Mass Assembly through Cosmic Time

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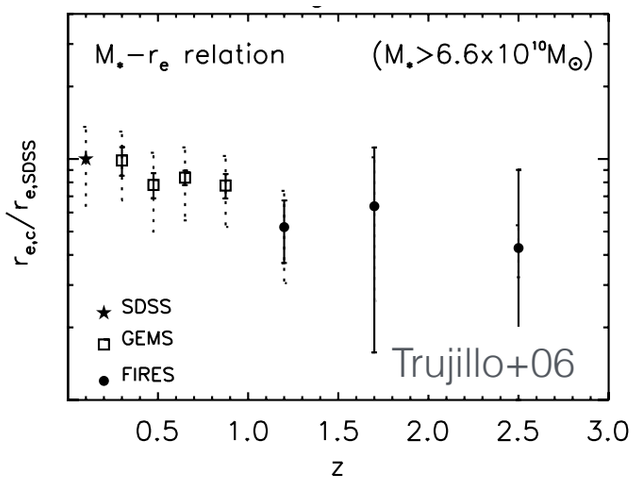
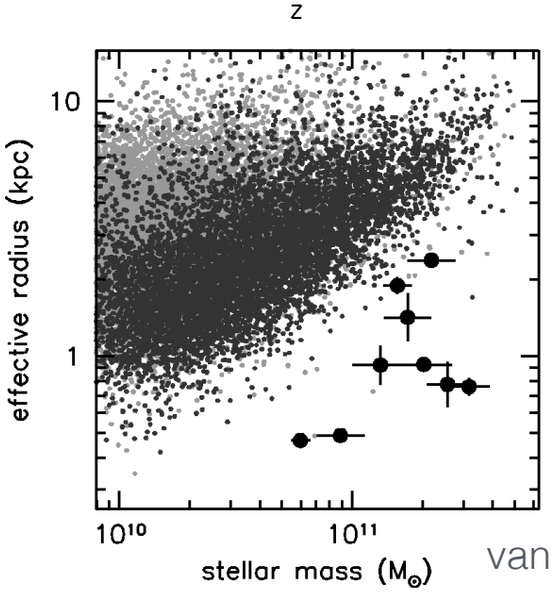
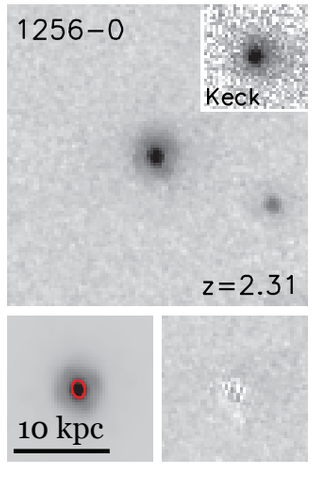
Cozumel April 2016

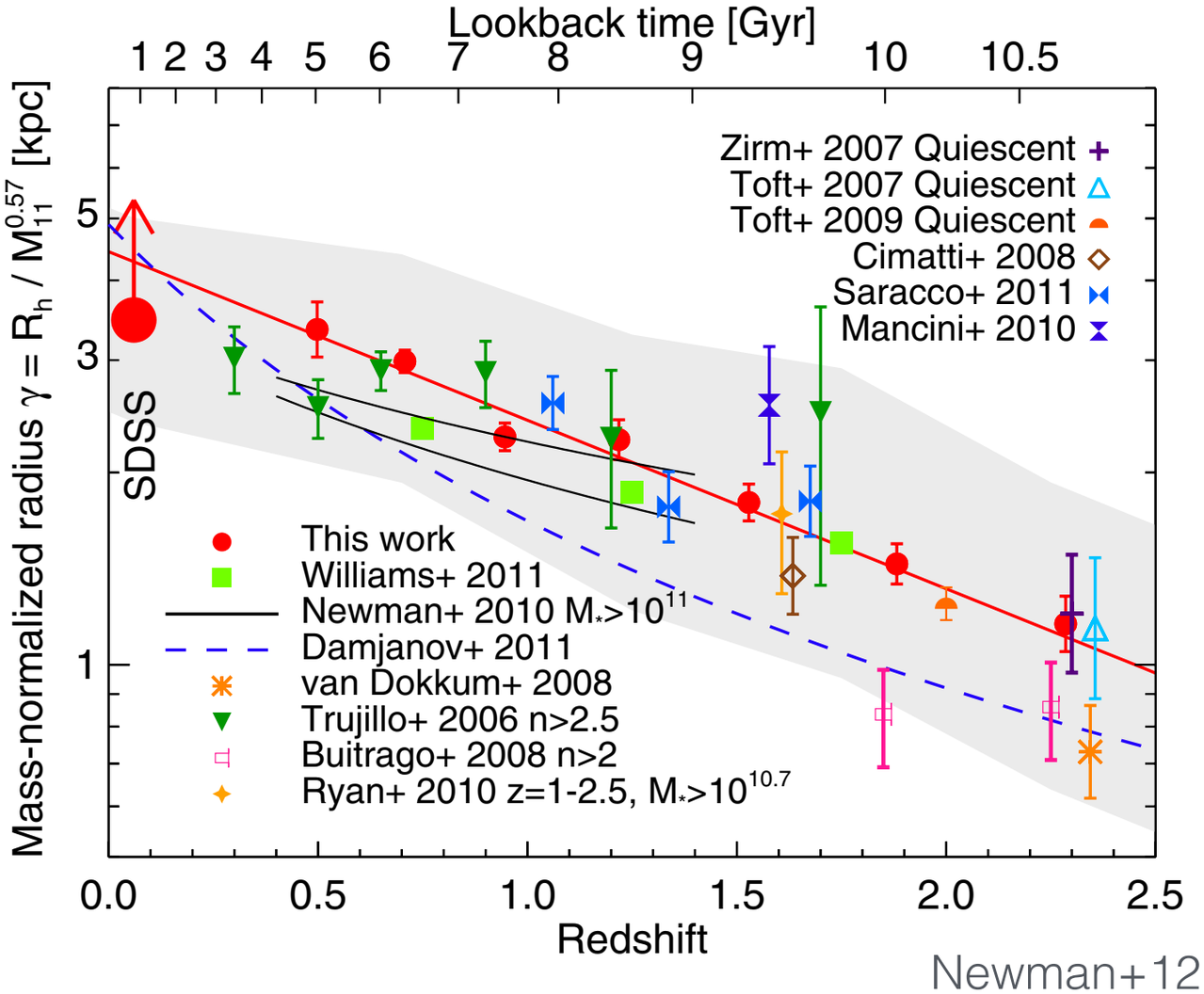
Observed: Massive galaxies grow in size





van Dokkum+08

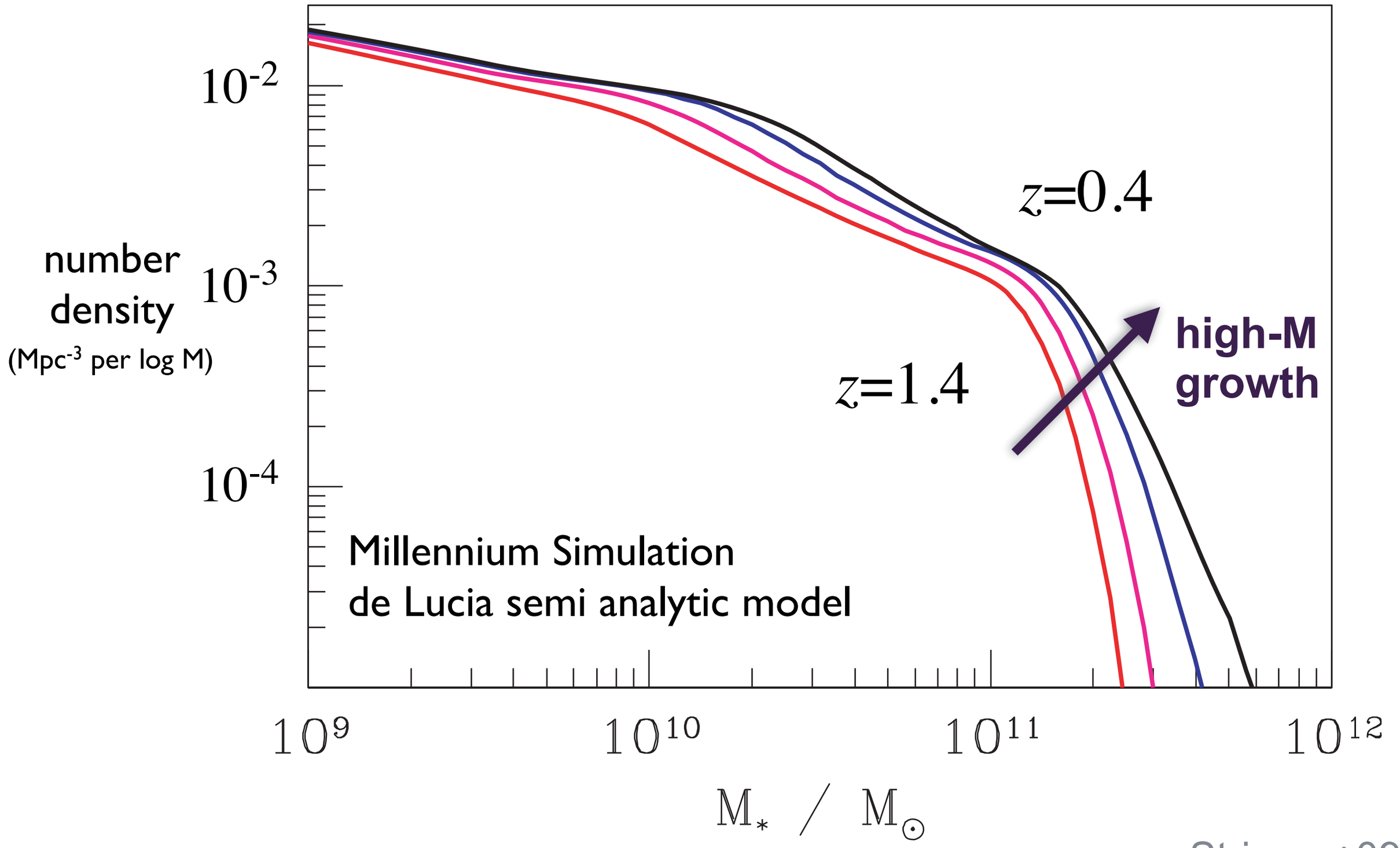




Newman+12

The remarkable compact "nuggets"

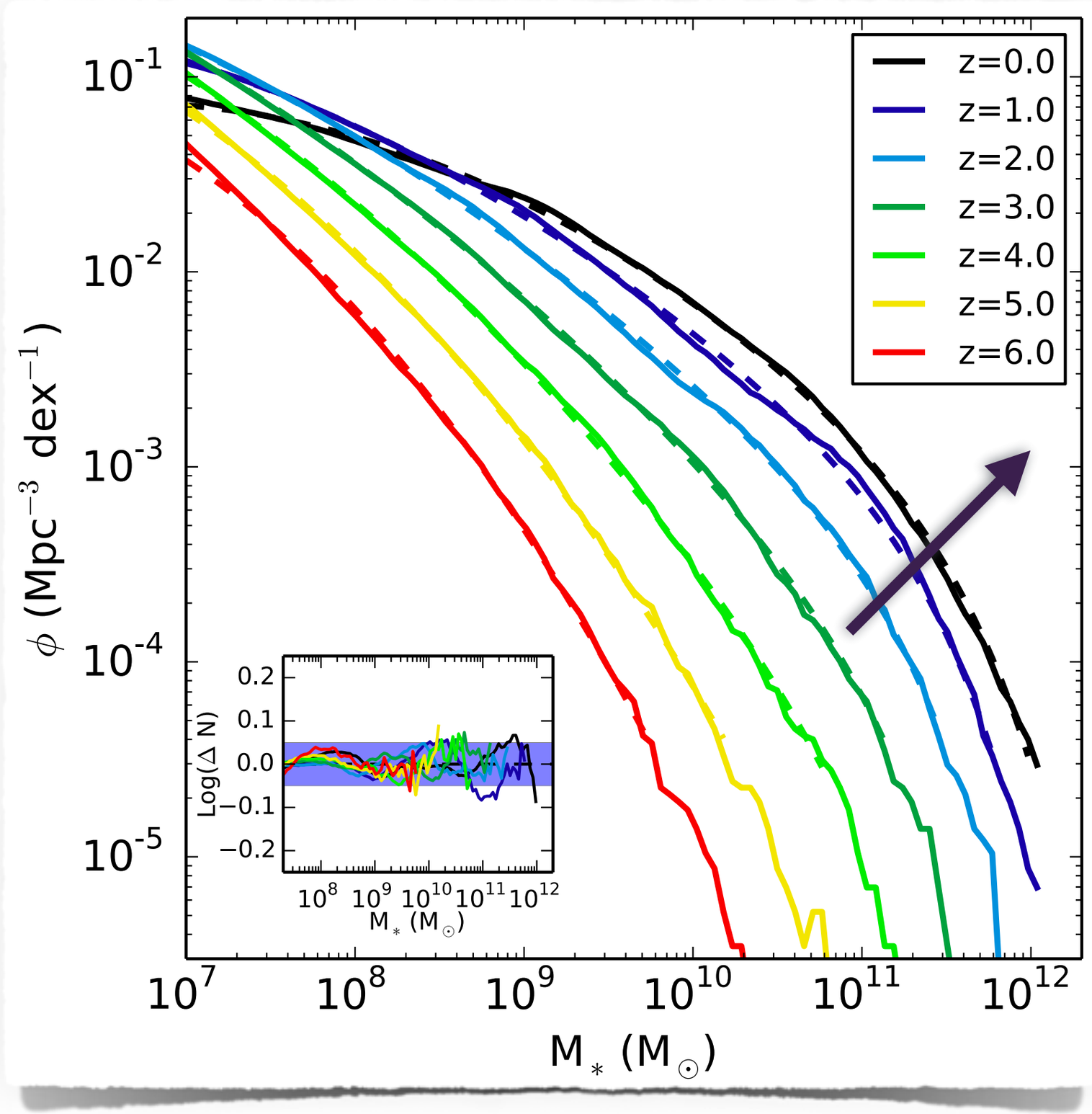
Predicted: Growth in the stellar mass function



Stringer+09

Predicted: Growth in the stellar mass function

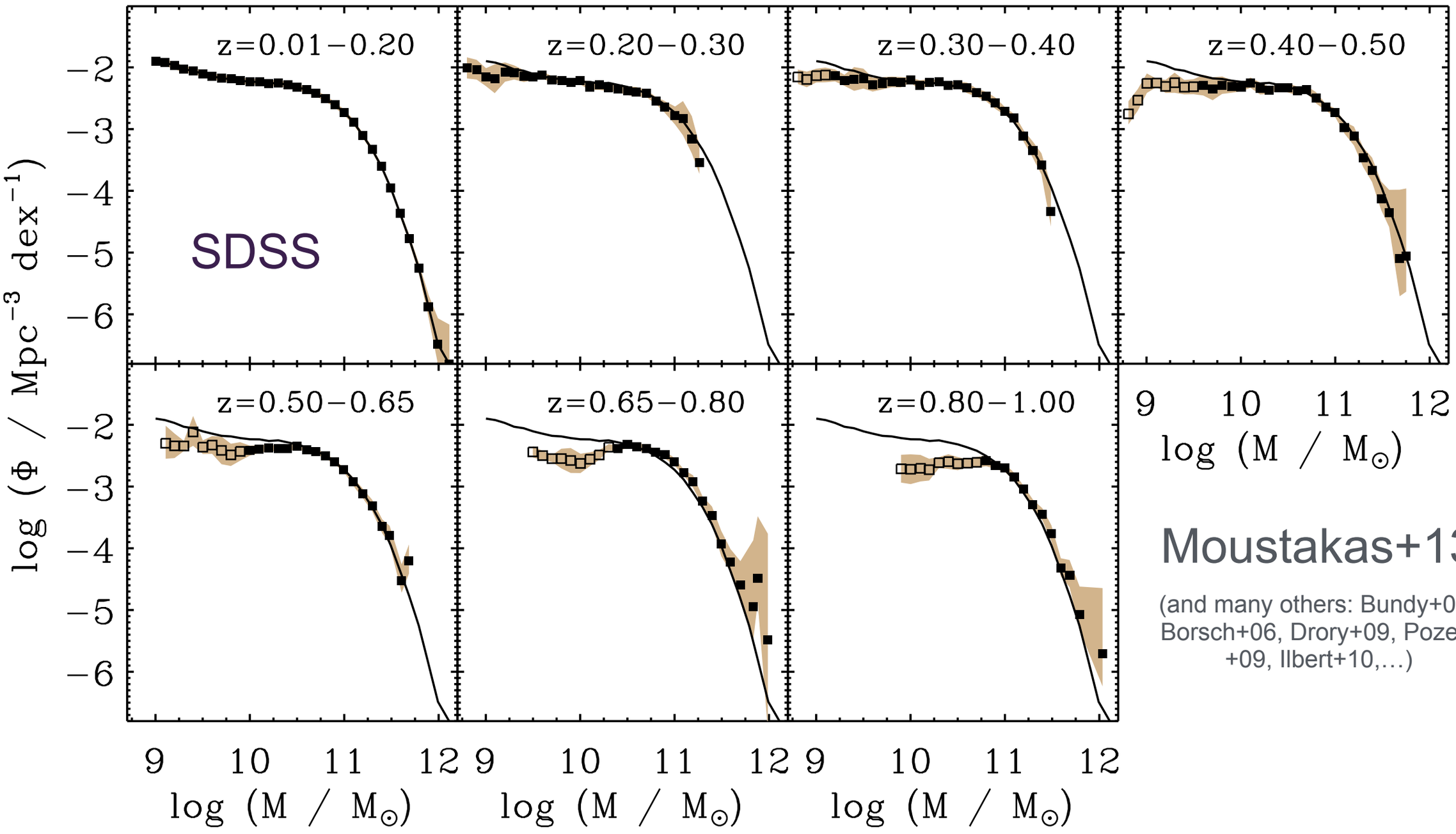
number density
(Mpc^{-3} per log M)



Illustris
Torrey+16

Observed: No growth in stellar mass

PRIMUS Survey: 5.5 deg^2

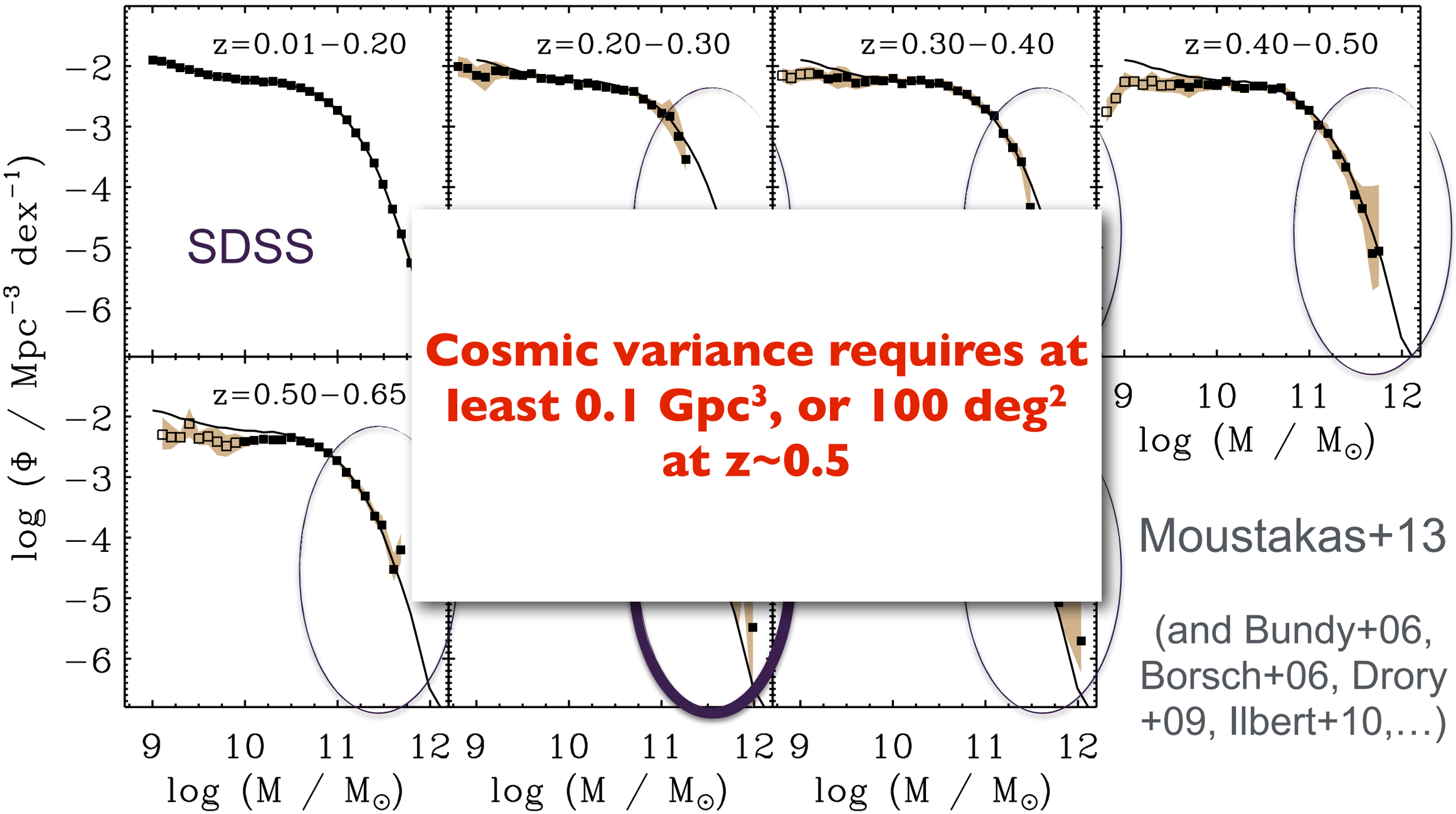


Moustakas+13

(and many others: Bundy+06, Borsch+06, Drory+09, Pozetti +09, Ilbert+10,…)

Observed: No growth in stellar mass

PRIMUS Survey: 5.5 deg^2



Cosmic variance requires at least 0.1 Gpc^3, or 100 deg^2 at z~0.5

Moustakas+13

(and Bundy+06, Borsch+06, Drory +09, Ilbert+10,…)

But, large errors at the high-mass end

Coming era of wide-field surveys

z > 2

z=1.4
0.001 Gpc^3

PRIMUS, DEEP2, COSMOS CANDELS

SDSS

z~0.1, 0.2 Gpc^3

Coming era of wide-field surveys

z > 2

z=1.4
0.001 Gpc^3

PRIMUS, DEEP2, COSMOS CANDELS

BOSS

14 Gpc^3, $z \rightarrow 0.7$
(*brightest* galaxies)

SDSS

z~0.1, 0.2 Gpc^3

Coming era of wide-field surveys

Hyper Suprime Cam Survey
grizy to i < 26 over 1400 deg^2

Vanishing sampling and
statistical uncertainties

z > 2

z=1.4
0.001 Gpc^3

PRIMUS, DEEP2, COSMOS CANDELS

HSC, DES

Eventually LSST, WFIRST

BOSS

14 Gpc^3, $z \rightarrow 0.7$
(*brightest* galaxies)

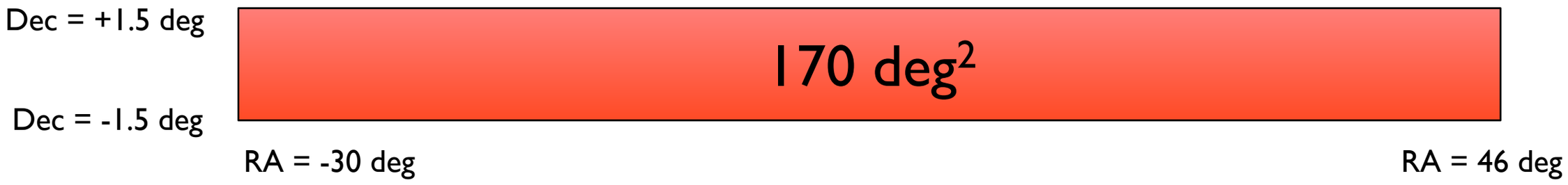
z~1
20 Gpc^3

SDSS

z~0.1, 0.2 Gpc^3

The BOSS Stripe 82 Massive Galaxy Catalog

Bundy et al. 2015b
MassiveGalaxies.com



Stripe 82 Coadds: 50-80 epochs, i_{AB} < 23.5, ~2 mag deeper than SDSS

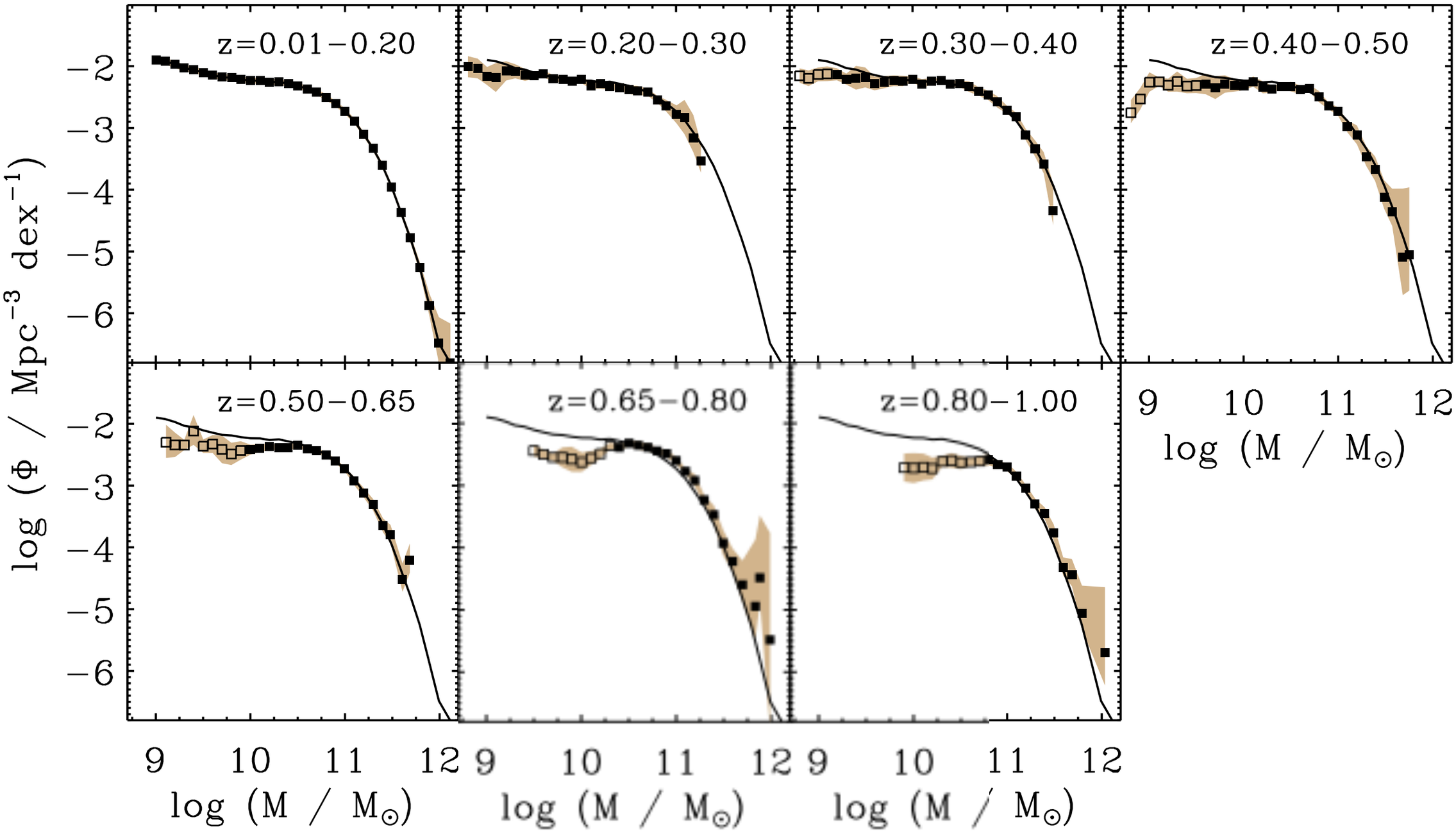
Synthetic Aperture Magnitudes (SynMags)

Bundy et al. 2012

Catalog-level PSF-matched photometry SDSS+UKIDSS: YJHK to ~19.8 AB

Optical + Near-IR 9-band stellar masses

Explore assumptions on priors and synthesis models


z=0.01−0.20
z=0.20−0.30
z=0.30−0.40
z=0.40−0.50
z=0.50−0.65
z=0.65−0.80
z=0.80−1.00
log (Φ / Mpc^{-3} dex^{-1})
log (M / M$_\odot$)
−2
−3
−4
−5
−6
9
10
11
12

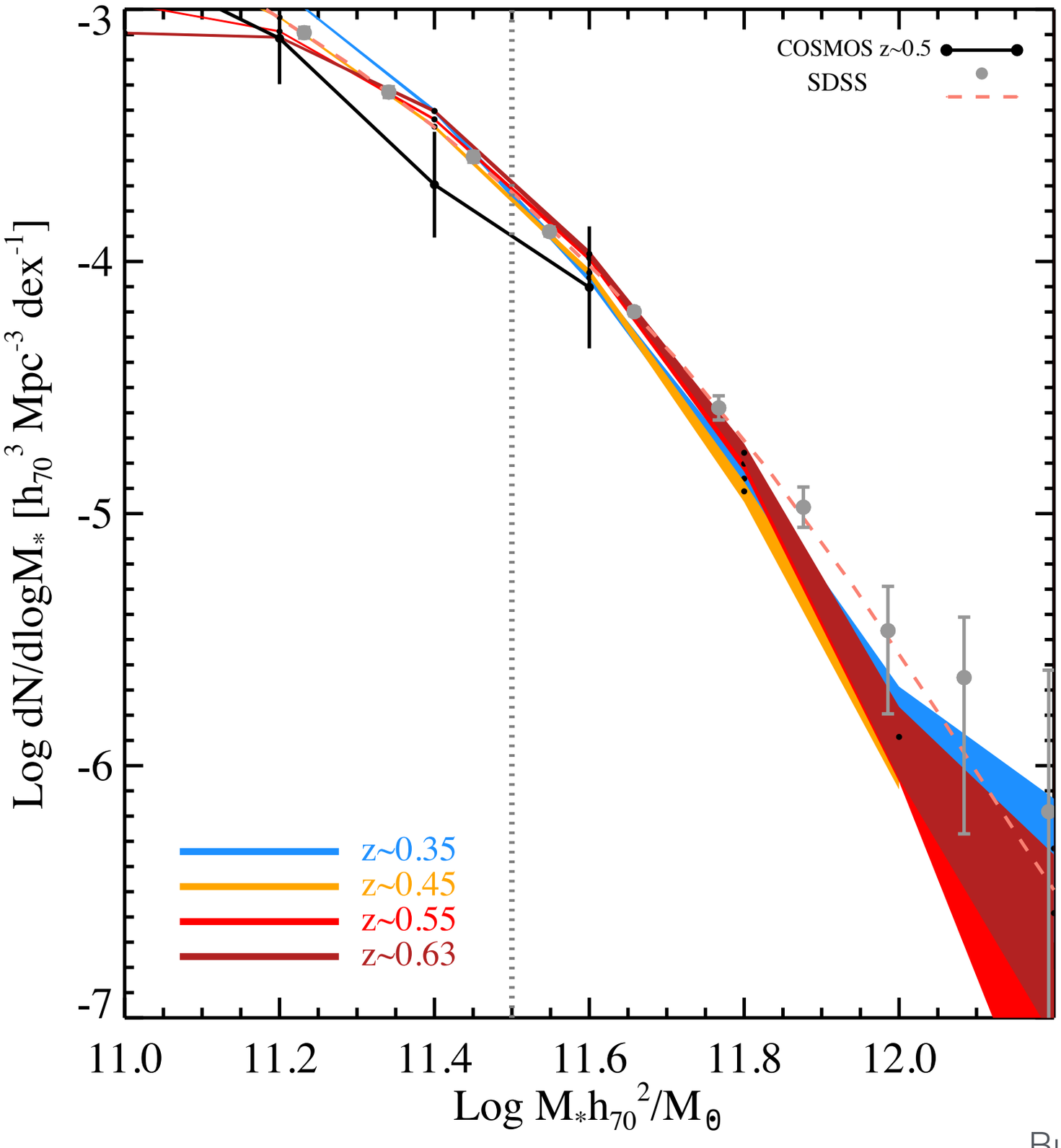
Wide-field preview with Stripe 82: BOSS + UKIDSS

170 deg²

~30,000 galaxies
(dominated by BCGs)

Near-IR $M_\star$

(+UKIDSS,
see Bundy+12)



Complete
at high-M

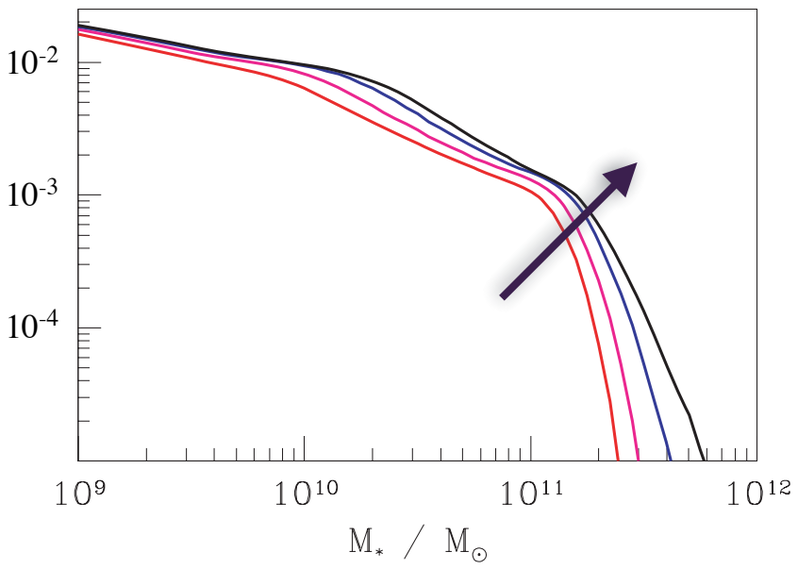
SDSS/BOSS + photoz

Nearly the
SDSS-I
volume!

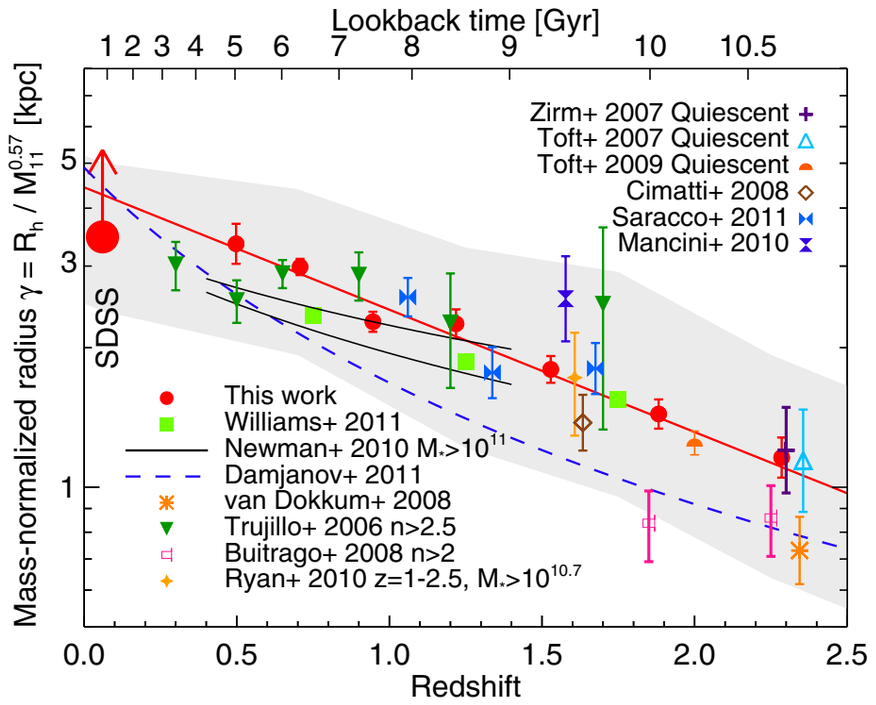
No
Evolution!

Bundy et al. in prep

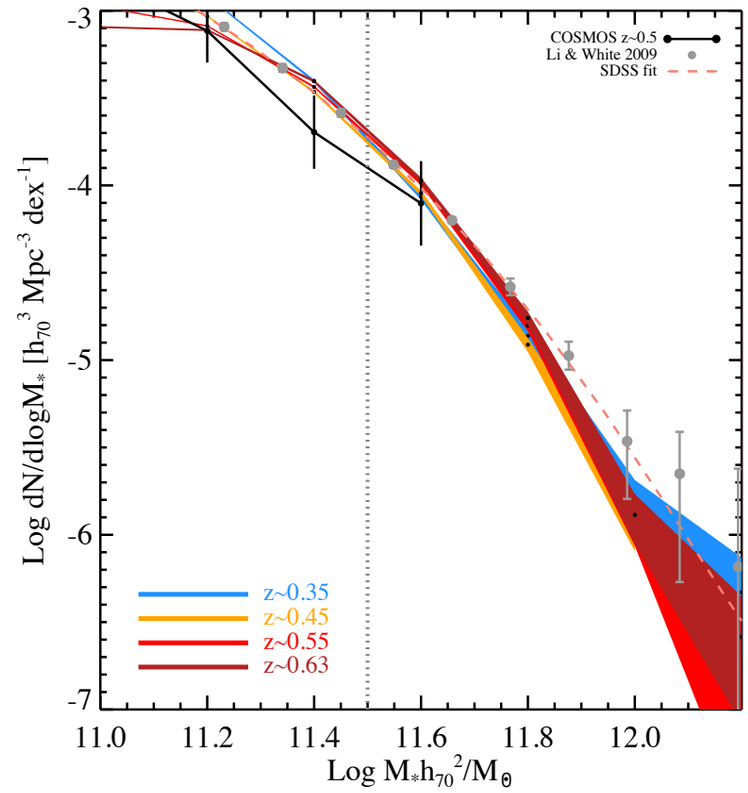
Predicted mass growth



Observed size growth



No observed mass growth

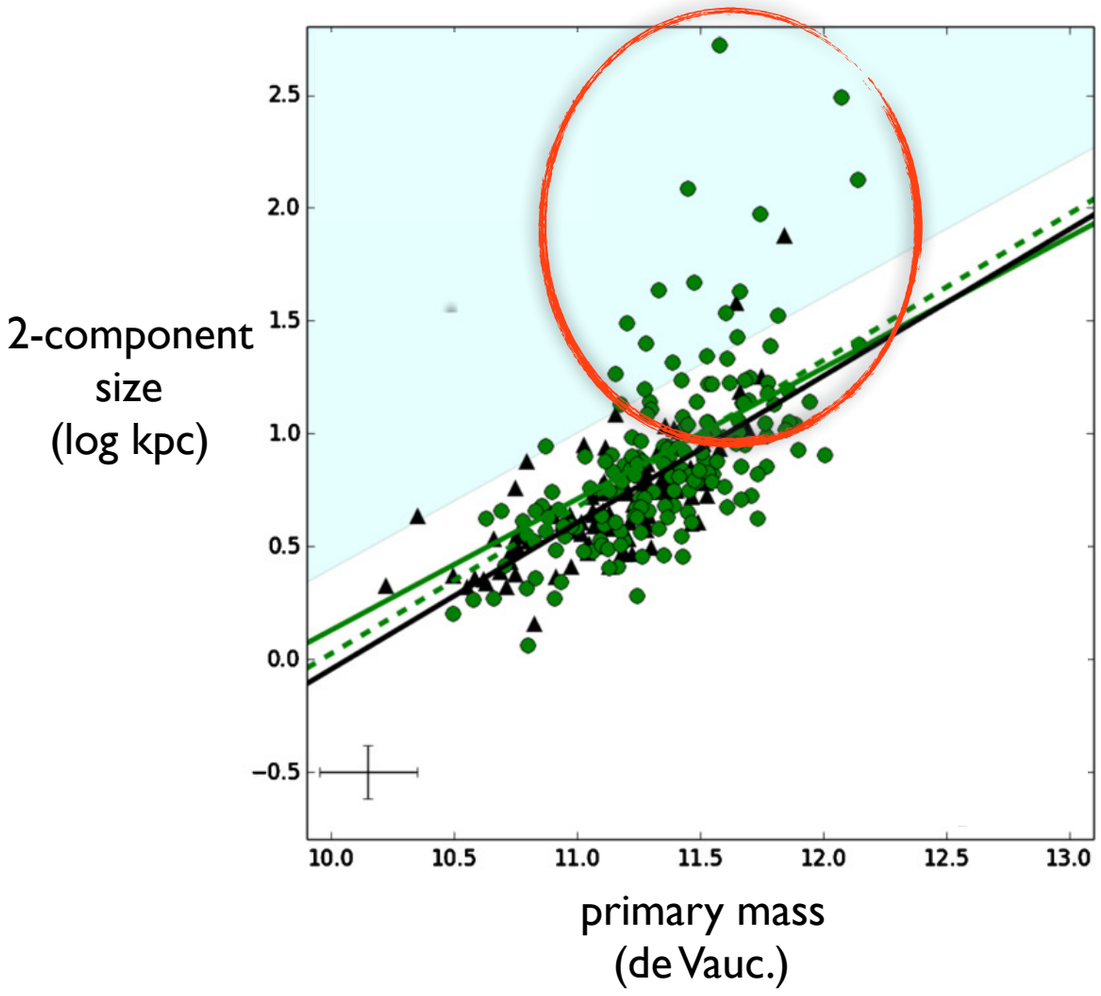


What are we missing here?

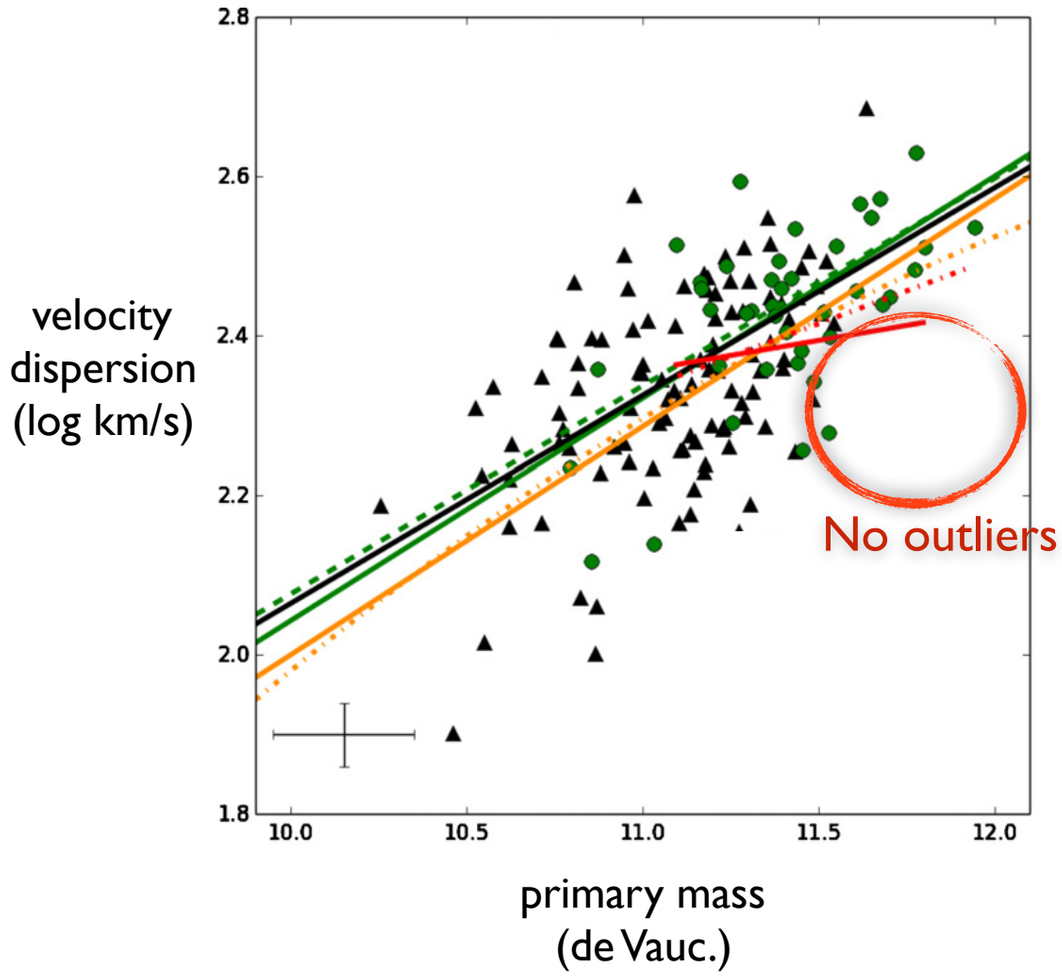
Multiple components: Envelopes and cores

We combined high-res (HST) imaging + spectroscopy
~40 BCGs in COSMOS at z~0.6

Vulcani, Bundy, et al. 2014



BCG progenitors are growing envelopes at z~0.6

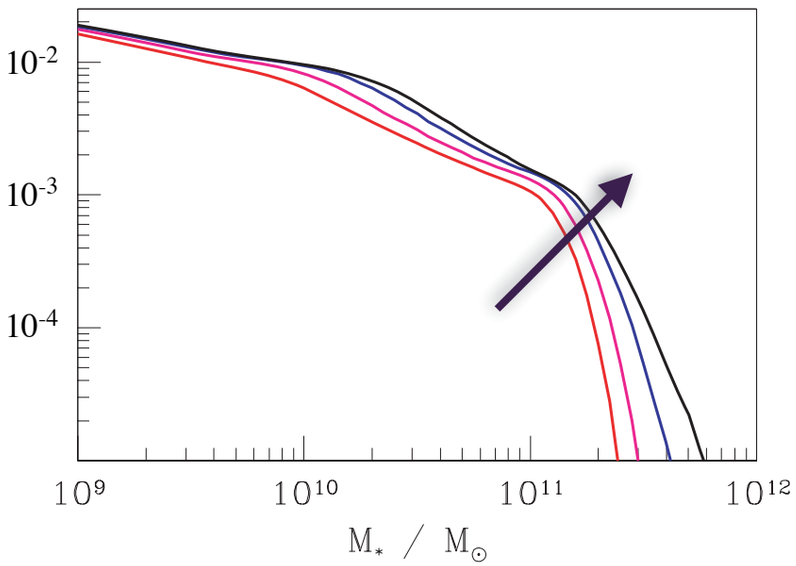


But their central, "primary" components are static

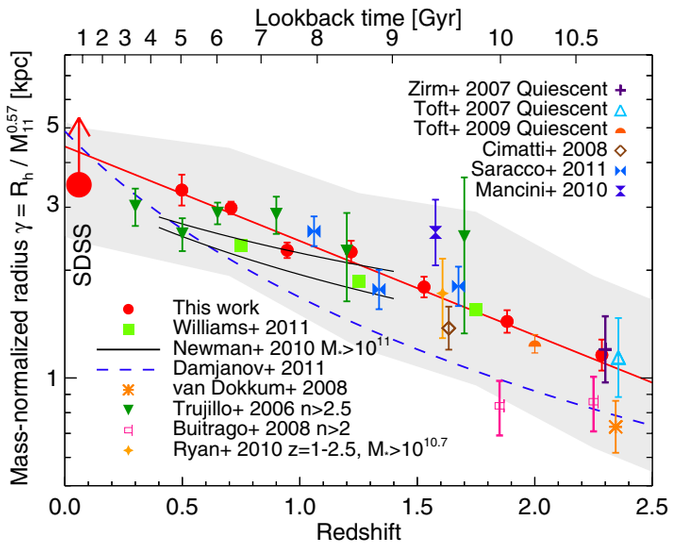
Also see: Huang+13, D'Souza+14, Patel+13, Greene+15, Bernardi+13, Kravtsov+14

Potential resolution of the puzzle…

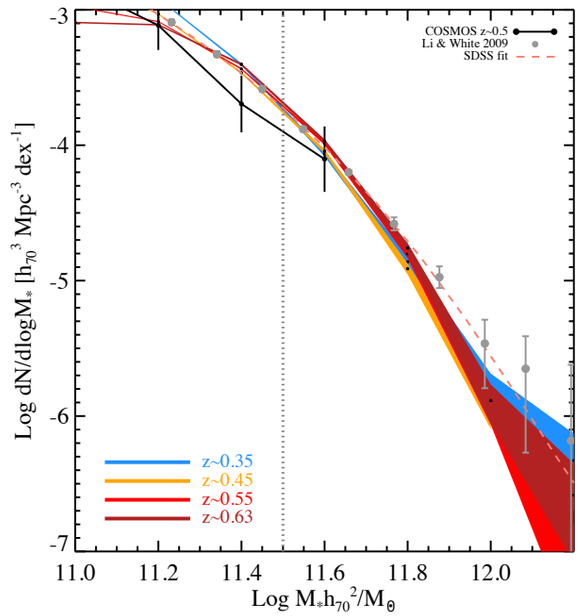
Predicted mass growth

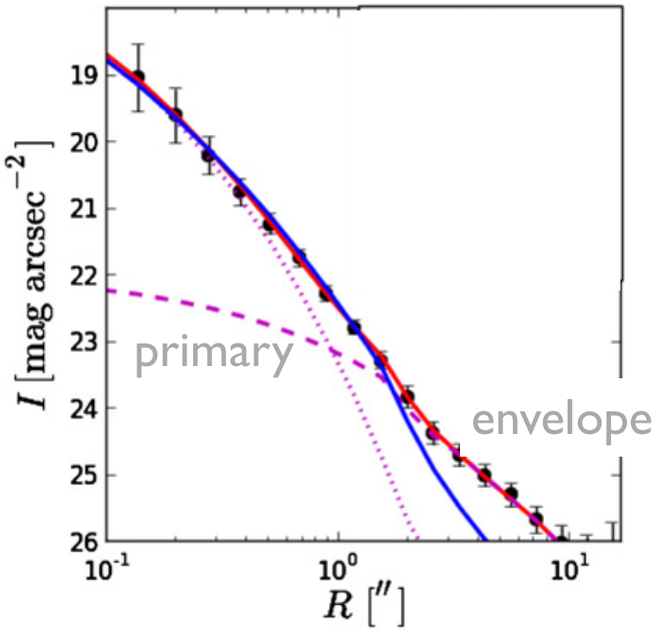


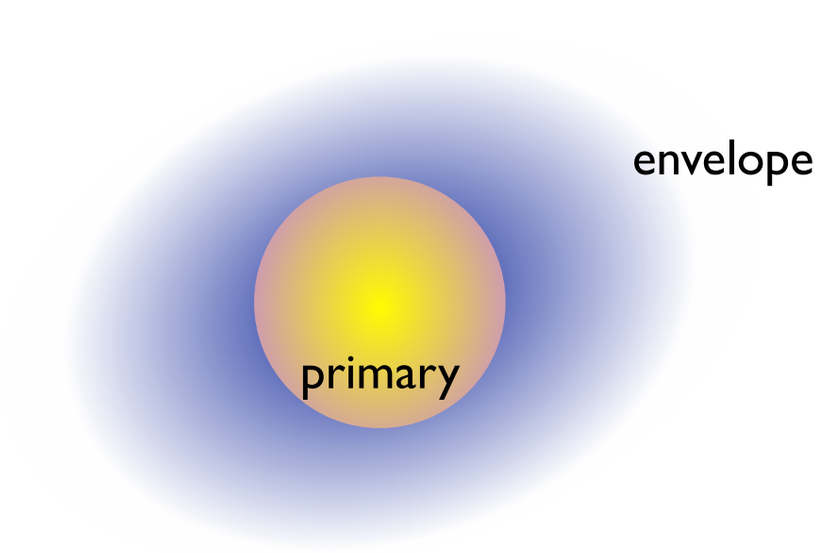
Observed size growth



No observed mass growth

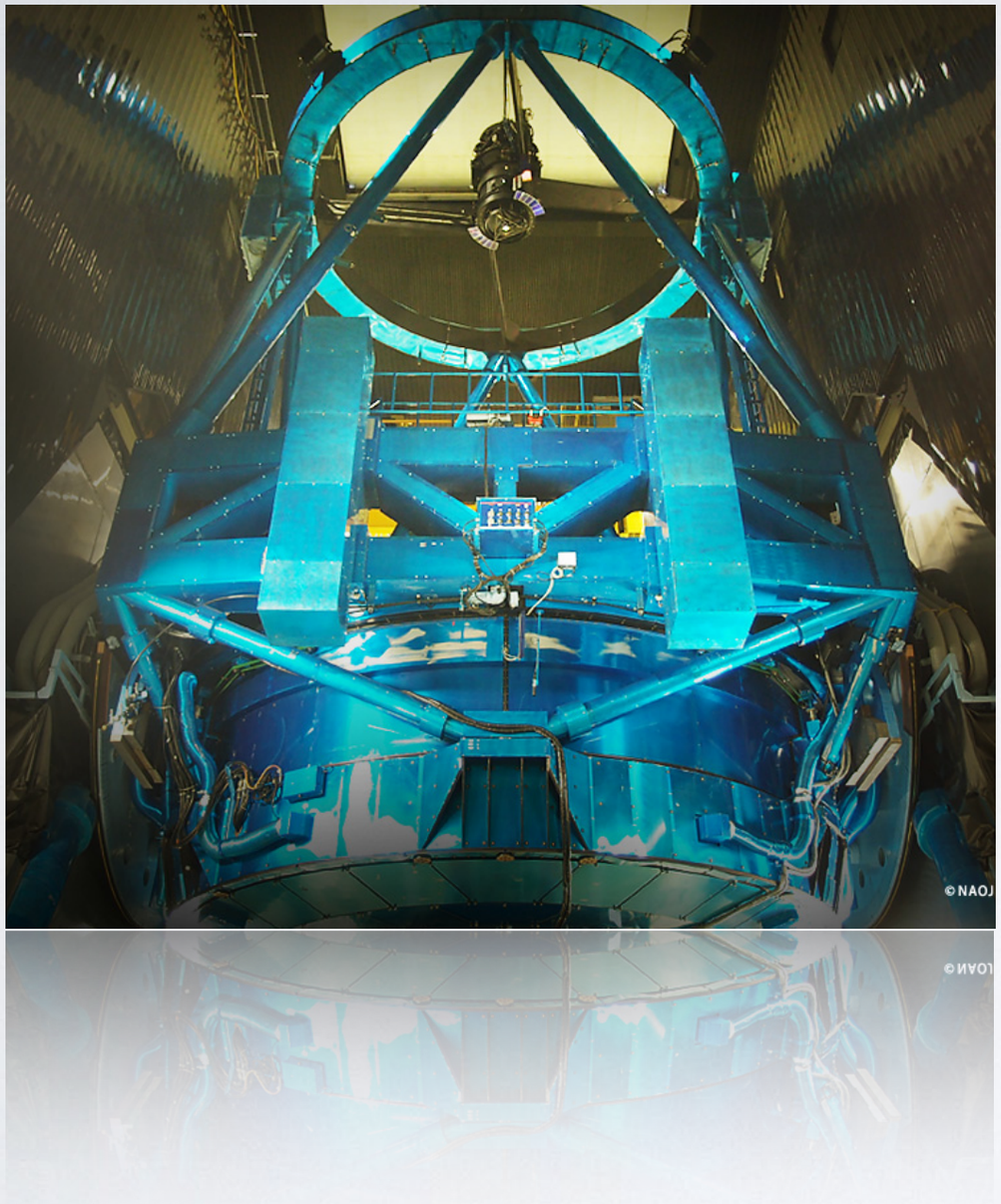






Hypothesis: Surveys to date have only measured primary components.
These don't grow.

Prospects with Hyper Suprime Cam



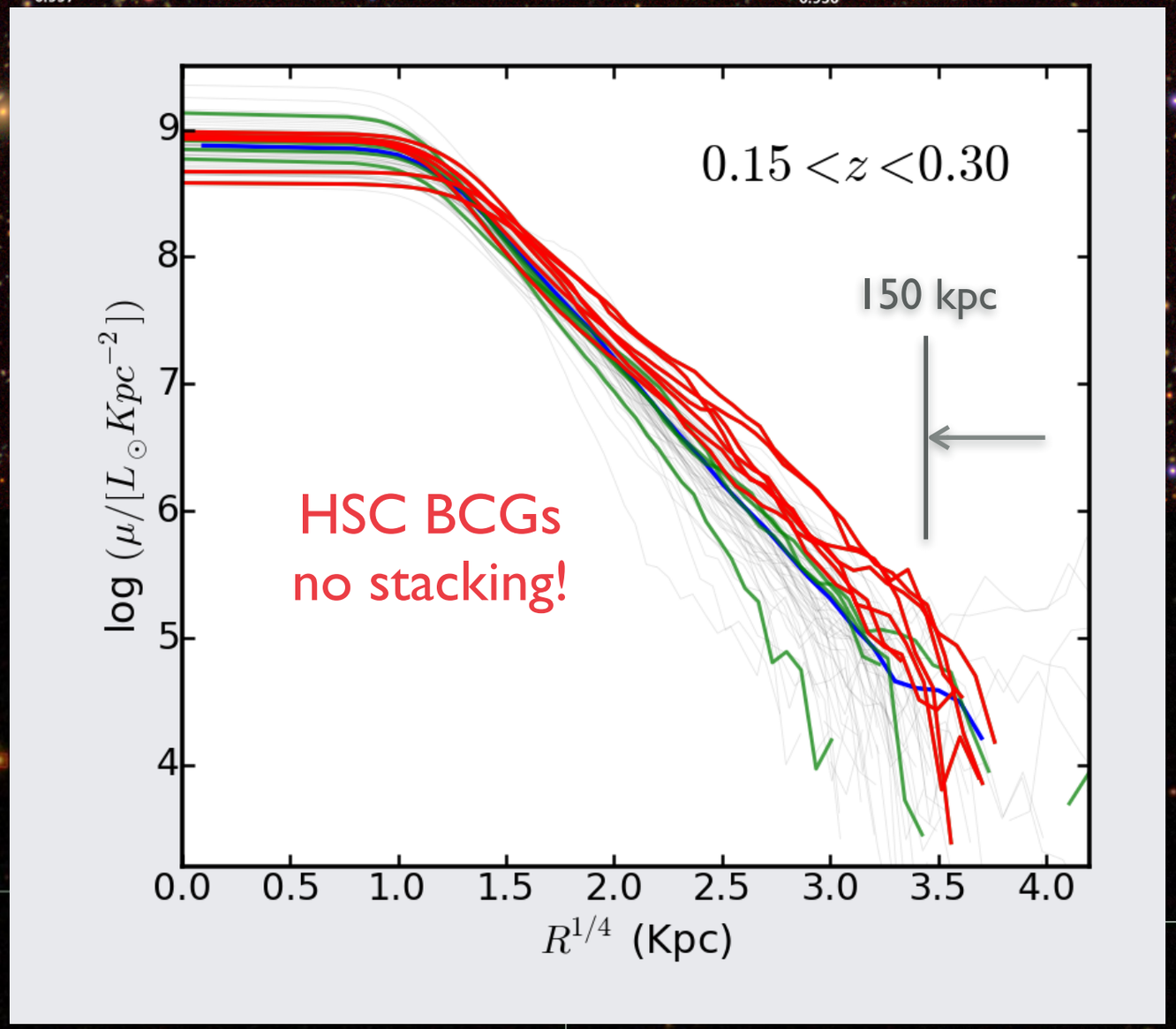
- Hyper Suprime Cam (HSC)
- 1.5 deg imager on Subaru
- Survey began in 2014
- *grizY* to 26 AB over 1400 deg^2

Prospects with Hyper Suprime Cam

z=0.326

z=0.420

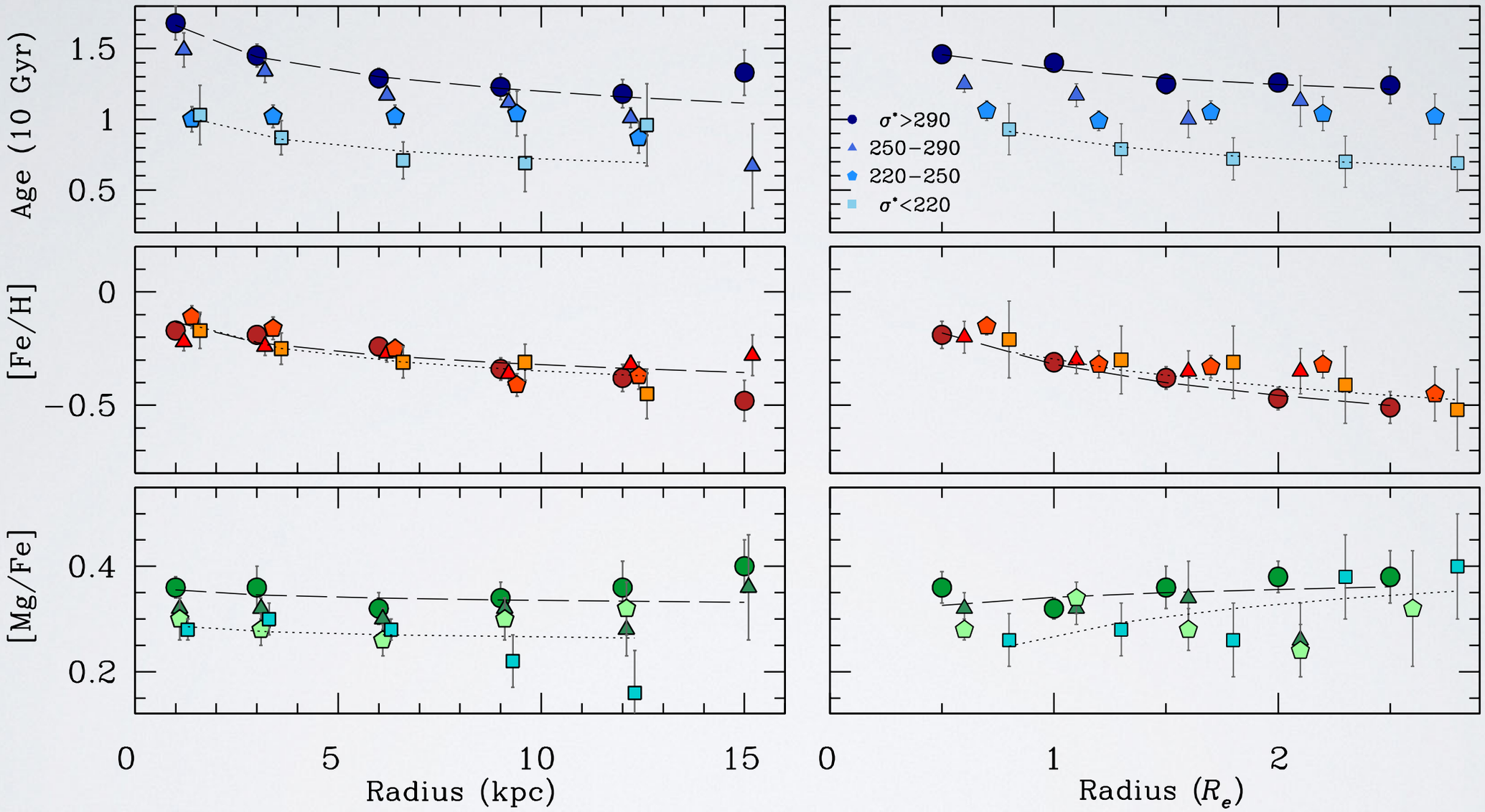
z=0.436



SDSS g'r'i'-Color Image

Prospects with MaNGA

Greene+15, 100 galaxies



MaNGA (DR13): 171 Early-types to 2.5 Re

MaNGA Update

2014-2020: 10,000 galaxies

Spatial resolution = 2” (1-2 kpc)
Spectral resolution = 60 km/s (sigma)
Wavelength range: 3600Å to 10,000Å
S/N = 4-8 at 1.5 Re (~3 hours)

Volume-limited samples: log M_{star} > 9
Flat in stellar mass and color
Uniform radial coverage

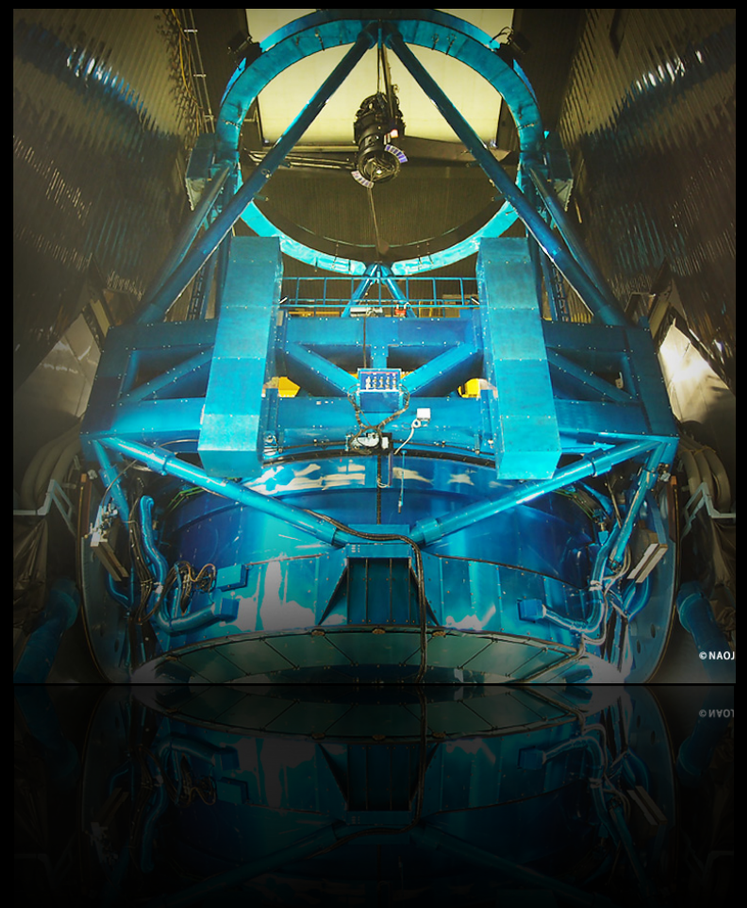
MaNGA Overviews:
Bundy et al. 2015, ApJ, 798, 7
Yan et al. 2016, in prep

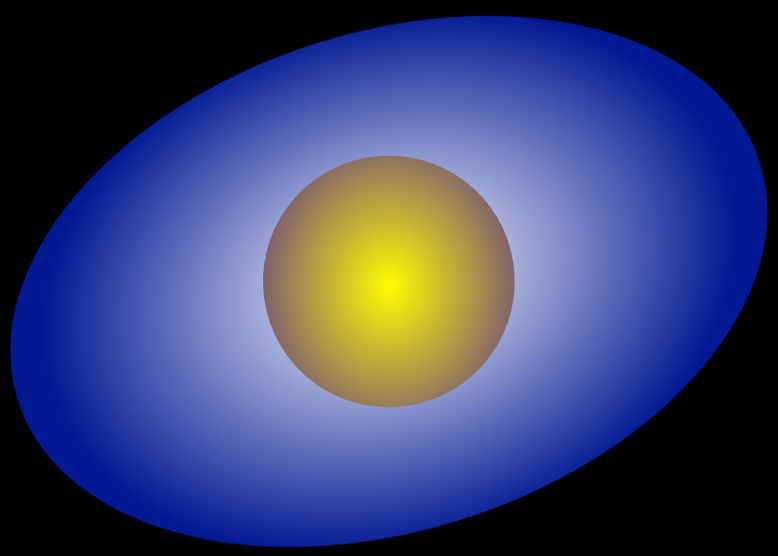
Current status: 2500 unique galaxies

MaNGA Public data release, **1400 unique data cubes**
July 2016

Conclusions

- A puzzle: High-mass galaxies grow in radius but not mass?
- New insight coming from deep wide-field imaging surveys like Hyper Suprime Cam (HSC).





- IFS surveys like MaNGA will provide a “global-to-local” test by measuring the chemistry of outer stellar populations