A Link Between Inner Mass Density and Quenching in SDSS Galaxies

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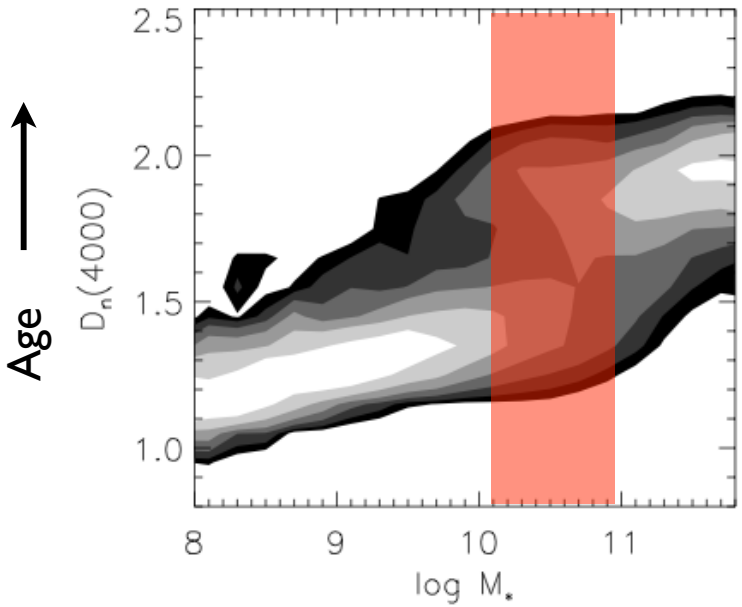
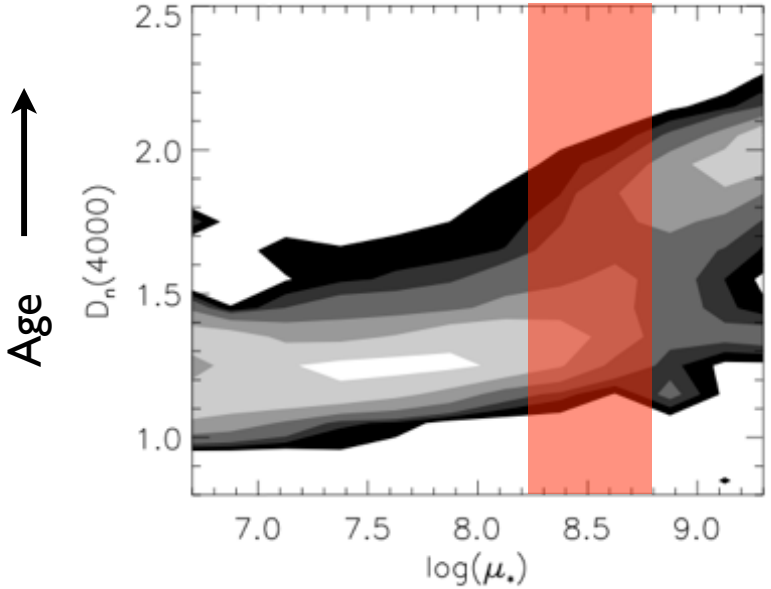
Early SDSS work indicated that galaxy age is linked with structure.

Stellar Mass



Effective Surface Density



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

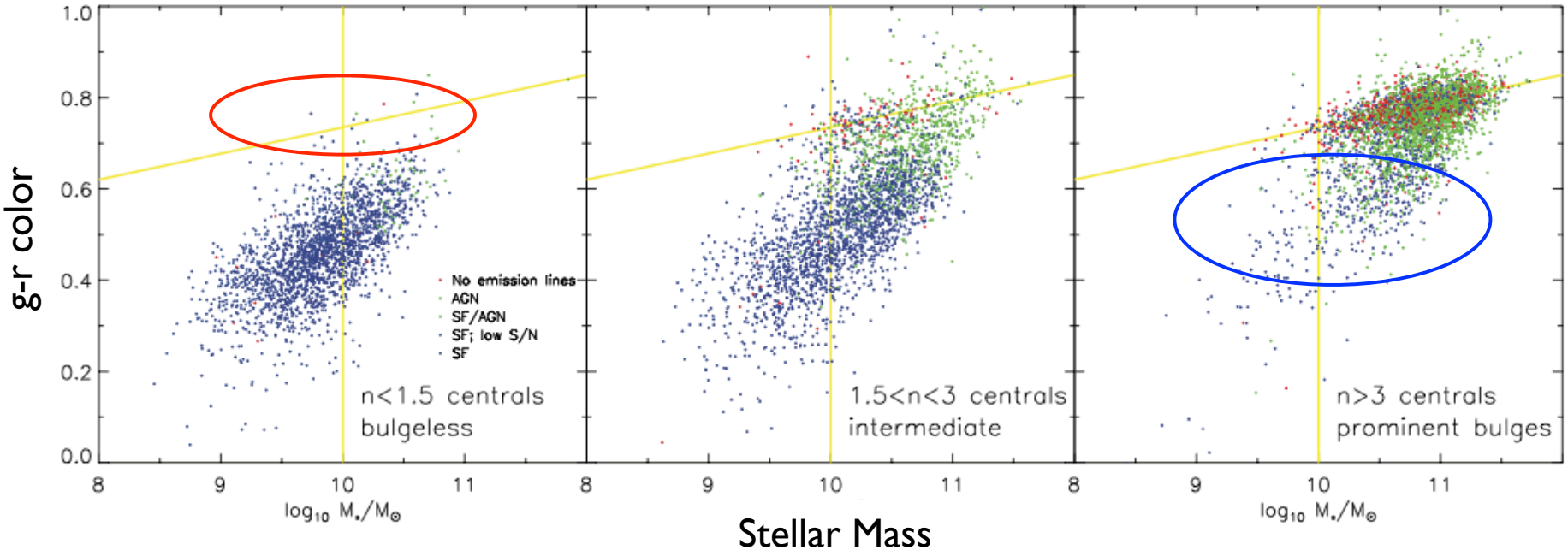
Kauffmann+2003

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

A tighter relation is found with μ_*.

A strong bulge is necessary* for a galaxy to be quenched.

SDSS; Bell 2008

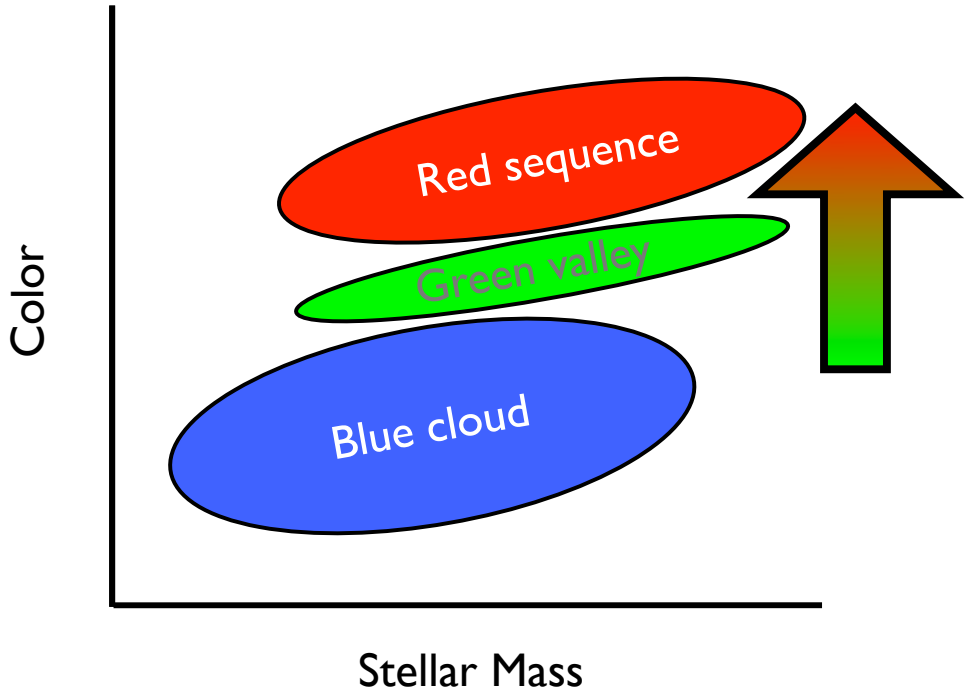


Virtually no bulgeless galaxies are quenched.

* = Necessary, but not sufficient!

Only galaxies above the n ~ 1.5 threshold are quenched.

The details linking quenching to structure are still unclear.



A fundamental parameter?

A fixed threshold value?

Link to physical processes?

Features of our work

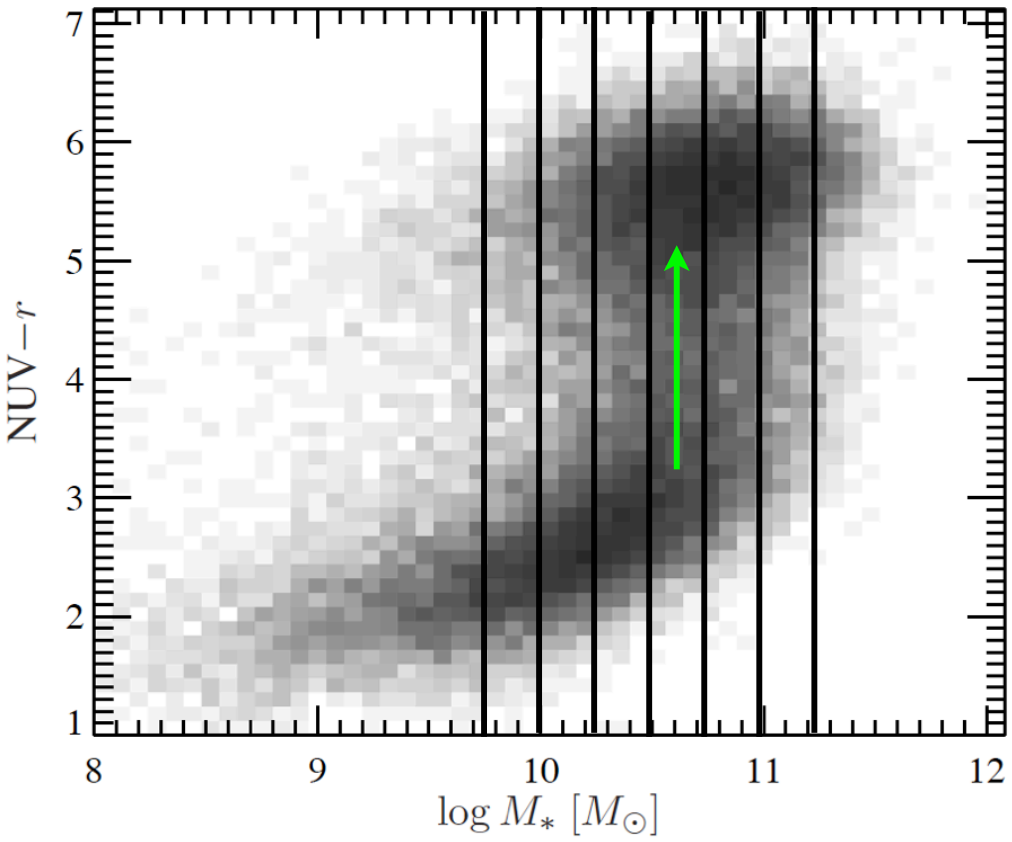
Use GALEX UV data to resolve the GV and highlight recently quenched galaxies.

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

Use mass density within 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.

Galaxies are divided into six stellar mass bins.



Sample definition

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

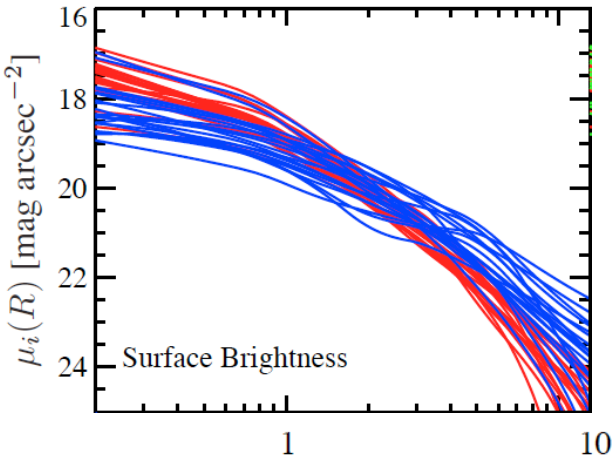
Bins are 0.25 dex wide

Assume each slice is an evolutionary path.

Mass remains ~constant as galaxy evolves from red to blue.

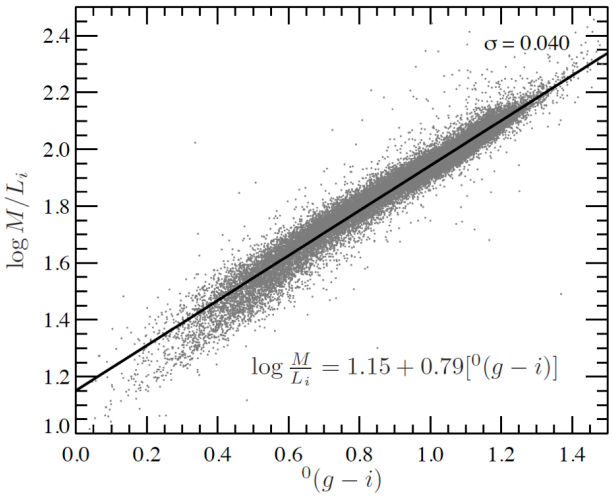
Mass profiles are computed from aperture photometry.

Surface brightness profile

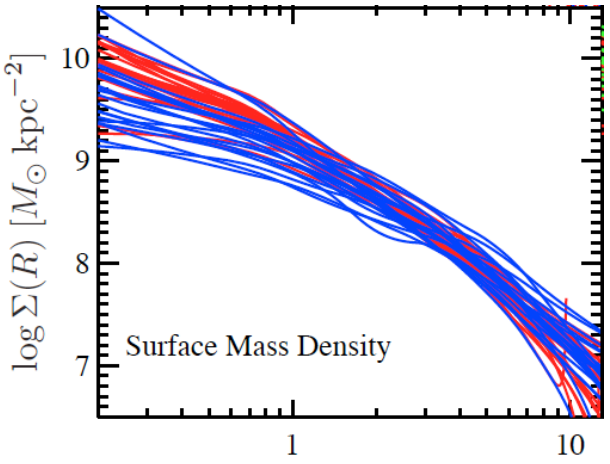


(interpolated catalog aperture photometry)

M/L conversion

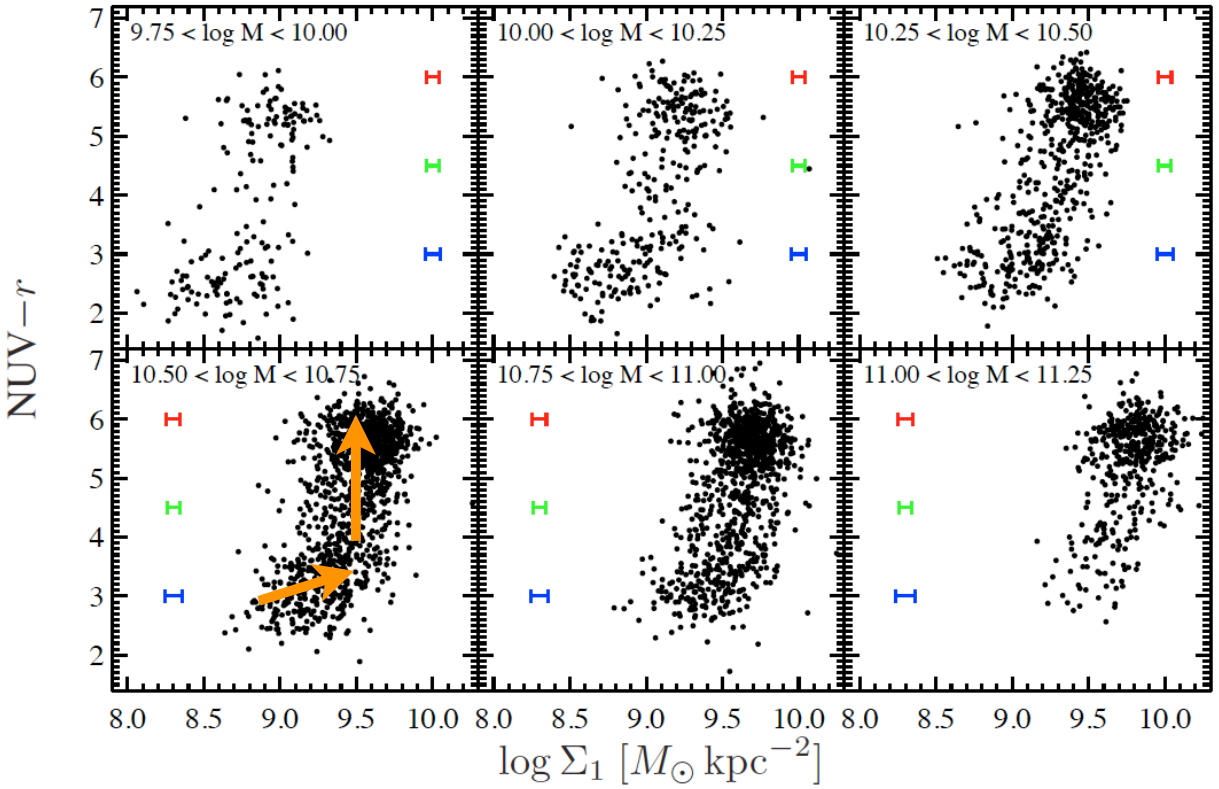


Mass density profile



Fang+12, in prep

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



Σ_1 = mass density within 1-kpc radius

(computed from mass profiles)

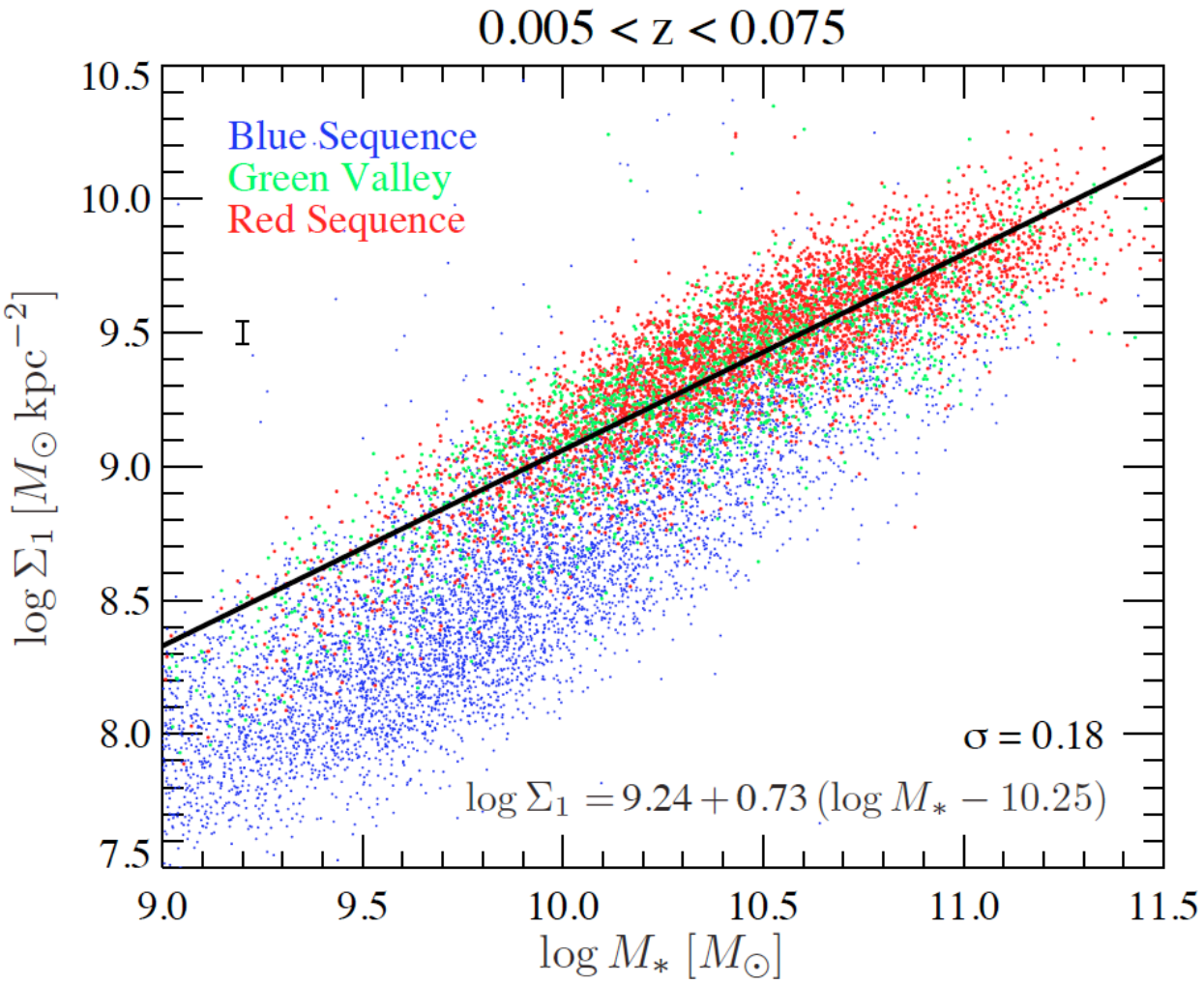
Σ_1 increases while a galaxy is blue.

A galaxy can quench above a threshold Σ_1.

Threshold Σ_1 increases with stellar mass.

Fang+12, in prep

Σ_1 in green and red galaxies is well-correlated with mass.

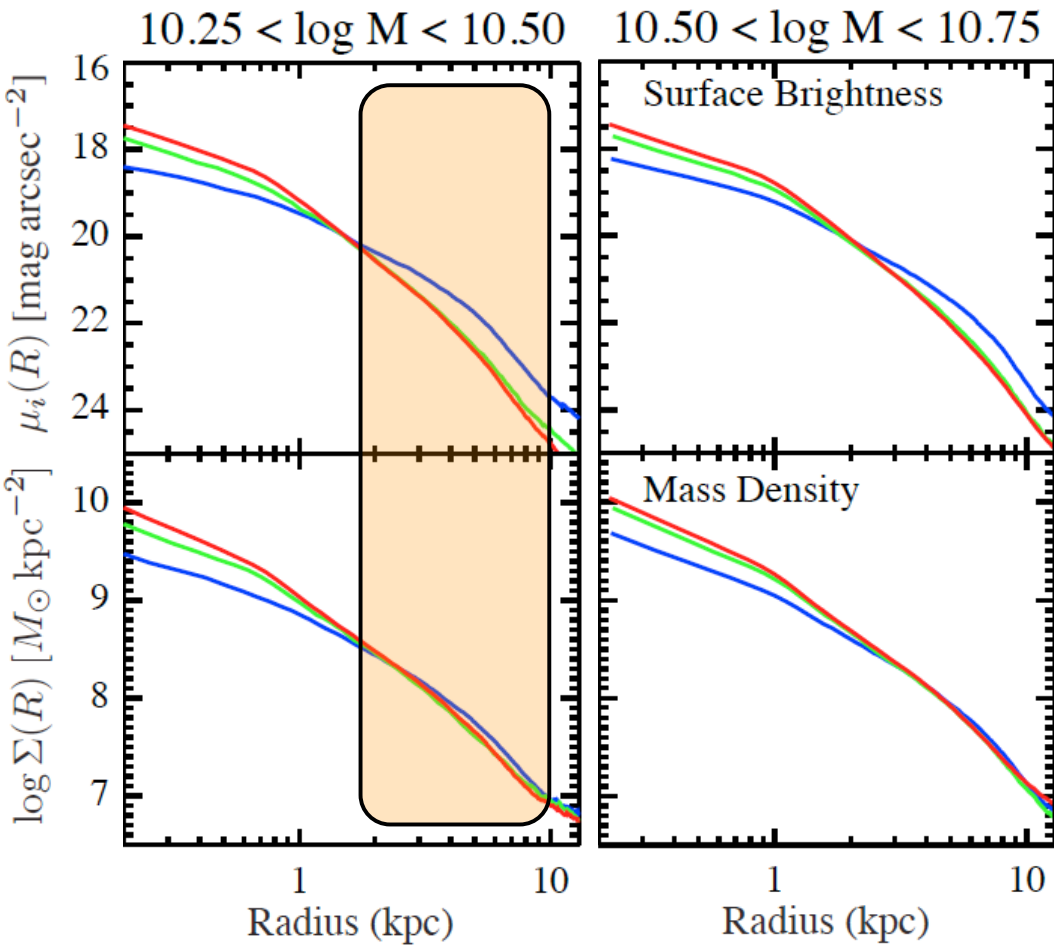


Correlation suggests a mass-dependent quenching threshold in Σ_1.

Challenges the notion of a fixed threshold.

Fang+12, in prep

Outer mass density remains constant as galaxies evolve.



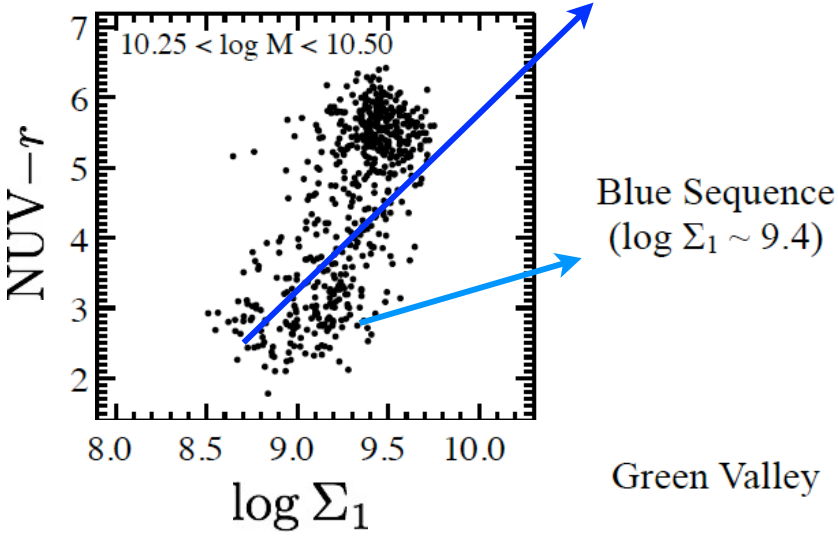
Blue galaxies have brighter outer disks than red galaxies...

...but similar outer mass densities.

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

Fang+12, in prep

High-Σ_1 blue galaxies look very similar to quenched objects.



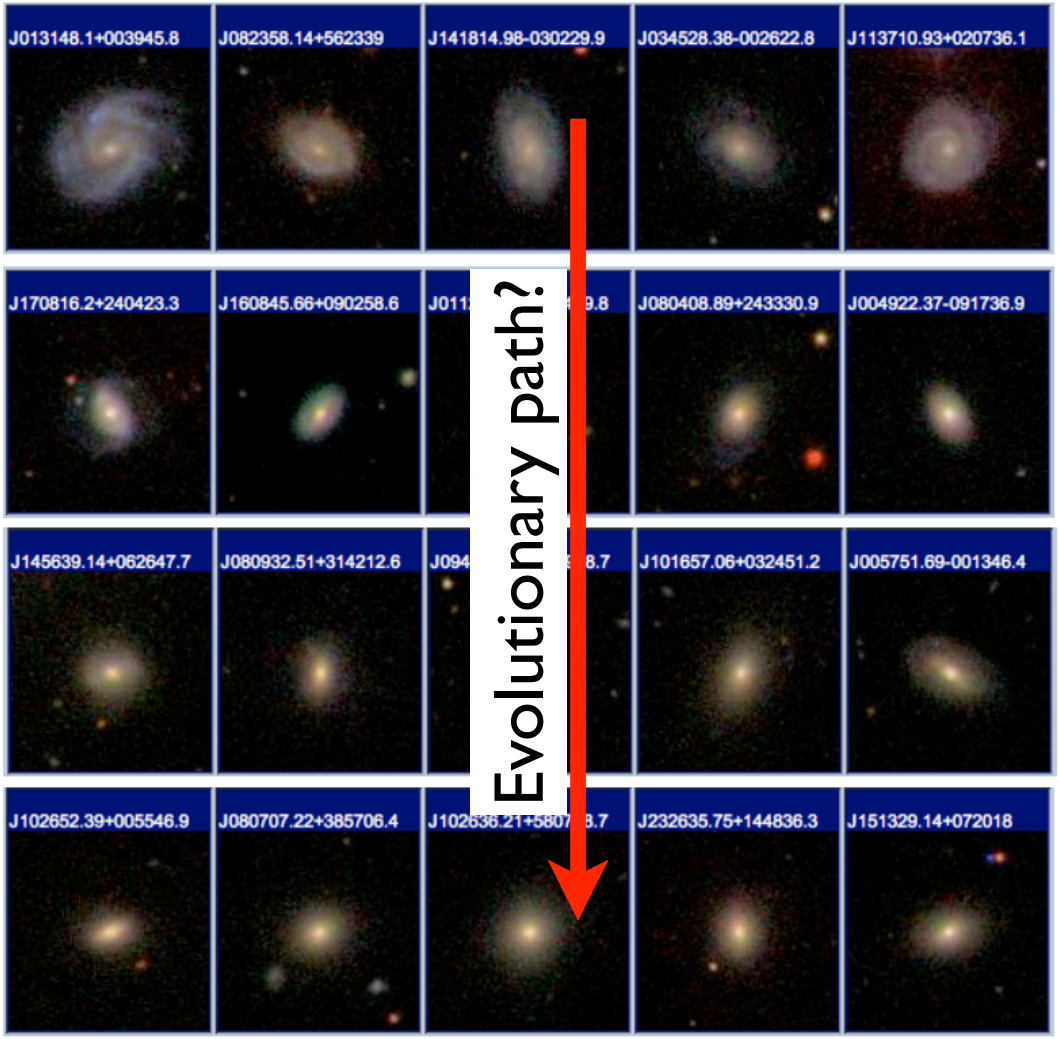
Blue Sequence
($\log \Sigma_1 \sim 8.7$)

Blue Sequence
($\log \Sigma_1 \sim 9.4$)

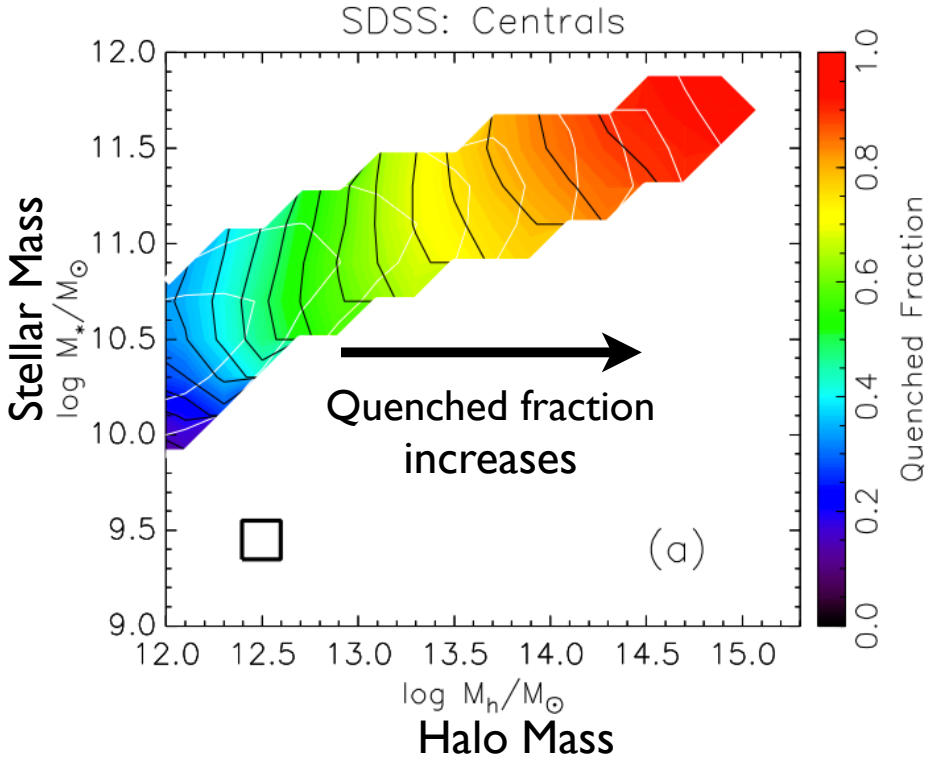
Green Valley

Red Sequence

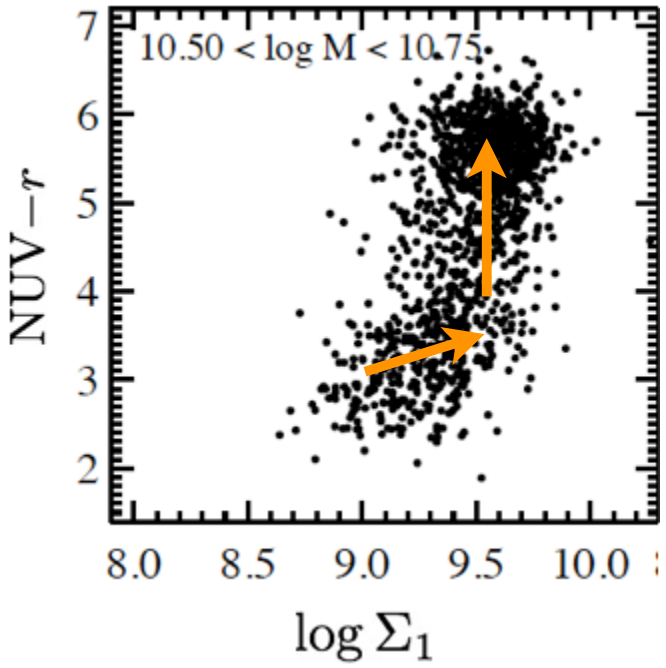
$0.04 < z < 0.05$; $10.25 < \log M_* < 10.5$



A tension between halo- vs. bulge-driven quenching?



Quenched fraction correlates better with halo mass.



A high-Σ_1 bulge is needed to be quenched.

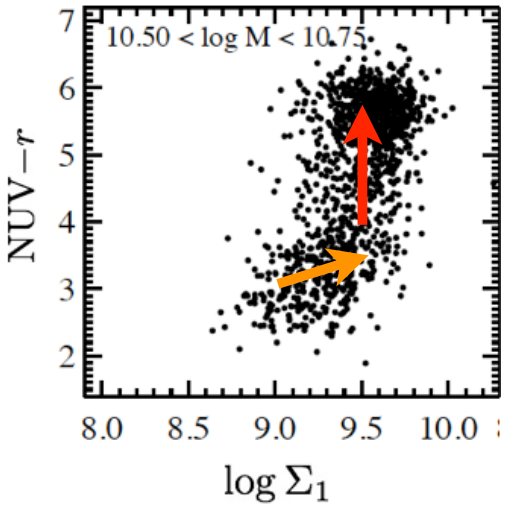
A two-step quenching process driven by both the bulge and halo?

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)



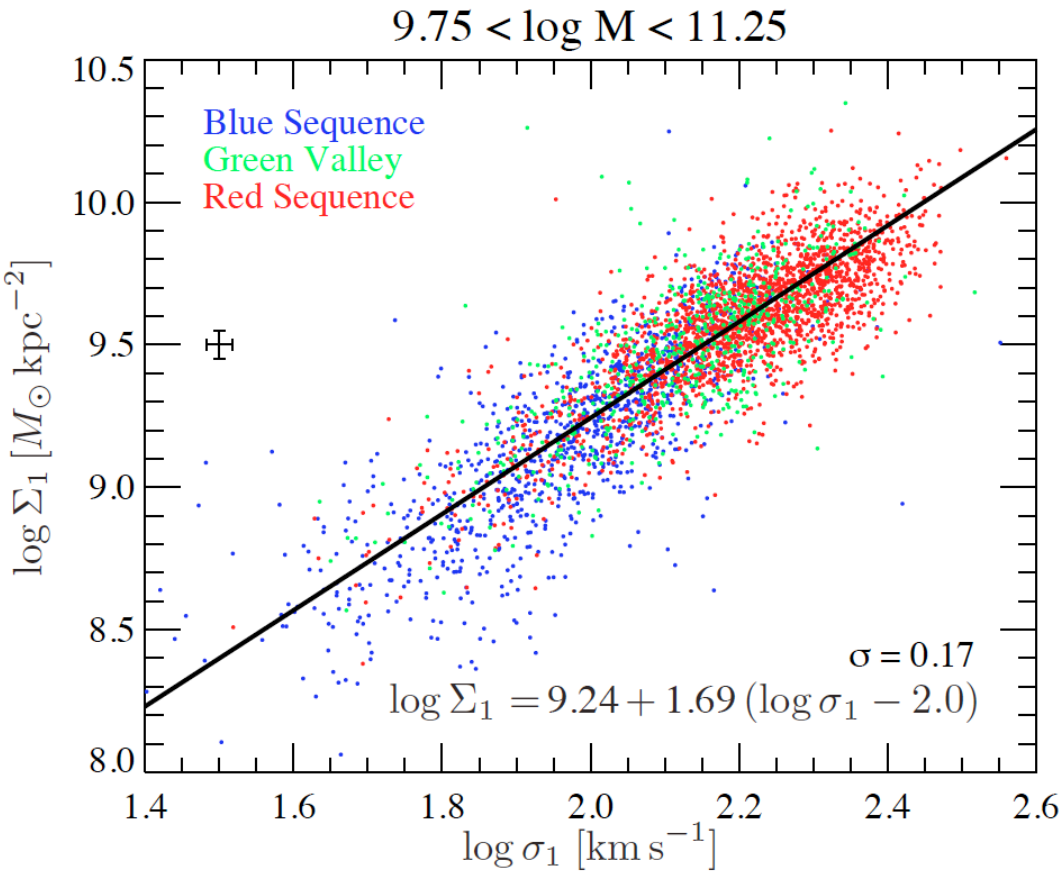
2. Suppression of further gas accretion

Virial shock heating

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

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

A tight relation exists between Σ_1 and velocity dispersion.



σ_1 = velocity dispersion scaled to 1 kpc aperture

Correlation holds for galaxies of all colors.

Correlation implies σ_1 and Σ_1 <u>both</u> trace bulge growth equally effectively.

Σ_1-σ_1 relation can be used to "convert" between either quantity.

Develop an M_{BH}-Σ_1 relation?

Fang+12, in prep

Conclusions

At fixed stellar mass, Σ_1 increases in the blue cloud until it reaches a (mass-dependent) threshold, at which point galaxies can quench.

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

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

Σ_1 and σ_1 are strongly correlated for all galaxies, implying both trace bulge buildup equally well. Use Σ_1 for BH studies?