Secular evolution in the green valley

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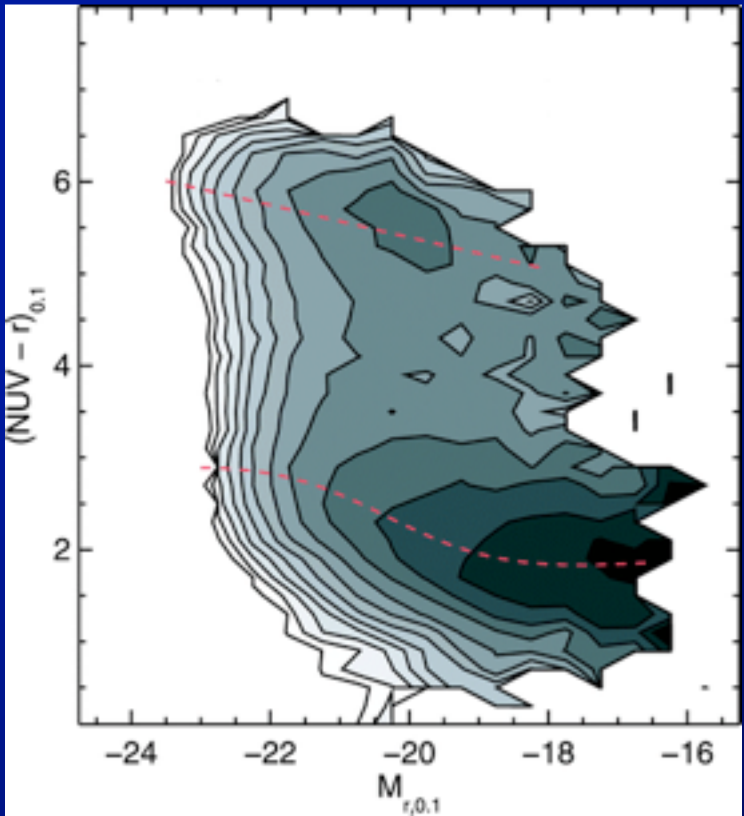
UNIVERSIDADE DO BRASIL

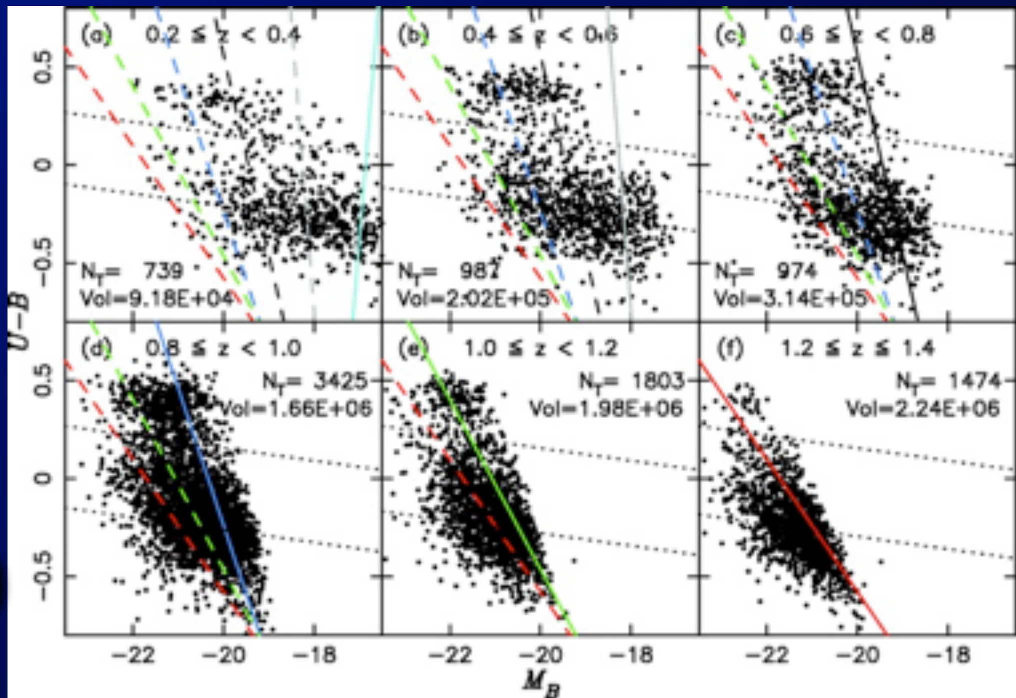
Bimodality in colors



z~0.1

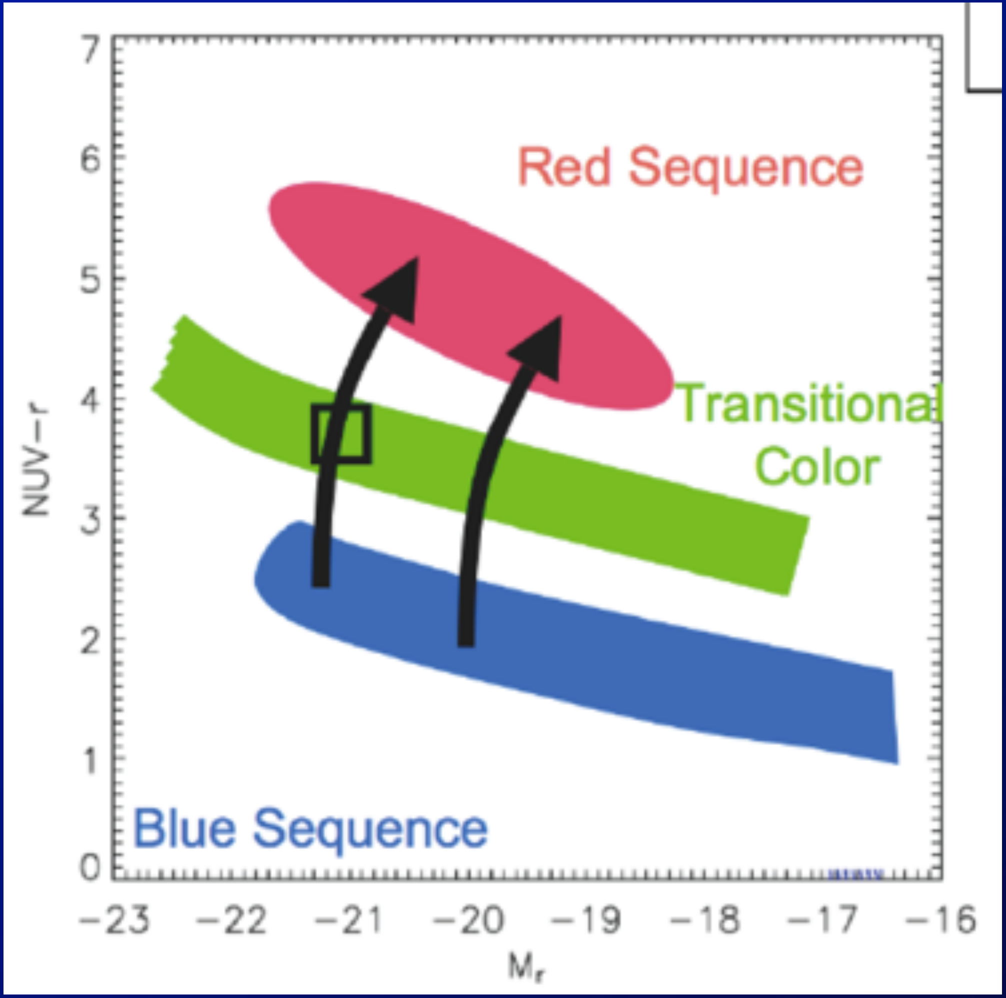
Wyder+07

z~1.0



Willmer+06

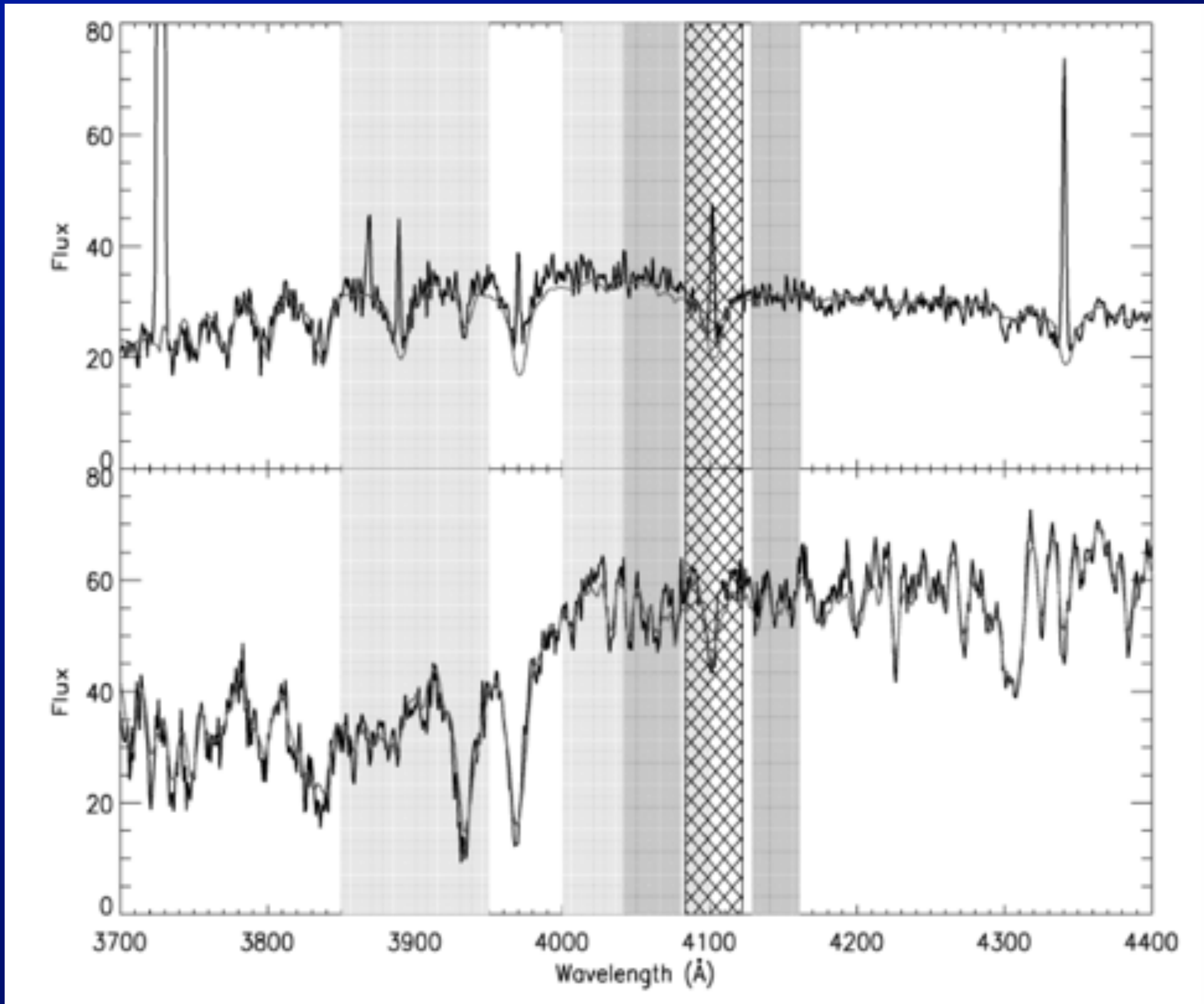
The mass flux density



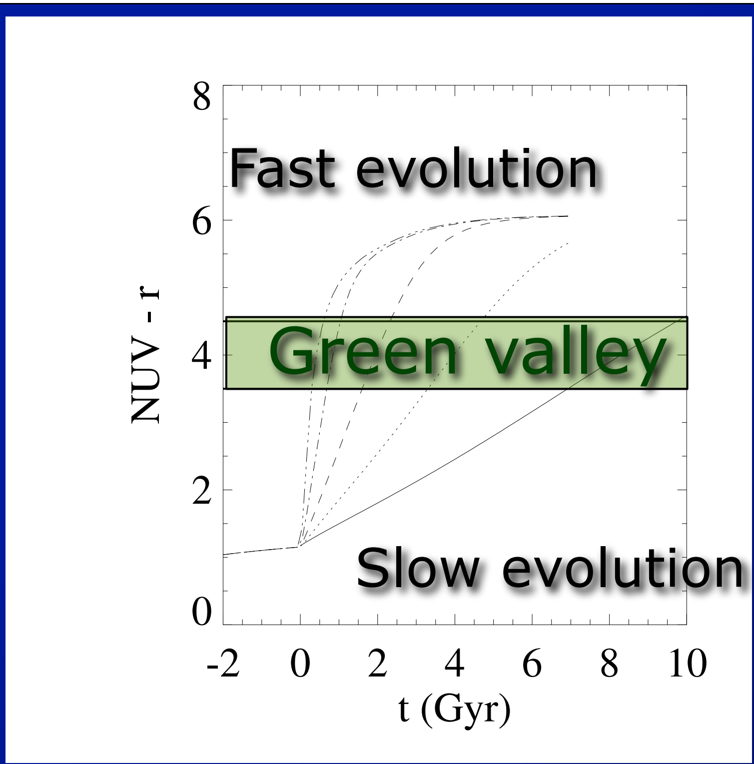
$$\Phi(M_r, NUV - r) = \dot{\Phi}_B(M_r)\langle\tau(M_r, NUV - r;\xi)\rangle$$

- Stellar mass
- Number density
- Transition timescales

Spectroscopic indices to determine star formation history of galaxies

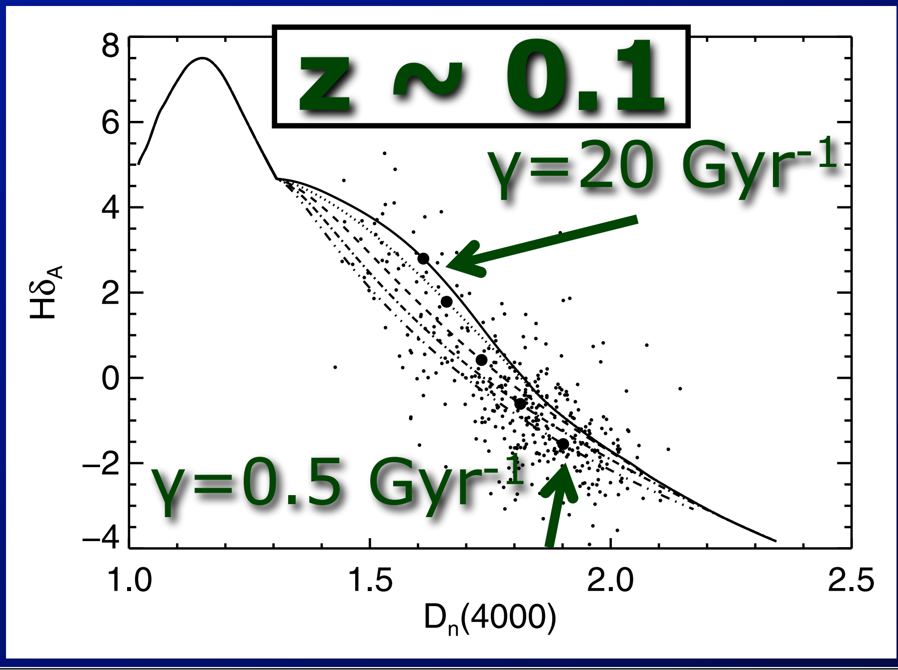


Kauffmann+03

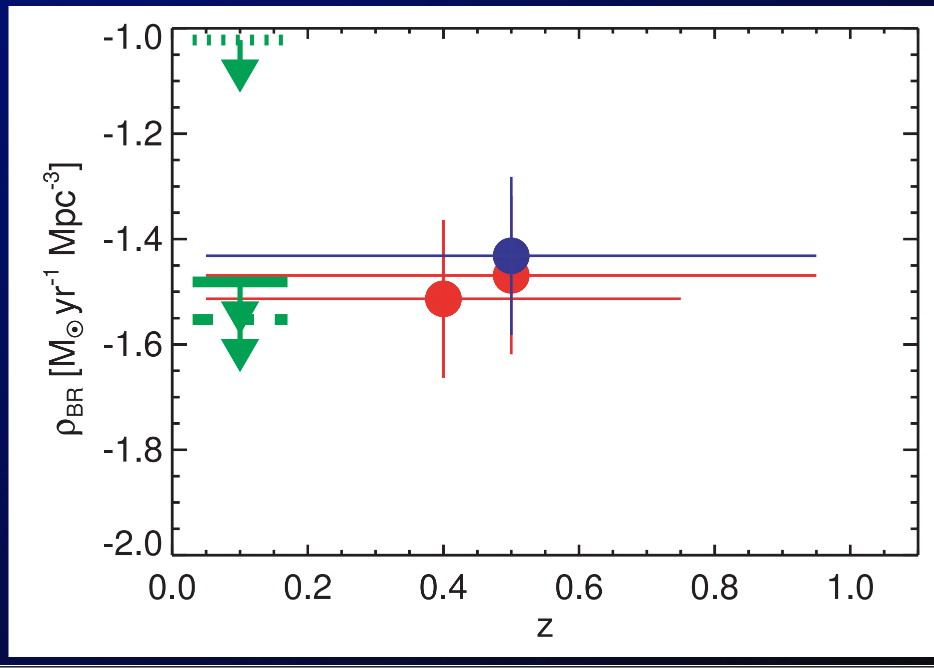


$$SFR(t) = \begin{cases} SFR(t_0) & t < t_0 \\ SFR(t_0)e^{-\gamma t} & t > t_0 \end{cases}$$

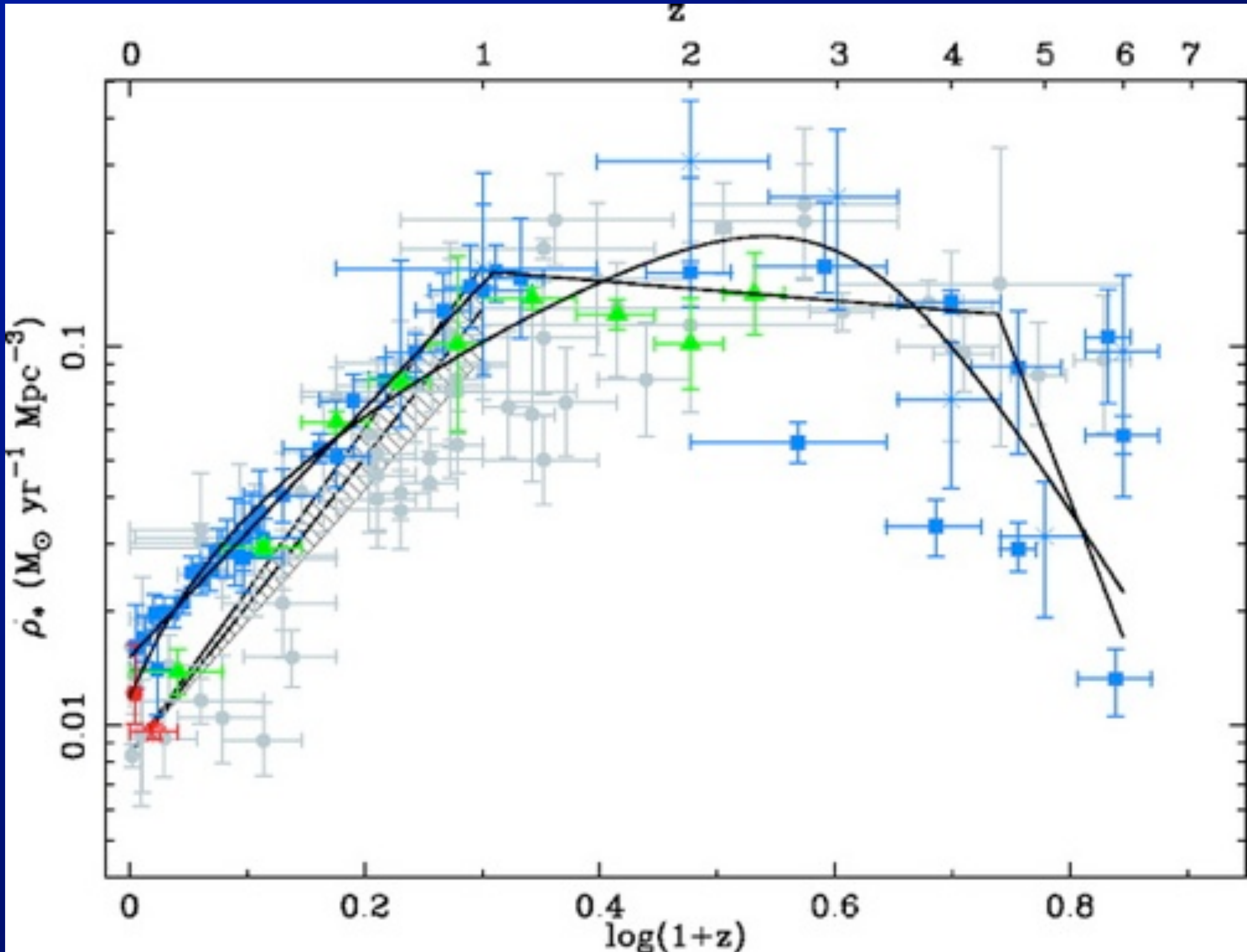
The mass flux density in the green valley and the evolution of the red sequence agree



Martin+07

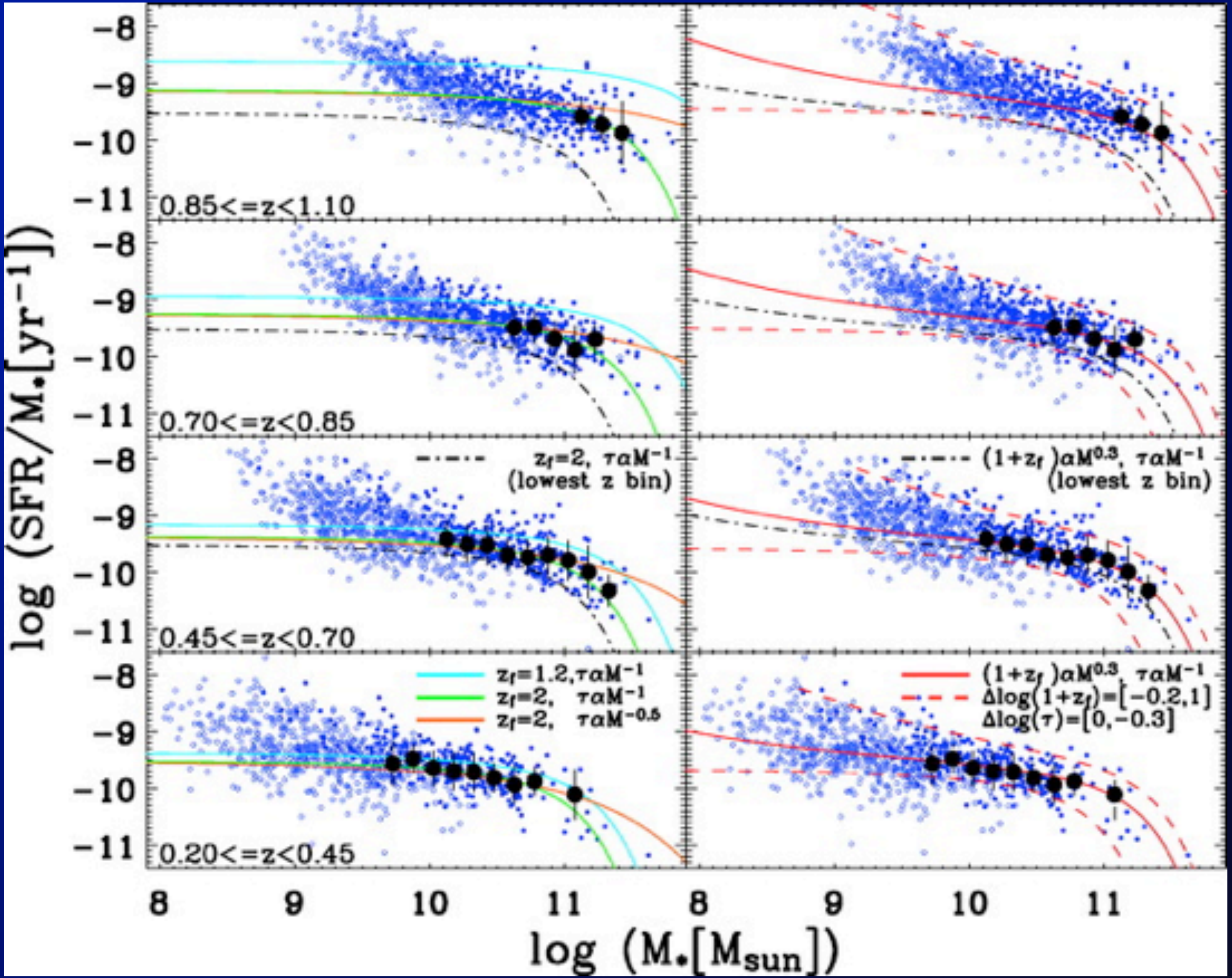


The universe was forming stars more at a faster rate in the past



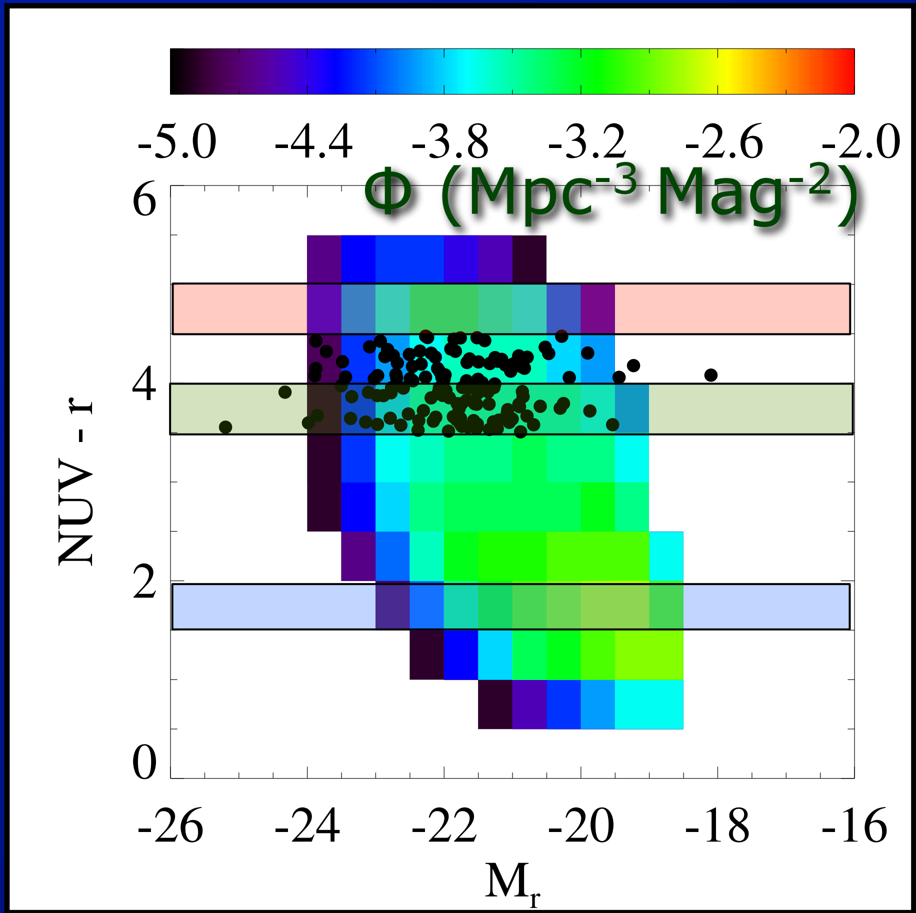
Hopkins+06

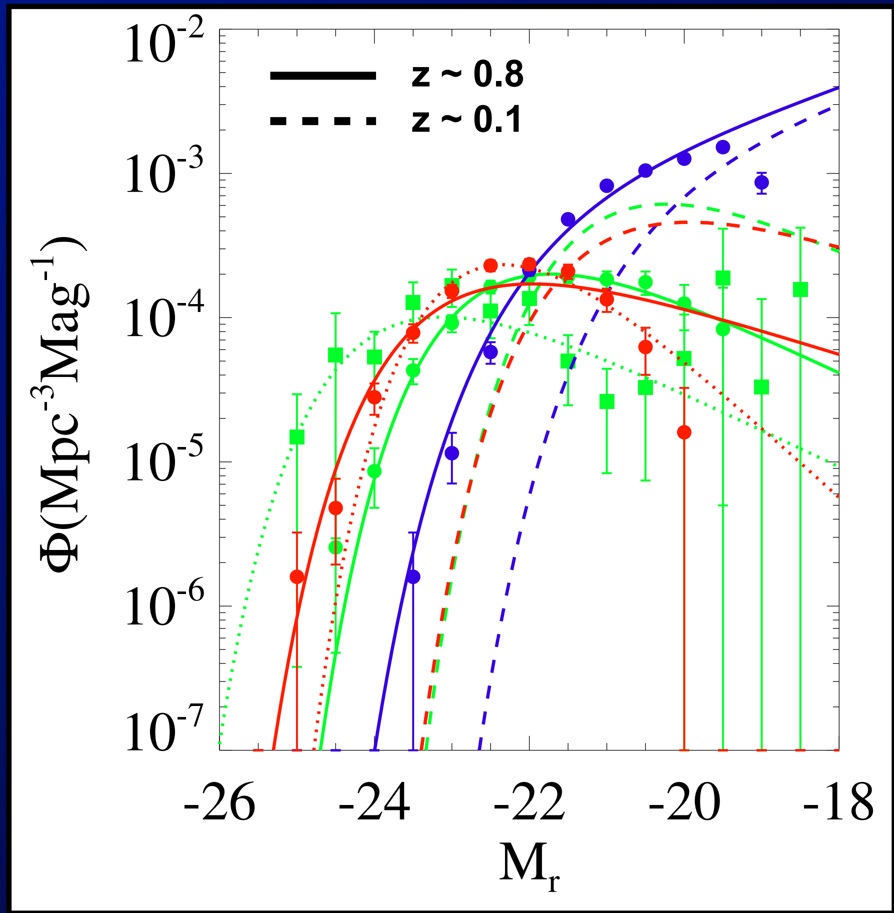
Downsizing!!



Noeske+07

The CM diagram and the Luminosity function at z~0.8

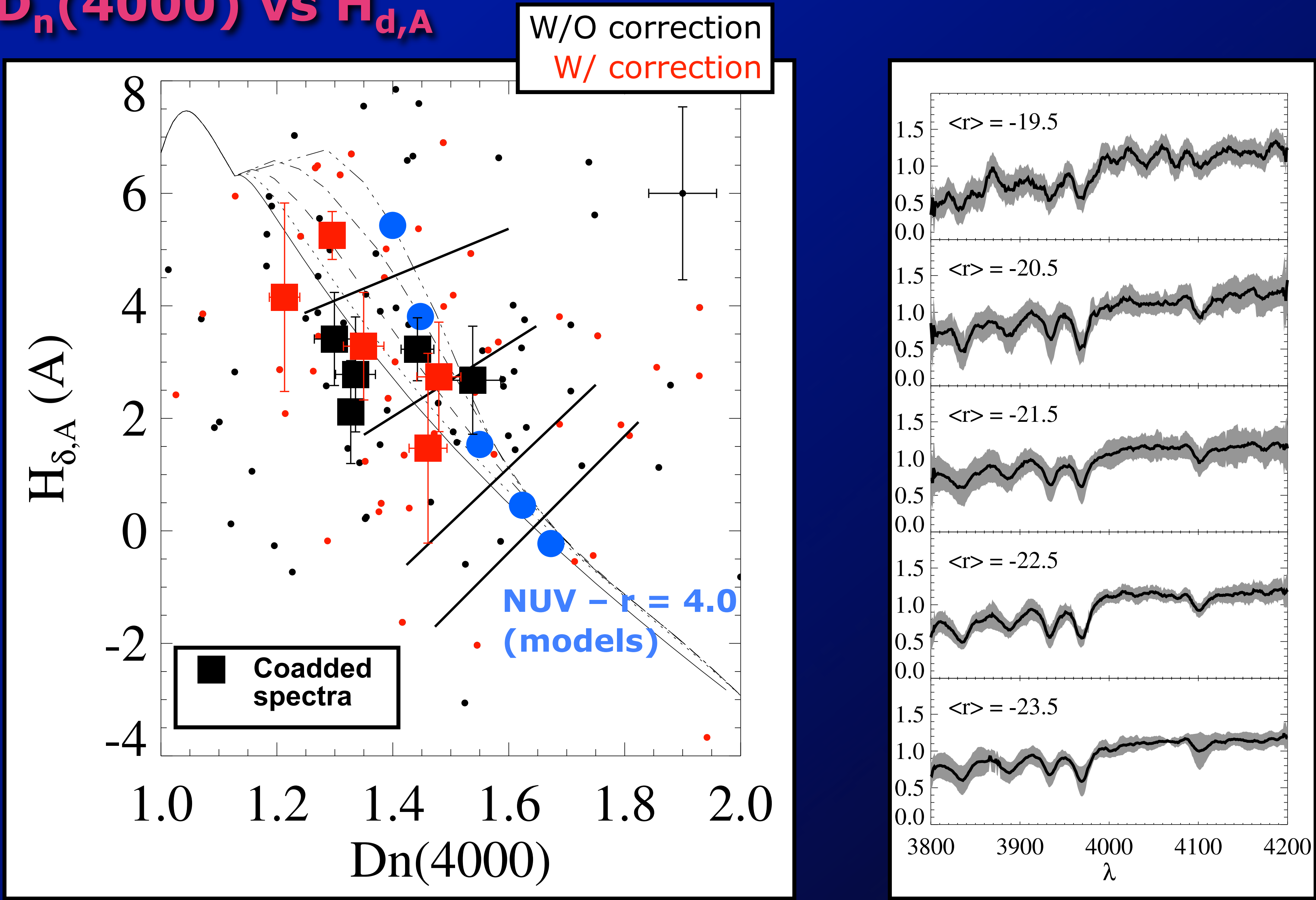




Gonçalves+12

Luminosity functions are systematically shifted towards brighter magnitudes at higher redshift

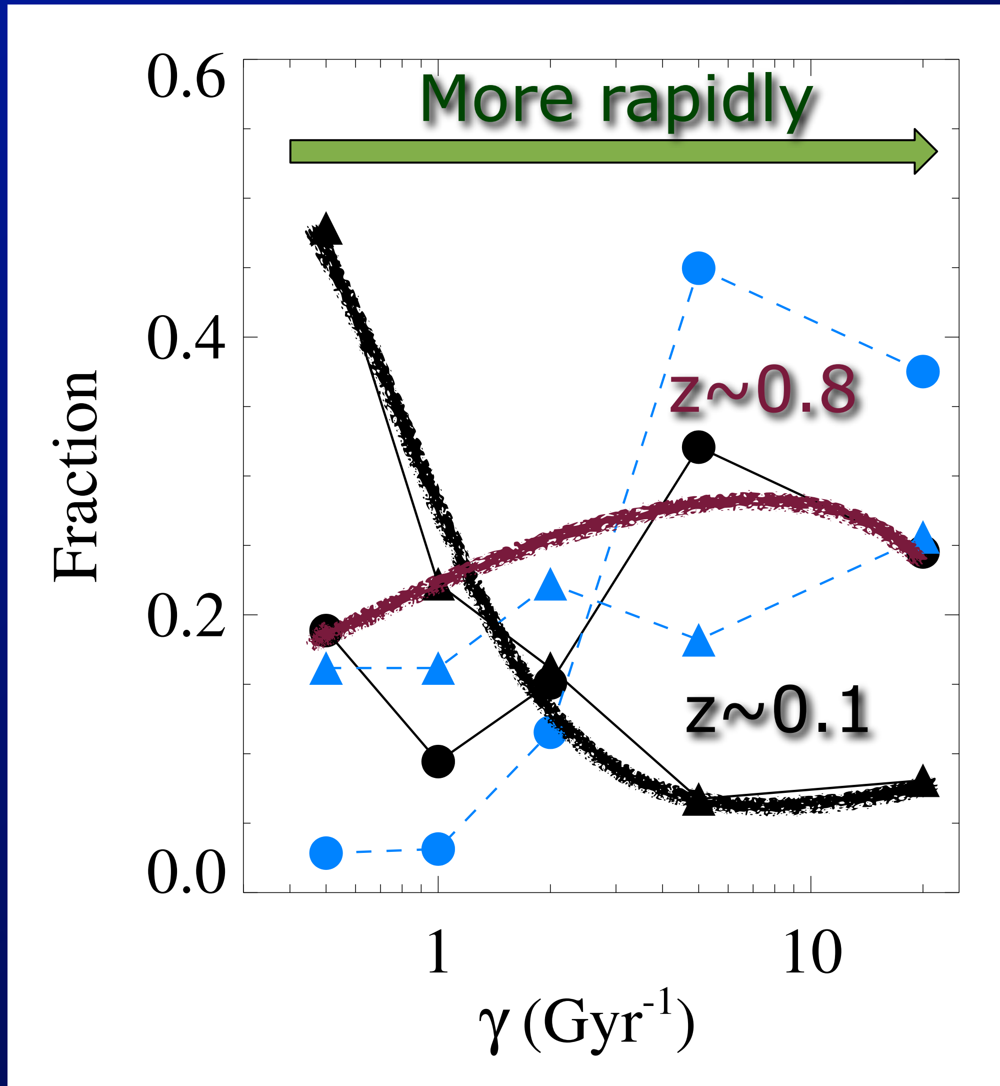
$D_n(4000)$ vs $H_{d,A}$



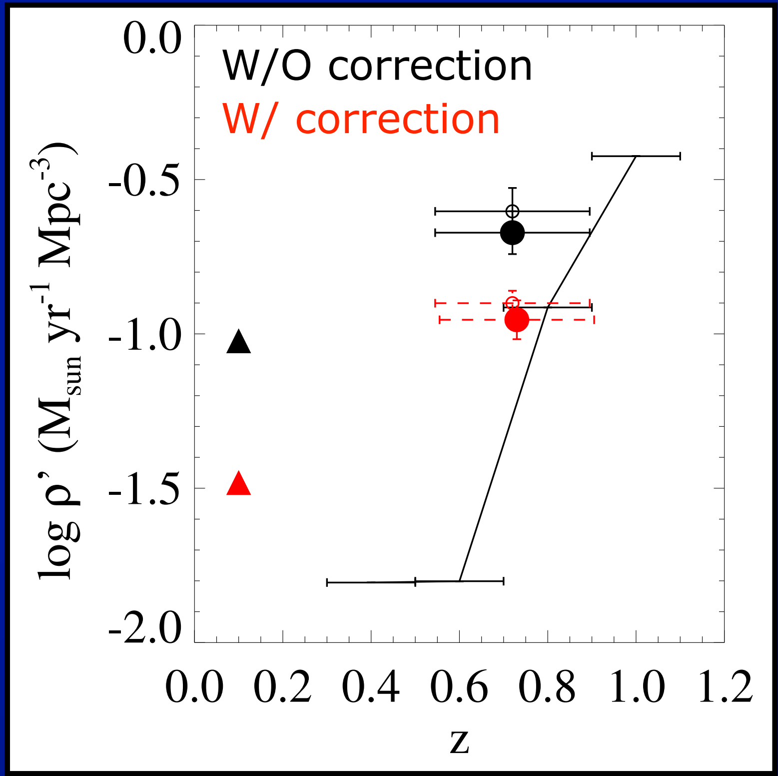
Gonçalves+12

Deepest spectra ever taken of green valley galaxies (8-9hr Keck)

Galaxies move across the green valley more rapidly at z~0.8

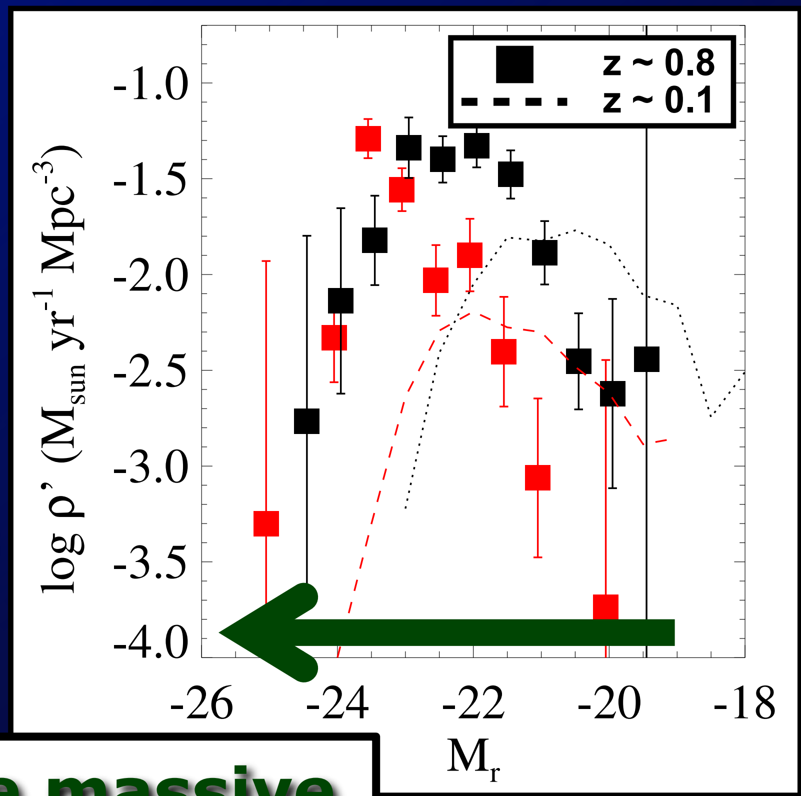


Gonçalves+12



The mass flux density evolution agrees with the growth of the red sequence (Faber et al. 2007)

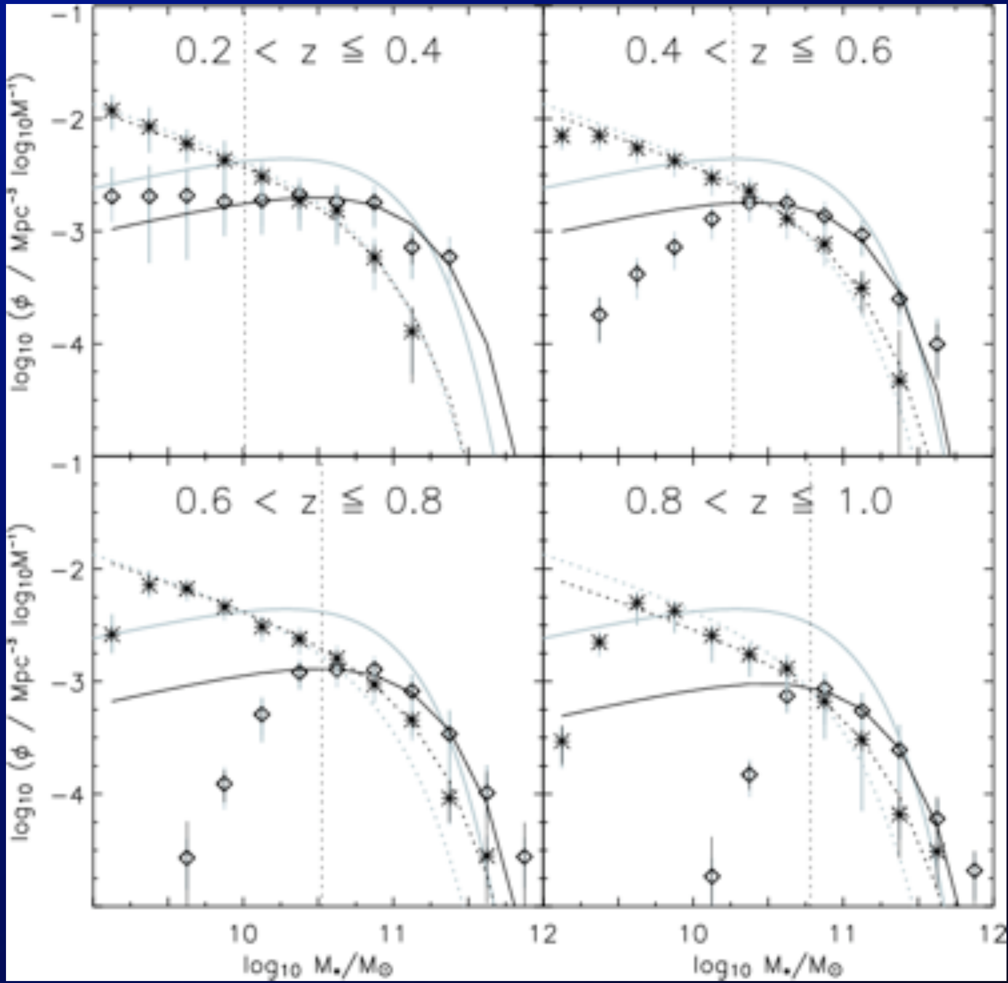
Mass flux density happens in fainter, less massive galaxies in recent times



Brighter, more massive

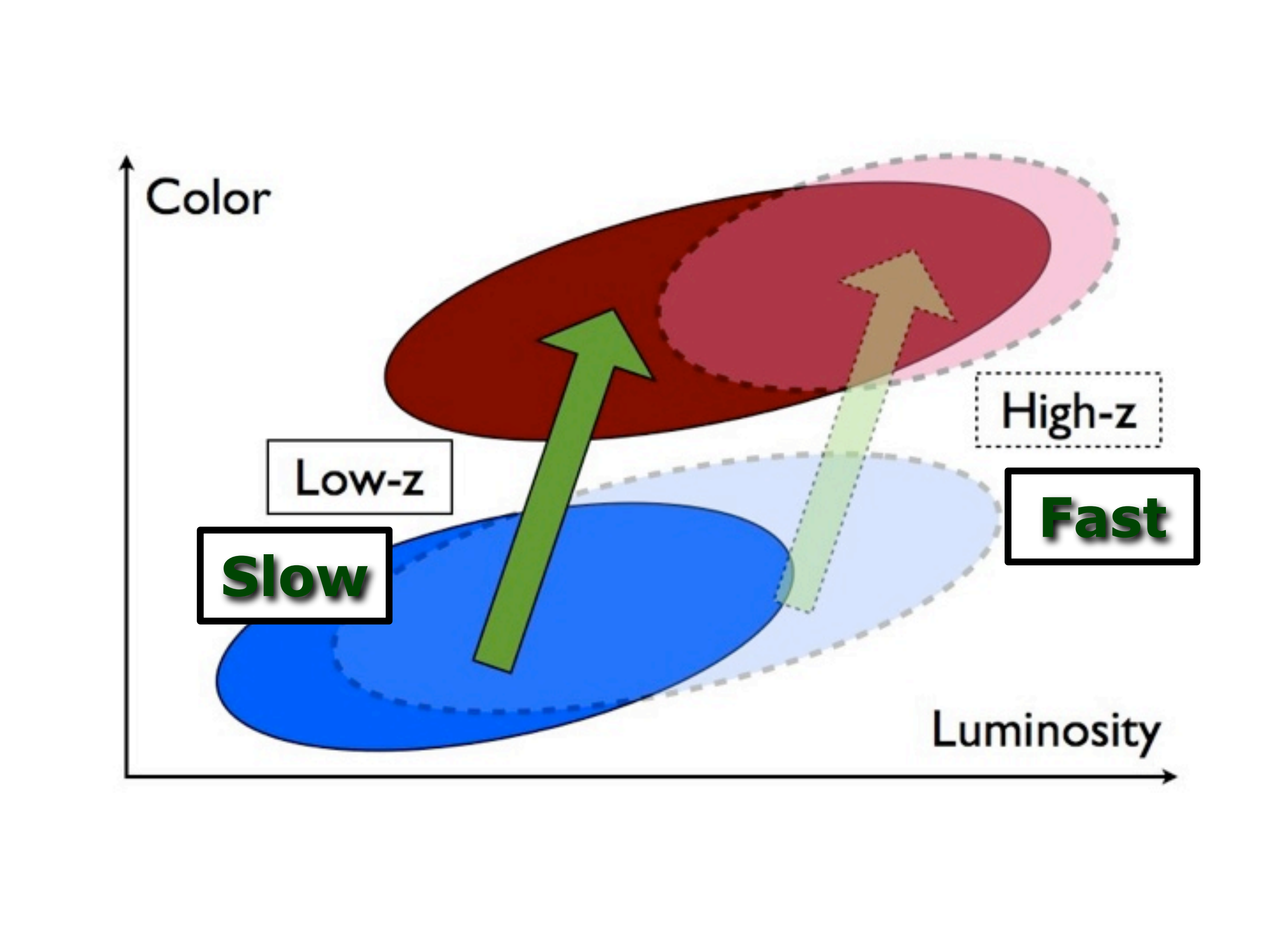
"Top-down" scenario for the evolution of the red sequence:

- Massive red galaxies form earlier from quenching of star formation in massive spirals
- This process moves to low-mass galaxies in the local universe
- Downsizing!

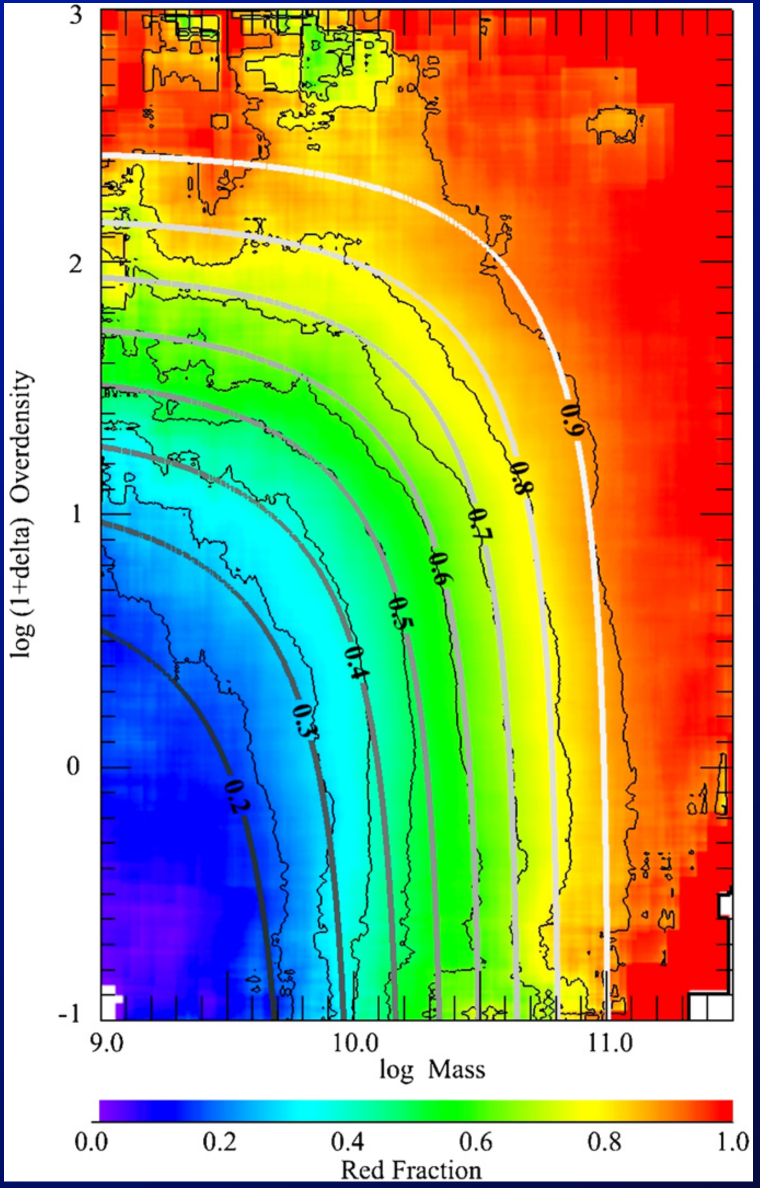


Borch+06

Evolution of the CM diagram

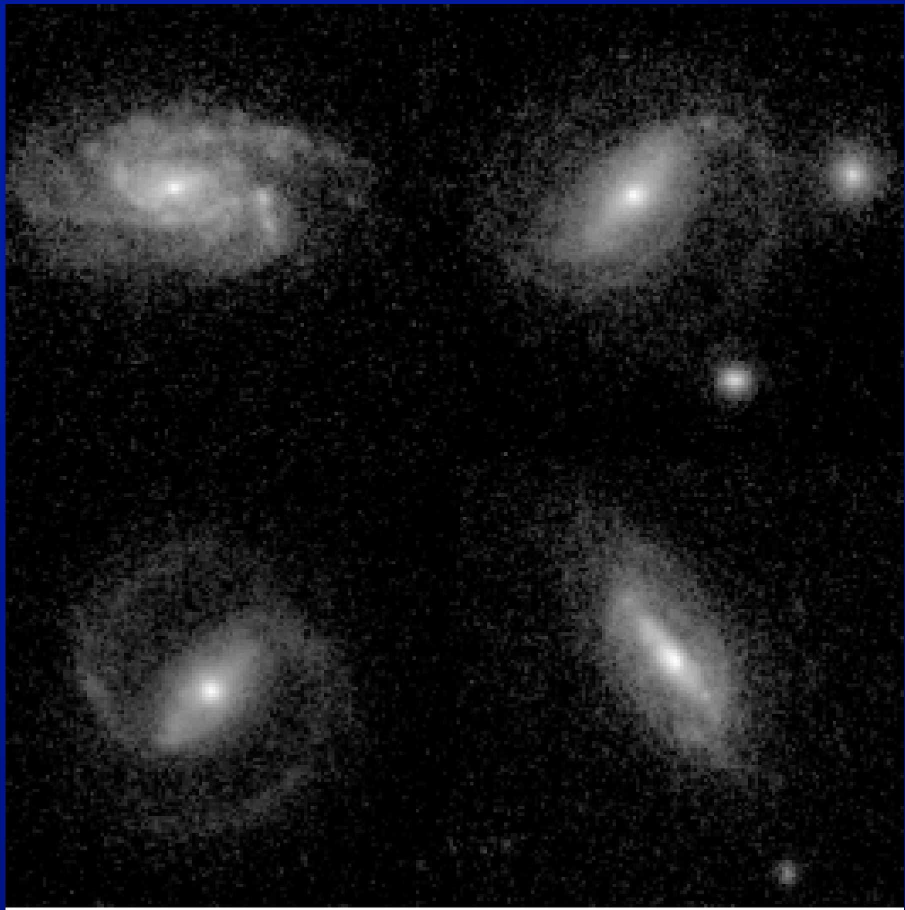


Physical processes?



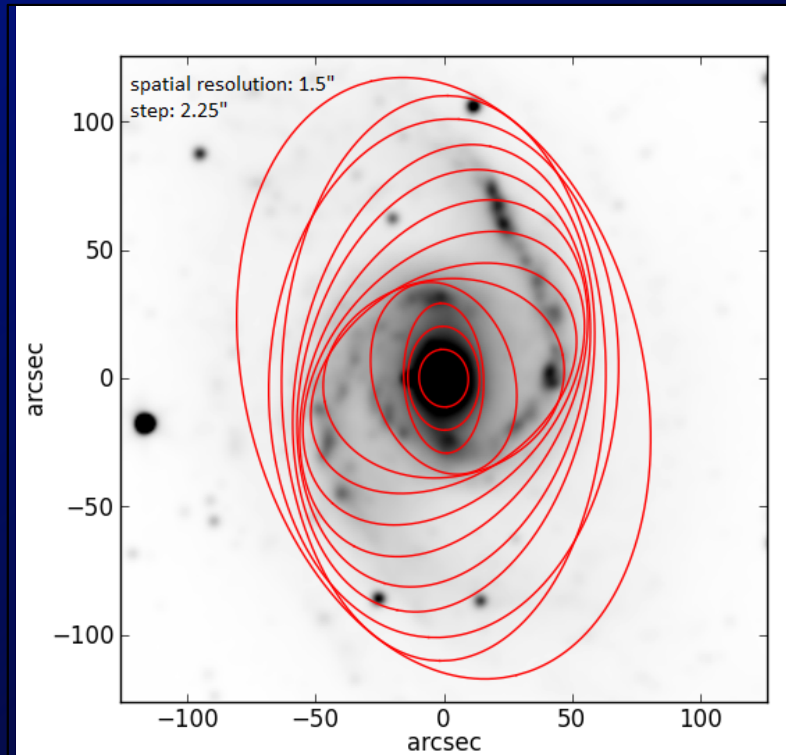
Peng+10

Bars and secular evolution



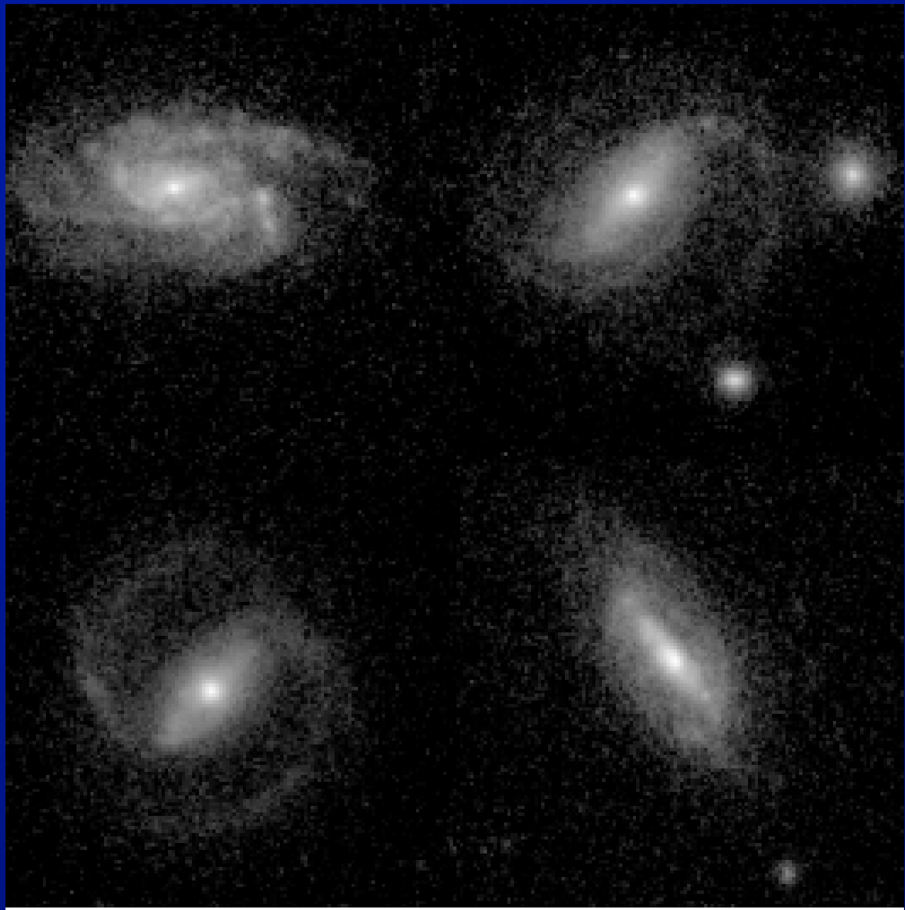
EGS, HST/ACS, z~0.8
Lotz+08

Nogueira-Cavalcante+13, in prep



Ellipticity determination
(Menéndez-Delmestre+07)

Bars and secular evolution



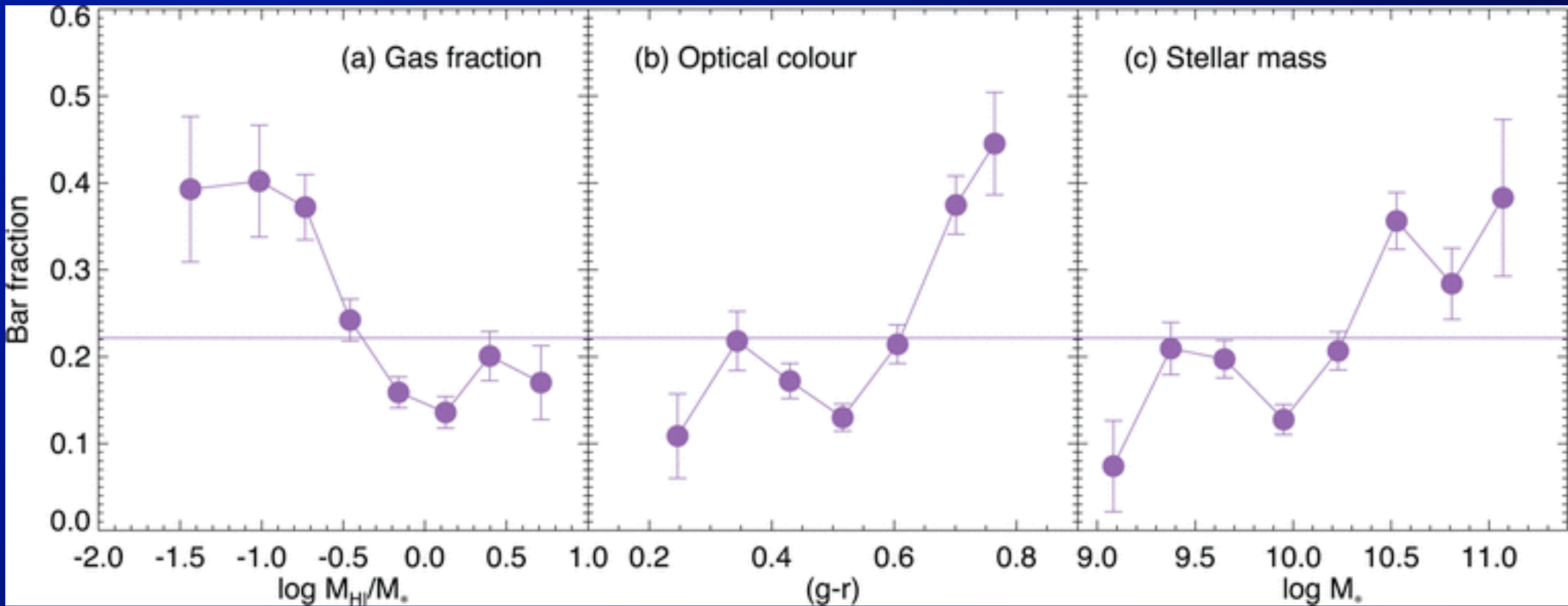
EGS, HST/ACS, z~0.8
Lotz+08

n < 2.5, i < 70º
GV galaxies
By-eye classification: 10-15%
Compared to ~30% total (Sheth+08)

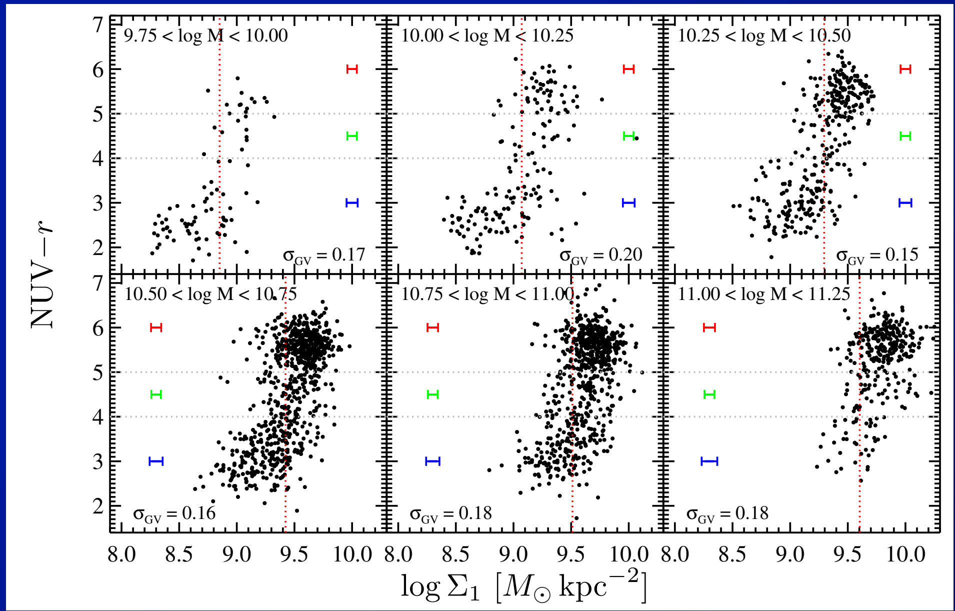
Nogueira-Cavalcante+13, in prep

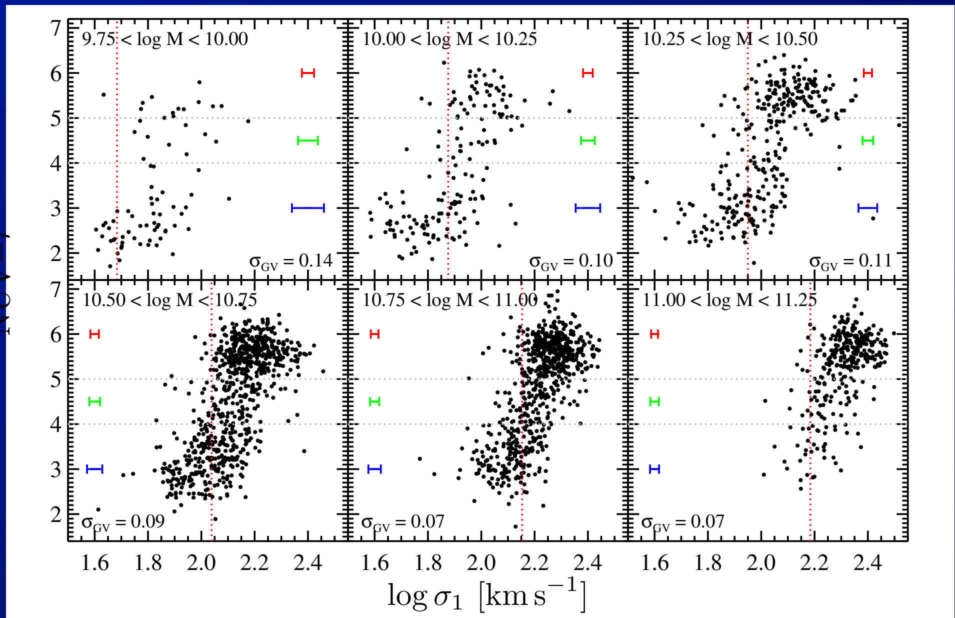
Bars come AFTER quenching?

Increased bar fraction in the red sequence



Masters+12





No evolution in central density or velocity dispersion after quenching

We will be able to correlate quenching timescales with bar properties - at low AND high redshift

Fang+13

Summary

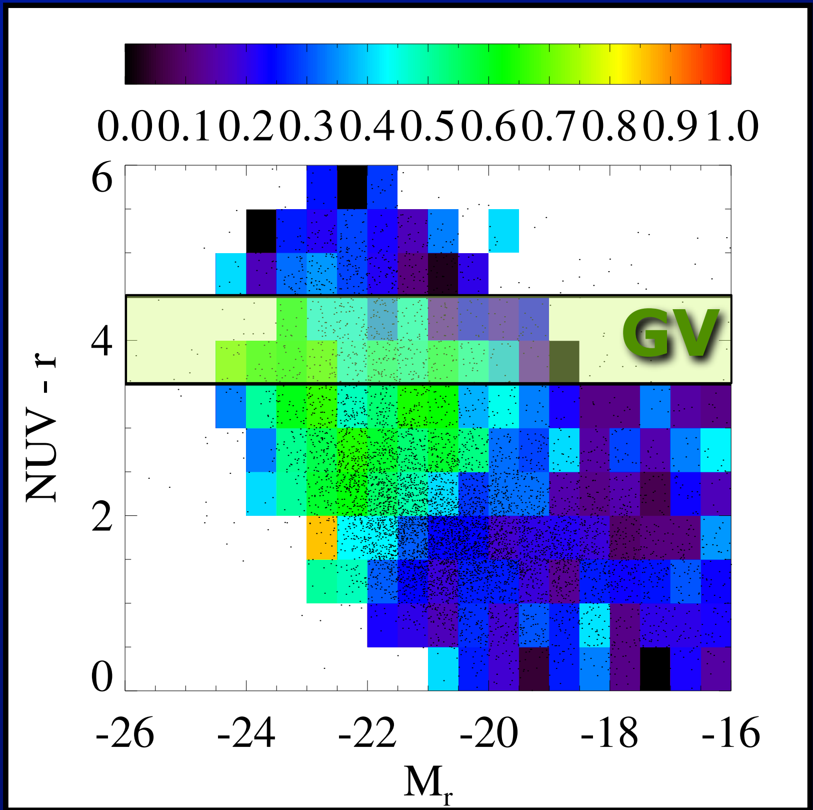
- Through deep spectroscopy, we can estimate the star formation history of galaxies at z~0.8
- The evolution of the mass flux density: at earlier times, faster transtion happening in more massive galaxies
- “Top-down” scenario: more massive galaxies in the red sequence were formed earlier, and less massive objects fill in at later times
- What is the role of bars in star formation quenching? Is it stronger at a given epoch?

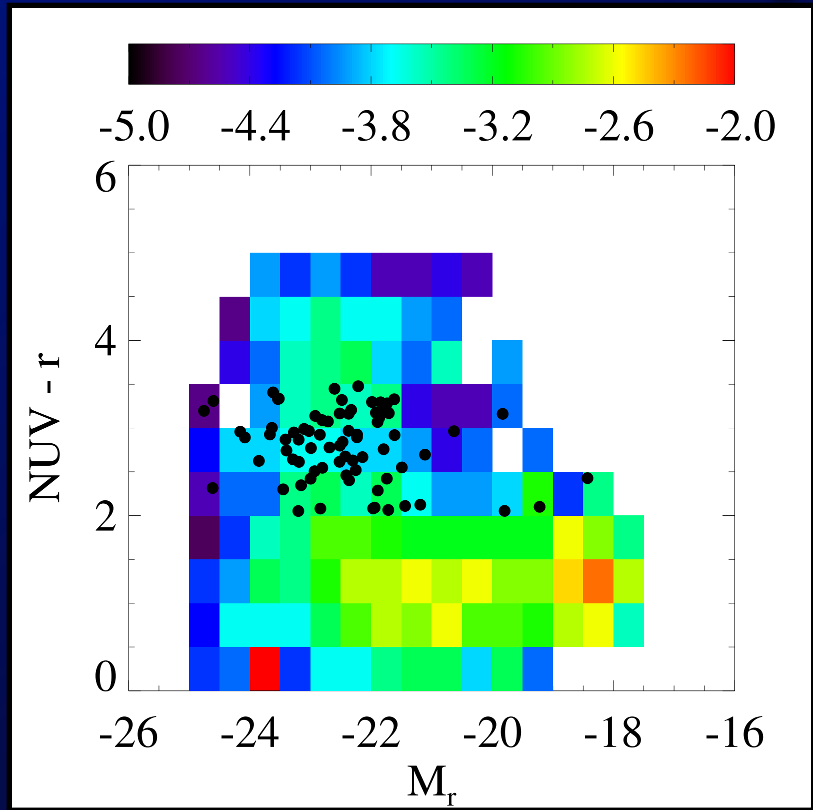
Correcting for extinction

Contamination:

Up to 70% of the green valley galaxies are dusty starbursts detected in MIPS 24um

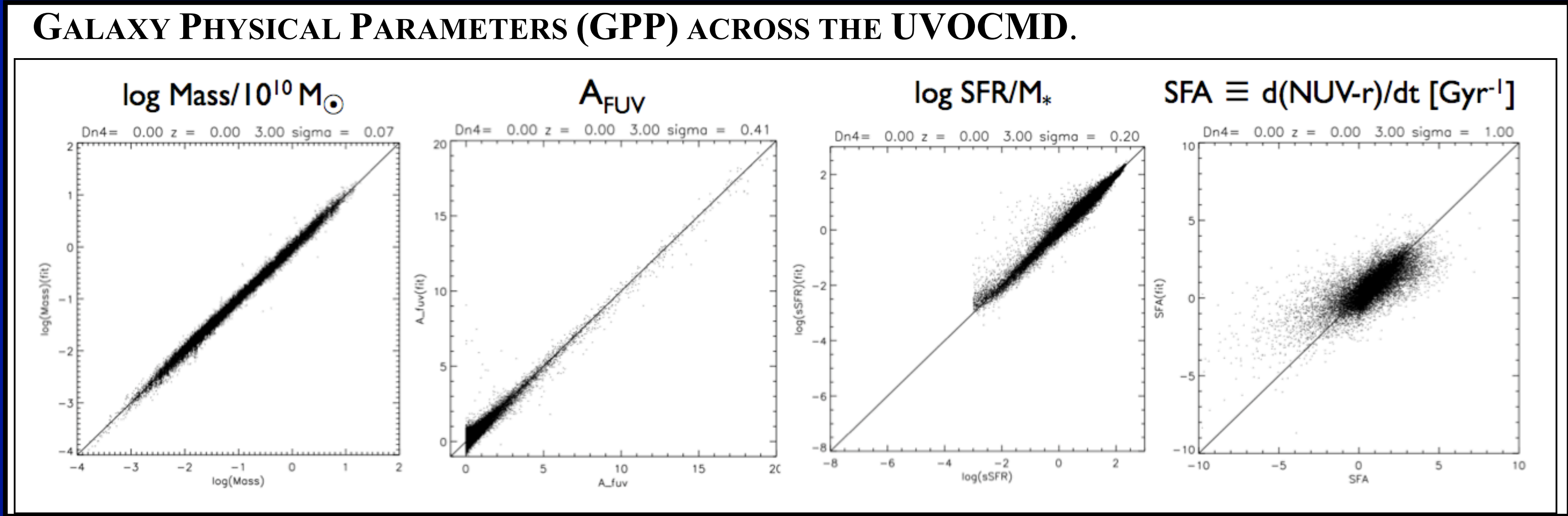
Extinction-corrected CM diagram

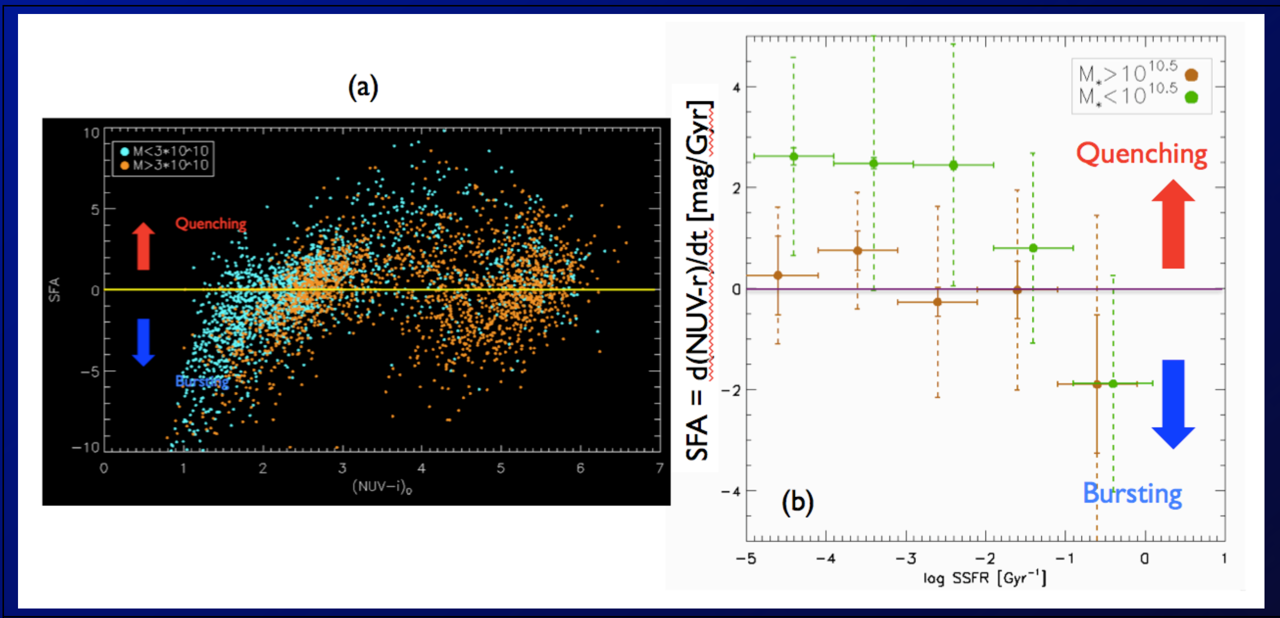




Gonçalves+12

Star formation acceleration (SFA)

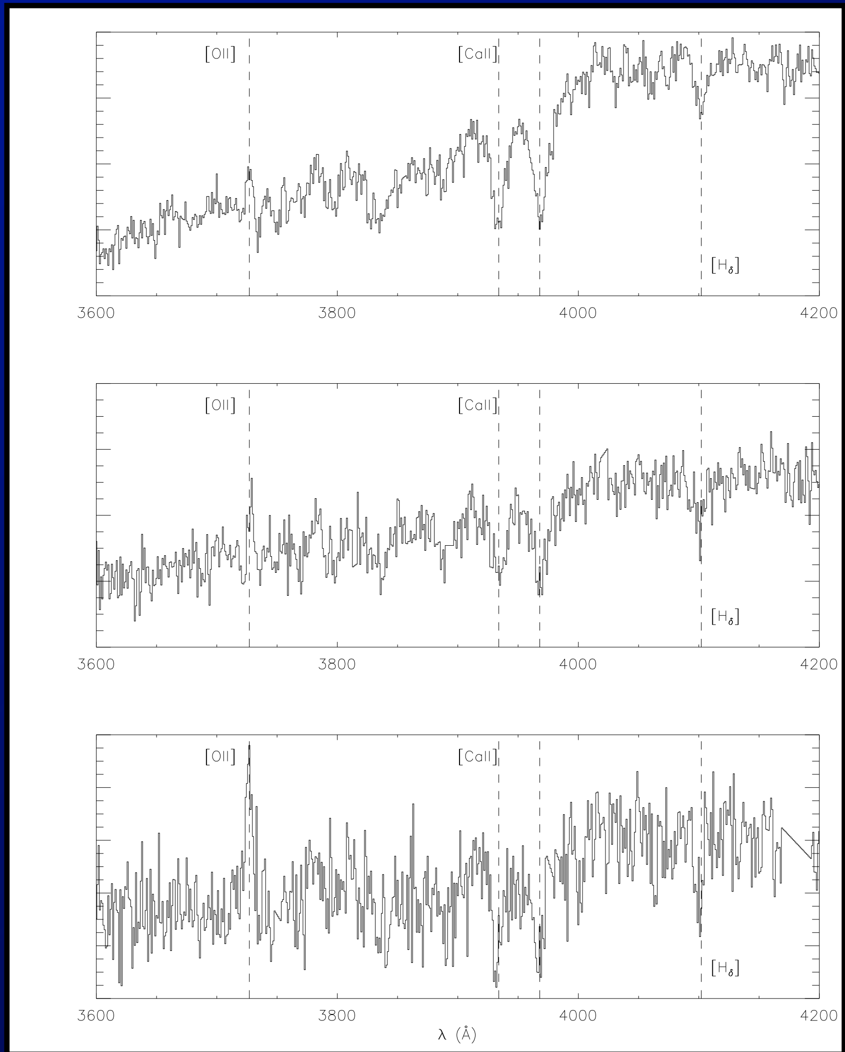




Martin, Gonçalves et al. 2013

Example spectra

Spectral features are distinguishable down to r~24



r ~ 21.5

r ~ 22.5

r ~ 23.5

Gonçalves+12