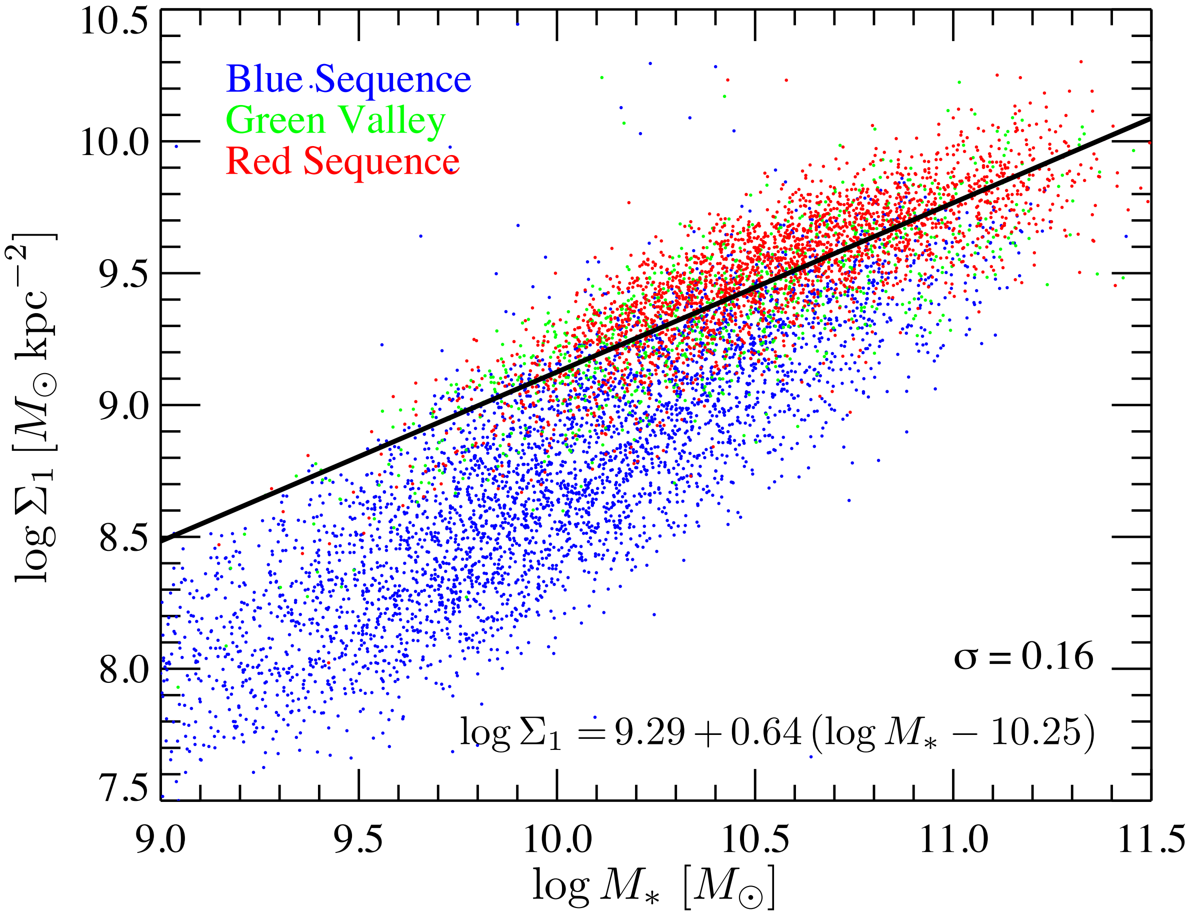




Radius (kpc)

Fang+13, submitted

Σ_1 in quenched galaxies is well-correlated with stellar mass.



Σ_1 = mass density within 1-kpc radius

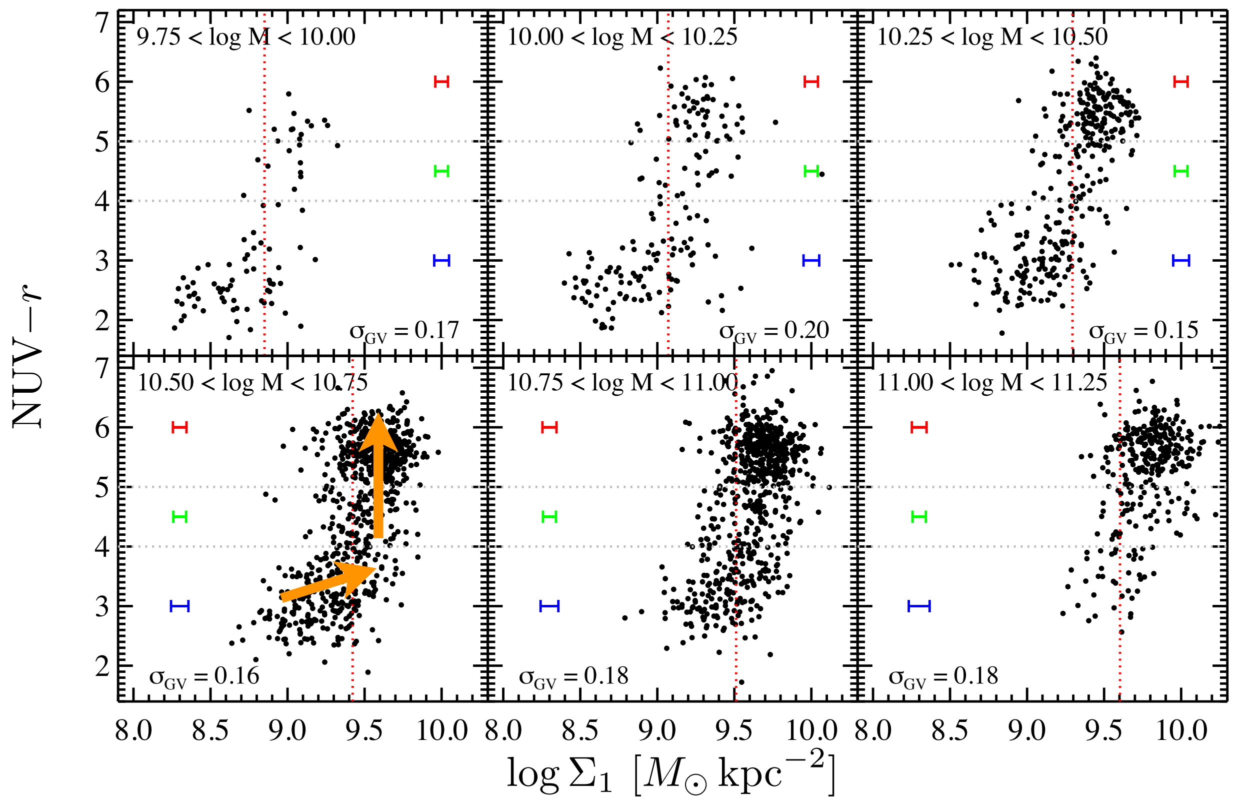
(computed from mass profiles)

Correlation suggests a mass-dependent ($\sim M^{0.64}$) quenching threshold in Σ_1.

Challenges the notion of a fixed threshold.

Fang+13, submitted

A plausible evolutionary track is seen in Σ_1 vs. NUV-*r* color.



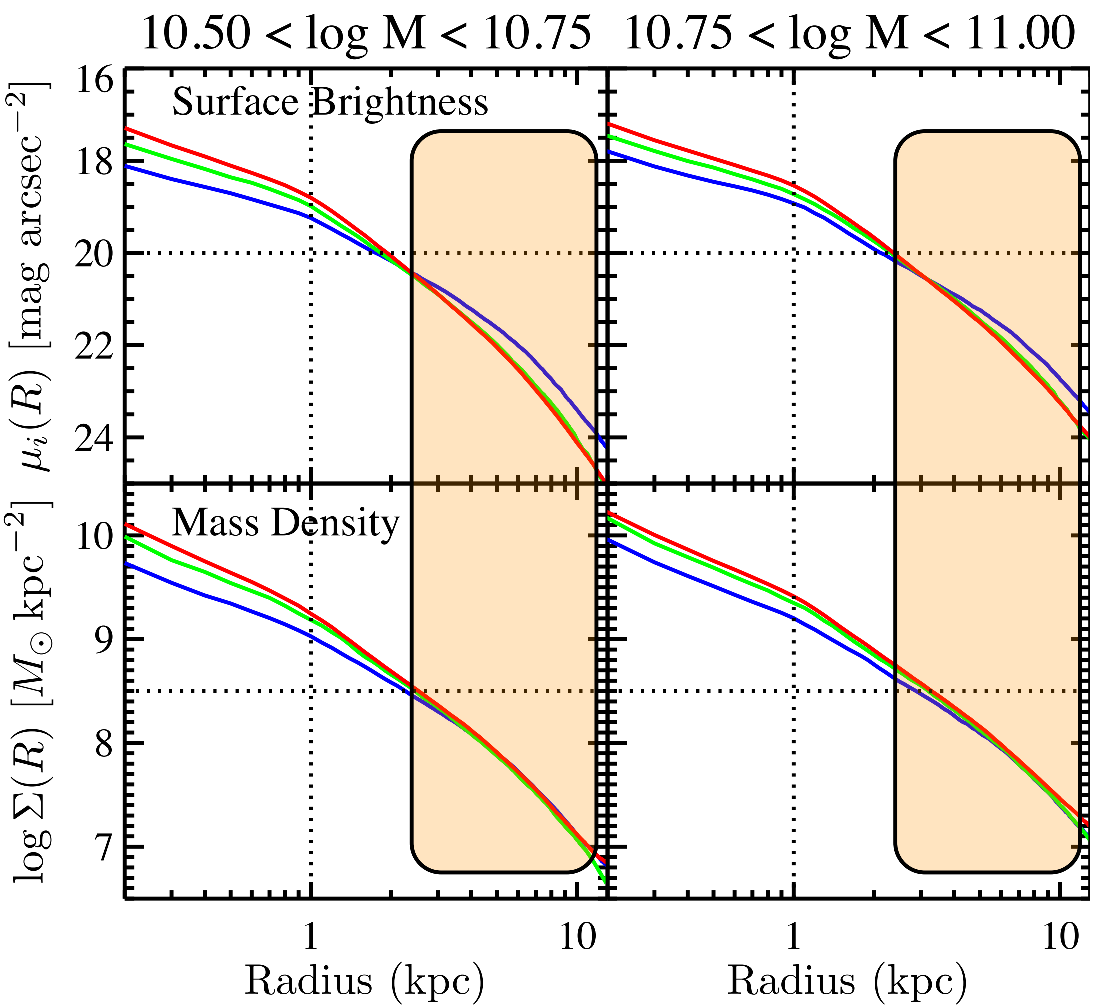
At fixed stellar mass...

Σ_1 increases while a galaxy is blue.

A galaxy can quench above the threshold Σ_1.

Fang+13, submitted

Inner mass density grows as galaxies quench.



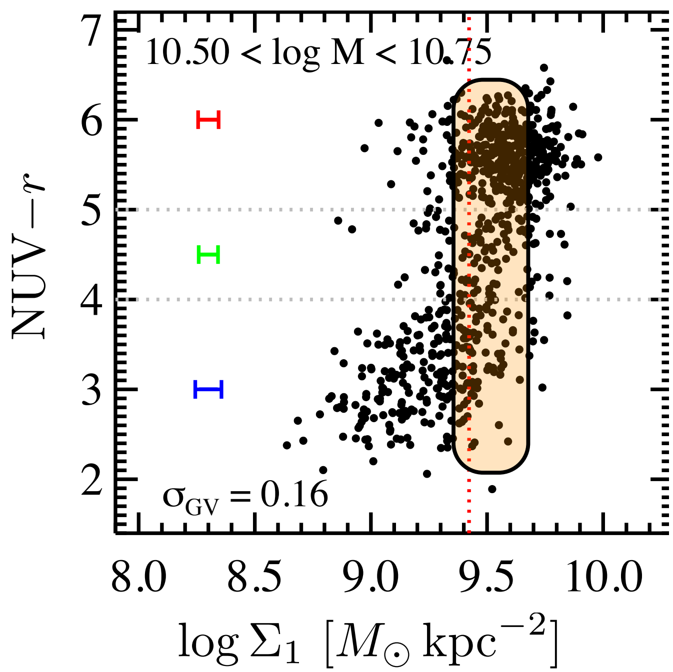
Blue galaxies have brighter outer disks than red galaxies...

...but similar outer mass densities.

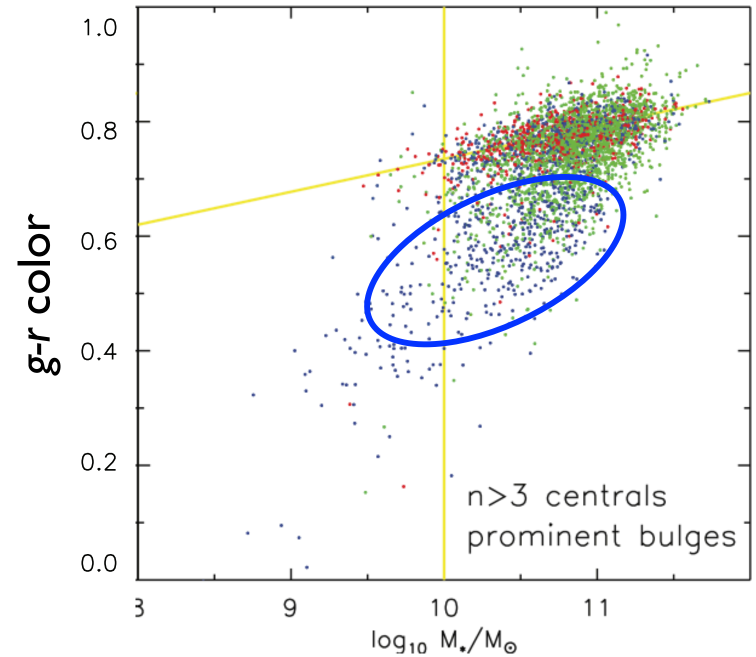
It is inner mass density that builds up as galaxies quench.

Fang+13, submitted

A high-Σ_1 bulge is necessary, but not sufficient, for quenching.



Bell 2008

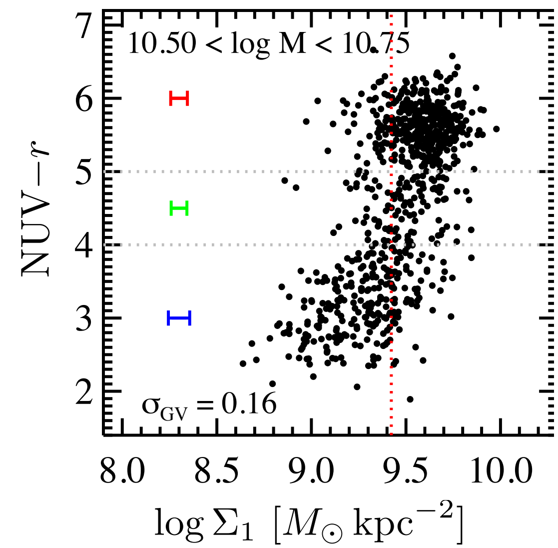


Stellar Mass

Vertical scatter in distribution implies a second process needed to ensure quenching.

A similar effect is seen when looking at high-Sersic galaxies.

Quenching may be a two-step process driven by both the bulge and halo.



1. Removal (or stabilization) of gas in galaxy

Merger-triggered starburst
AGN feedback
Morphological quenching

All are linked with the growth of the galaxy bulge, traced by, e.g., Σ_1.

(e.g., Mihos+1994, Hopkins+2006, Martig+2009)

2. Suppression of further gas accretion

Virial shock heating

Process is dependent on the DM halo, traced by, e.g., M_h.

(e.g., Birnboim+2003, Dekel+2006, Woo+13)

Conclusions

Σ_1 is well-correlated with stellar mass for quenched galaxies, challenging the notion of a fixed, mass-independent threshold.

At fixed M_*, Σ_1 seems to increase in the blue cloud until it reaches the threshold value, above which galaxies can quench.

But the outer surface density remains ~constant as galaxies evolve from blue to red--the difference is in the bulge.

Quenching may be a two-step process that requires (1) gas removal (bulge-driven) and (2) suppression of further gas infall (halo-driven).