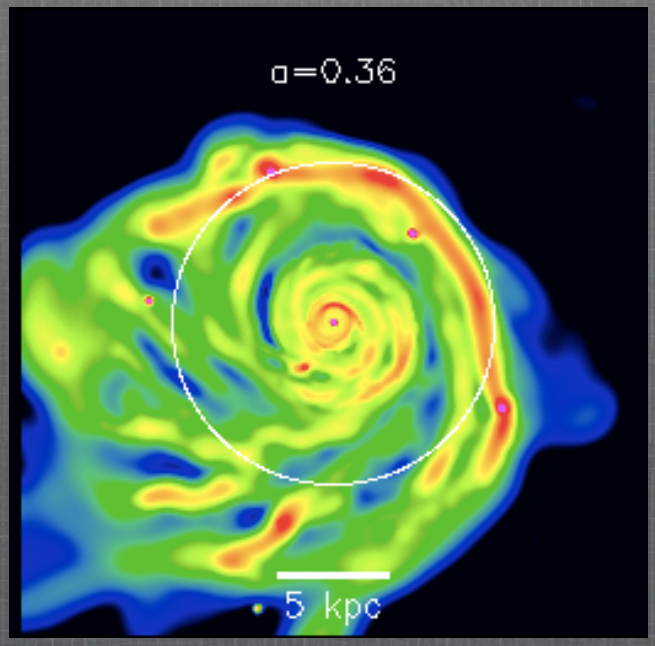
HOW TO MAKE A COMPACT STAR FORMING SPHEROID



Adi Zolotov / Hebrew University

Daniel Ceverino , Avishai Dekel, Dylan Tweed

COSMOLOGICAL SIMULATIONS

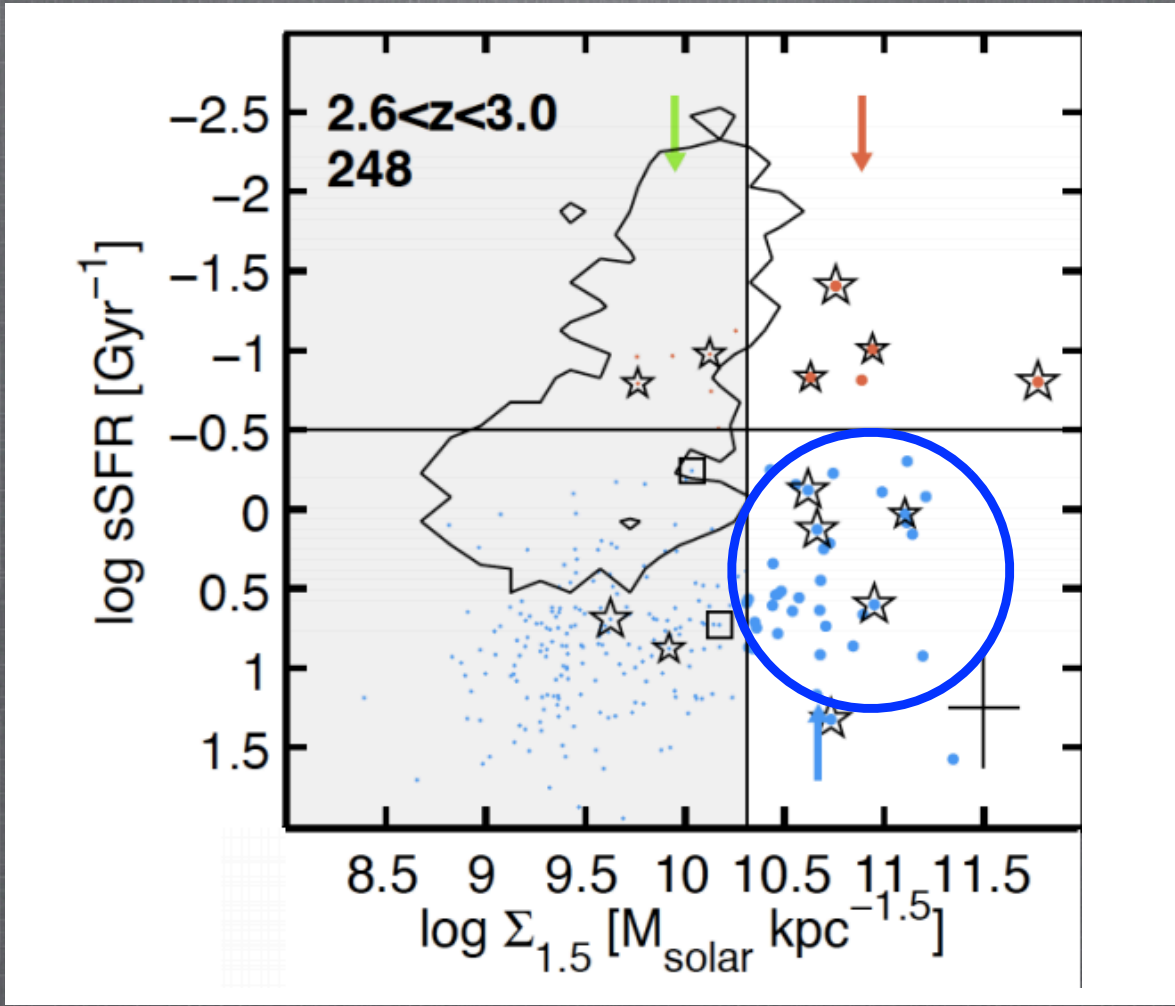
- HydroART simulations: Kravstov, Klypin, Ceverino

- Zoom-in cosmological simulations of 30 massive galaxies (M_{vir} ~ 0.5 - 2 x 10^{12} $M_{\odot}$ at z=2)

- High-resolution: ~ 20 - 50 pc spatial resolution

- Feedback: thermal ("Gen1"), radiative pressure ("Gen3") - see Ceverino's talk this afternoon.

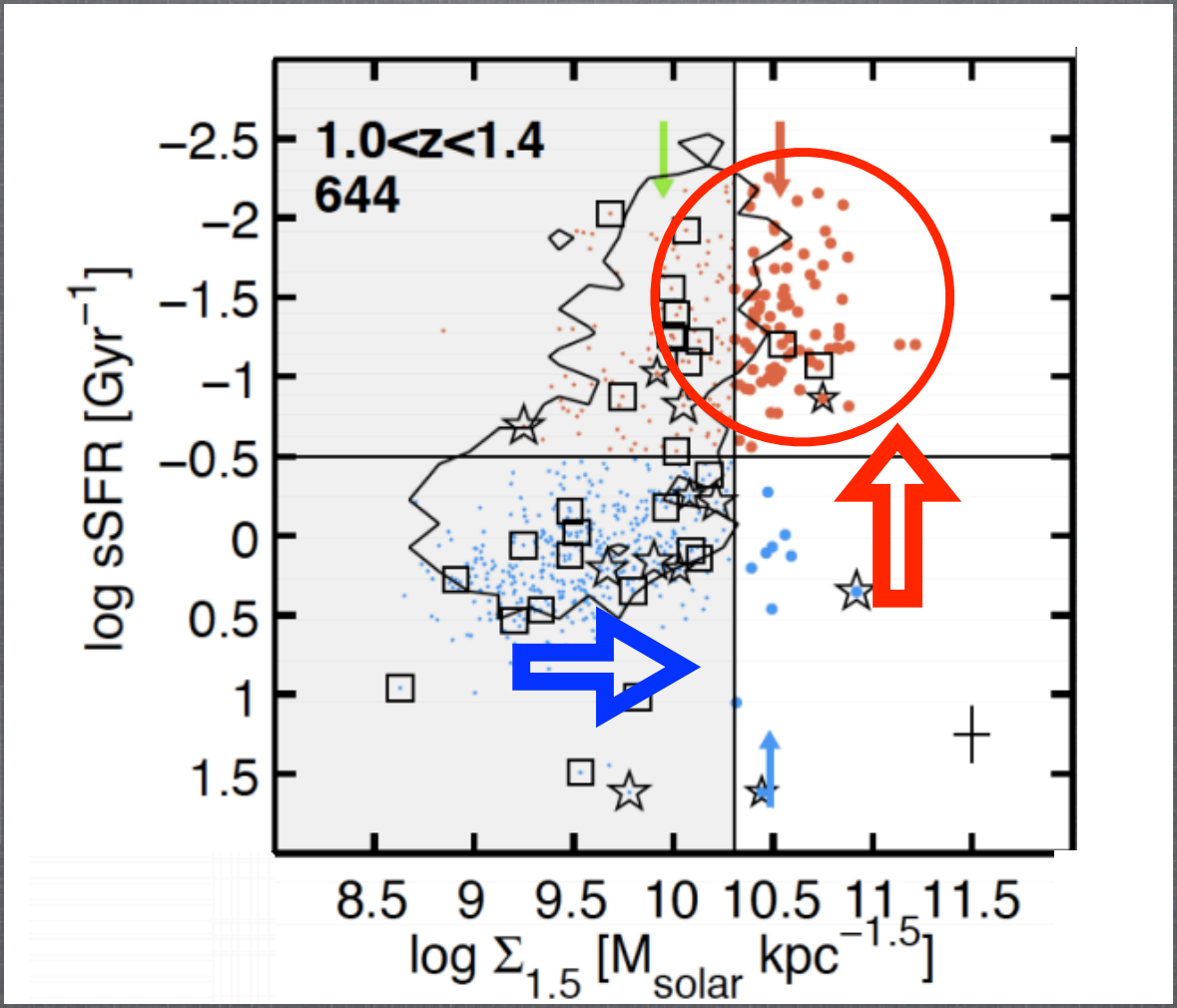
Motivation:
Observations of "Nuggets"



BARRO ET AL. (2013)

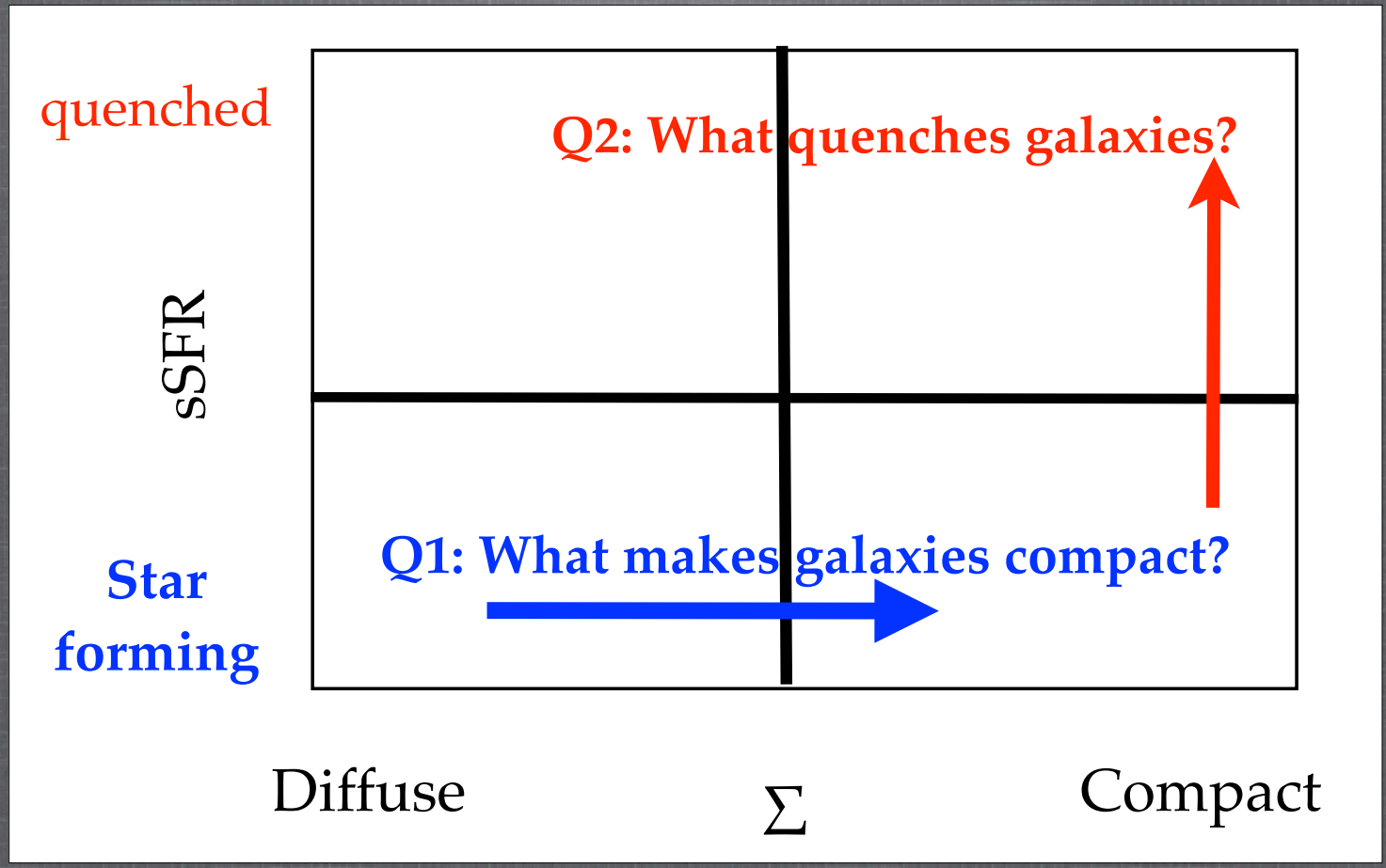
also: Fang et al. (2012), Cheung et al. (2012)

Motivation:
Observations of "Nuggets"

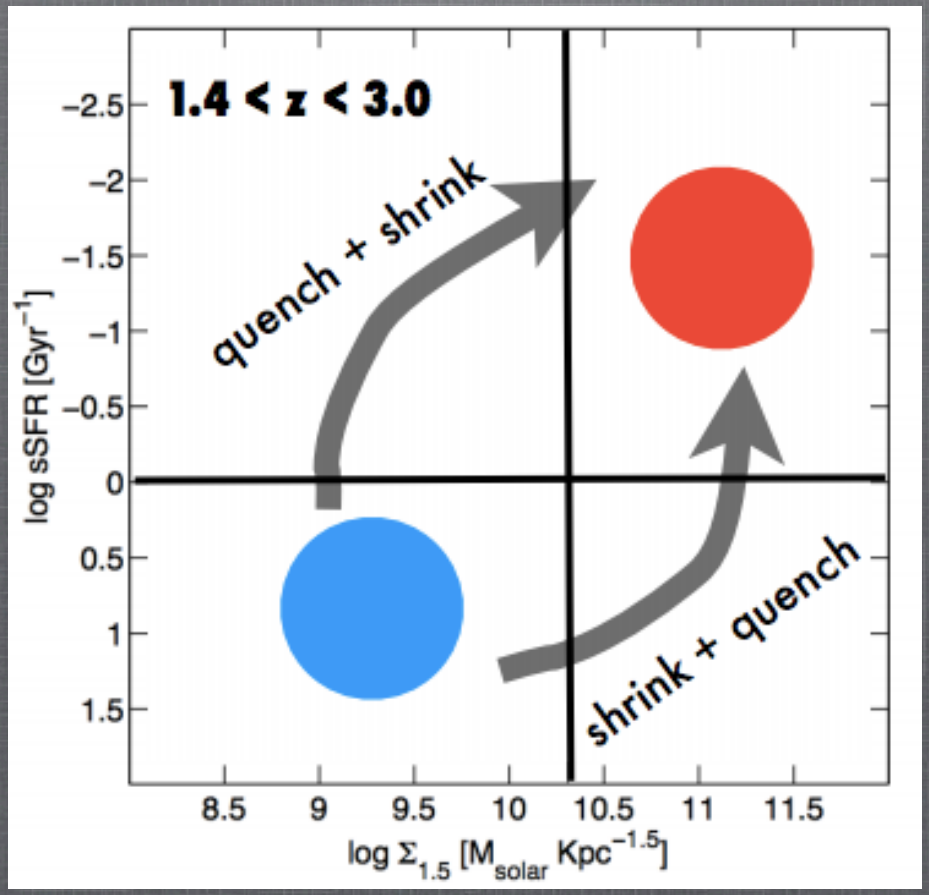


BARRO ET AL. (2013)

Open Questions

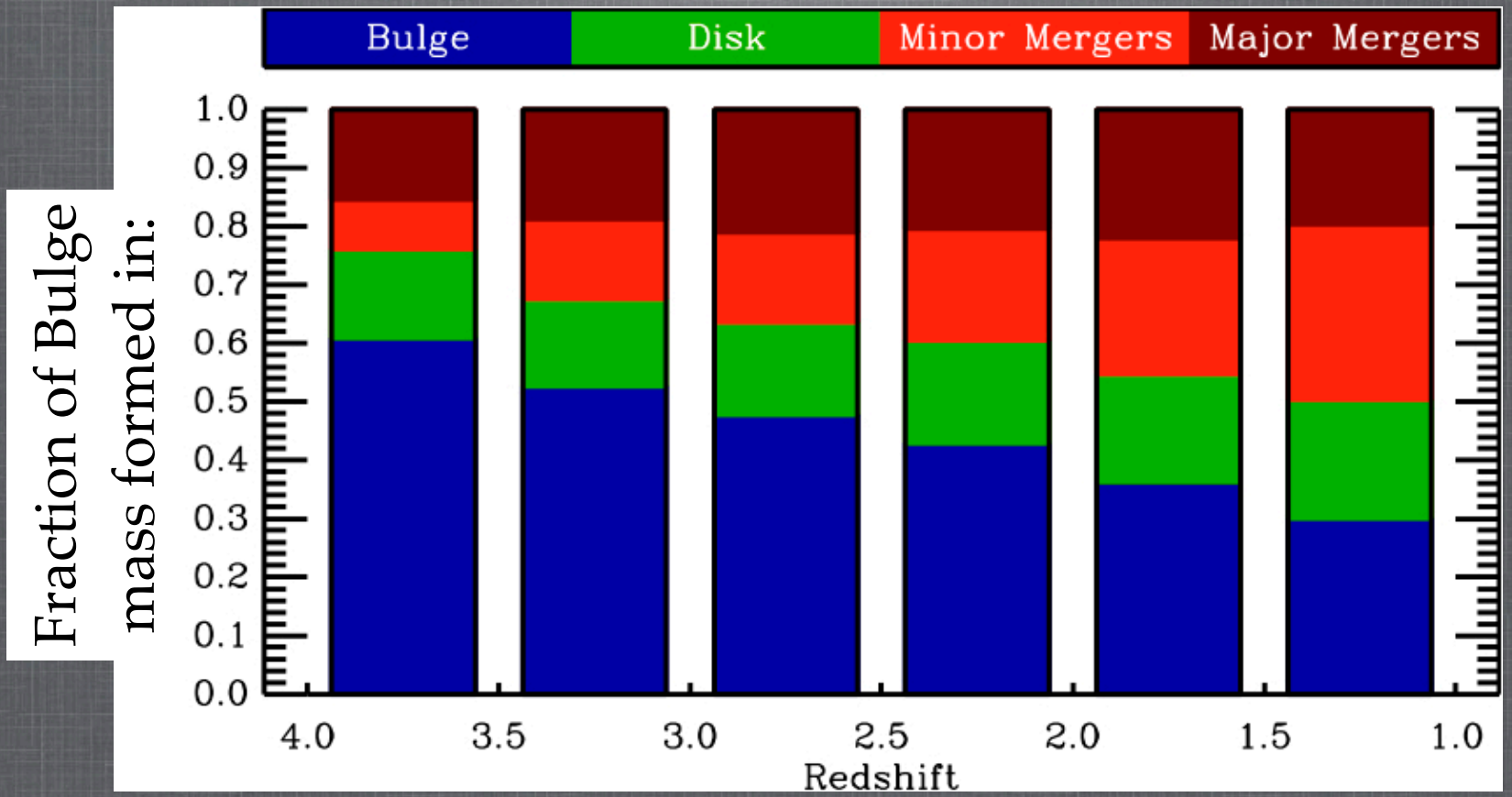


Q3: What is the evolutionary path?



Barro et al. 2013

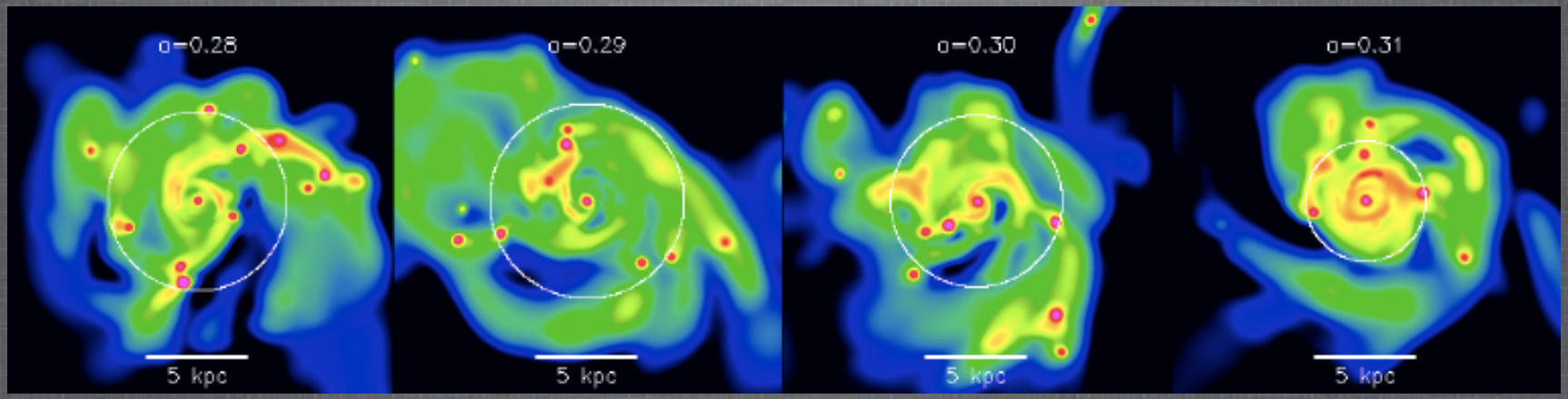
STELLAR BULGE FORMATION



A lot of stars form in situ in the bulge!

Tweed, Zolotov, Dekel +

WHAT FUELS IN SITU STAR FORMATION IN BULGES?



1. Gas from wet mergers

- and/or -

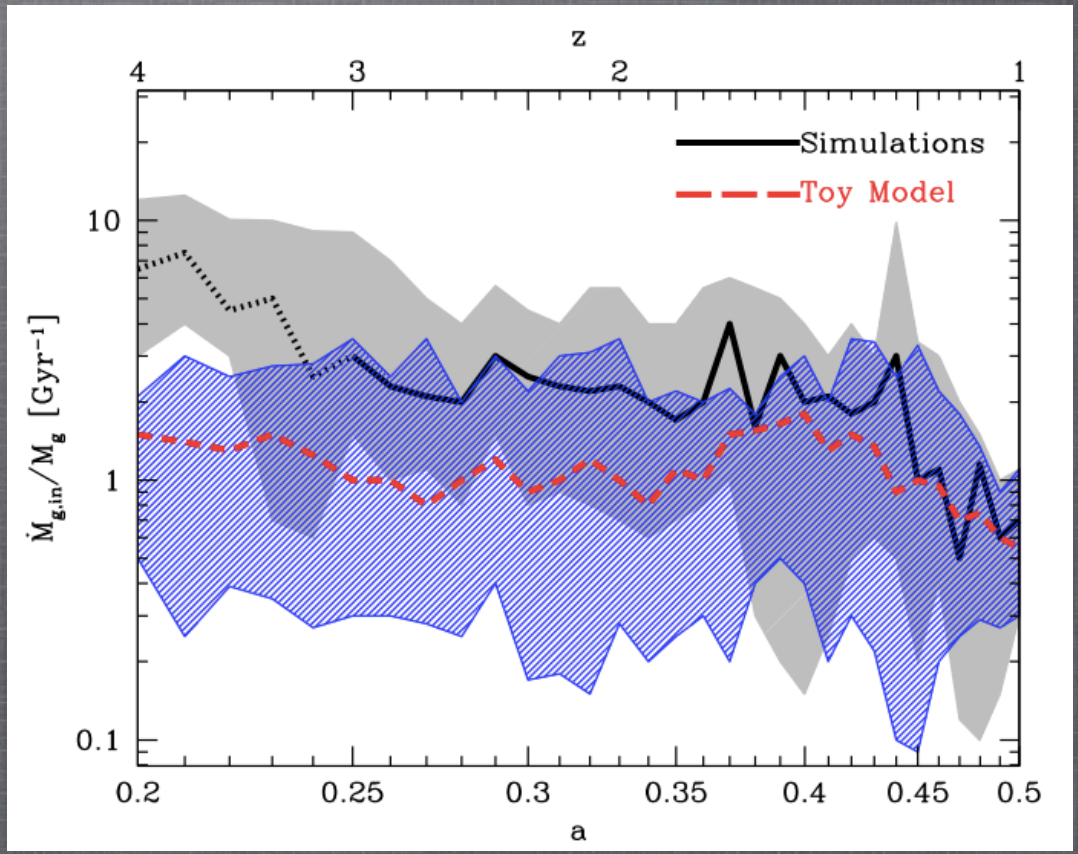
2. Disk instability → Inflow of gas, stars, & clumps to center

INFLOW OF GAS WITHIN THE DISK

Torques between perturbations drive AM out and mass in

$$Q \sim \frac{\Omega\sigma}{G\Sigma} \leq 1$$

$$\left\langle \dot{M}_{\text{inf low}} \right\rangle \sim 25 M_{\odot}/yr$$

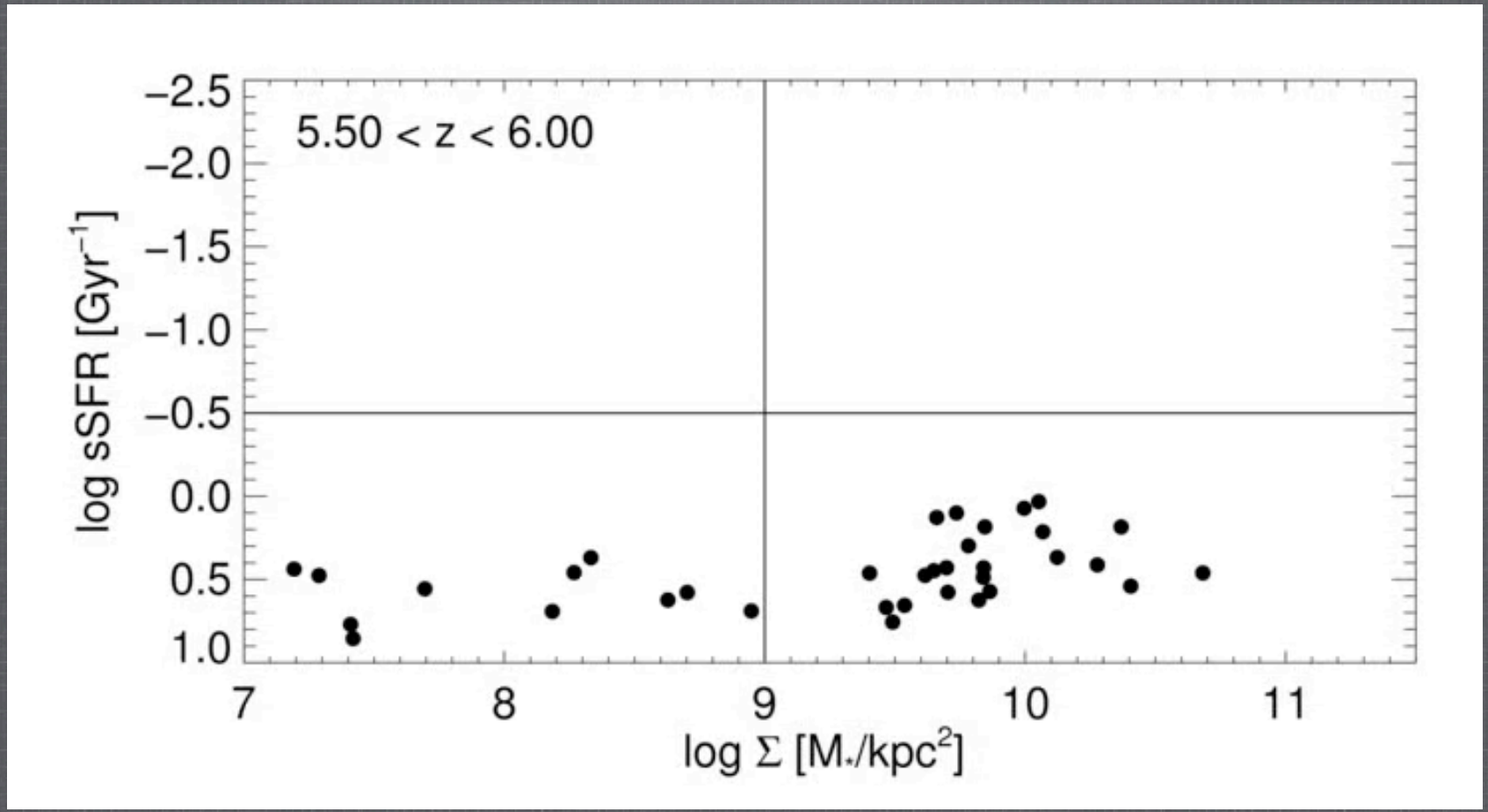


Dekel, Zolotov + (2013)

also: Gammie + (2001), Dekel + (2009), Krumholz + (2010), Cacciato + (2011)

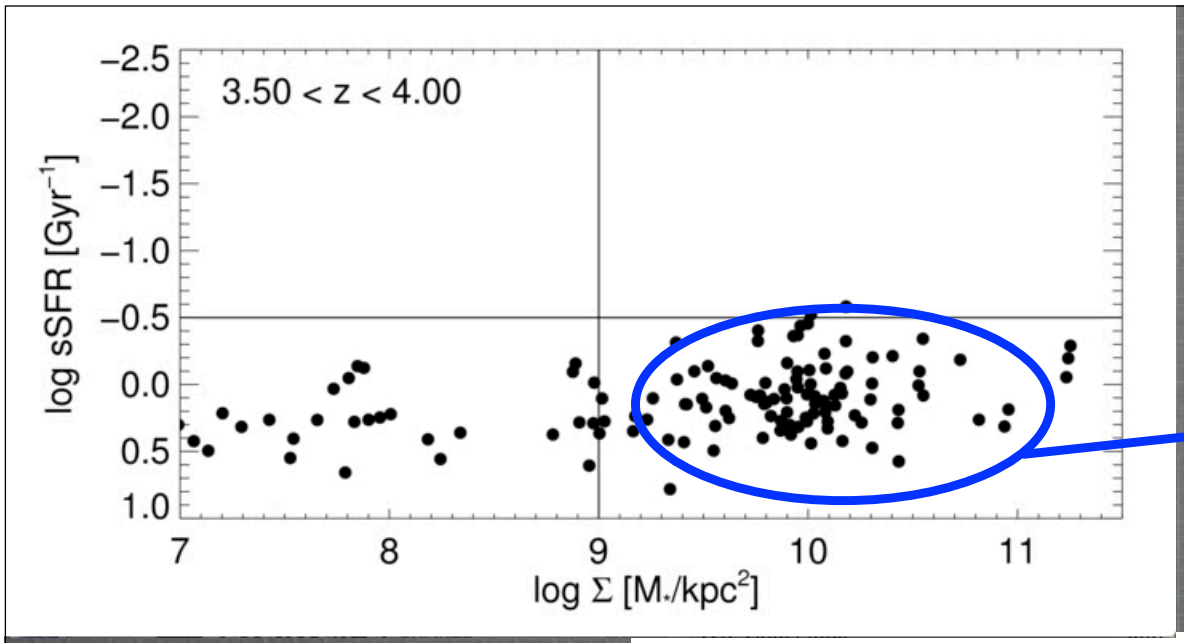
observations: Genzel + 2006, 2008, 2011 Elmgreen + 2004, 2005, Guo +2013

The Formation of Compact Galaxies
1 < z <6



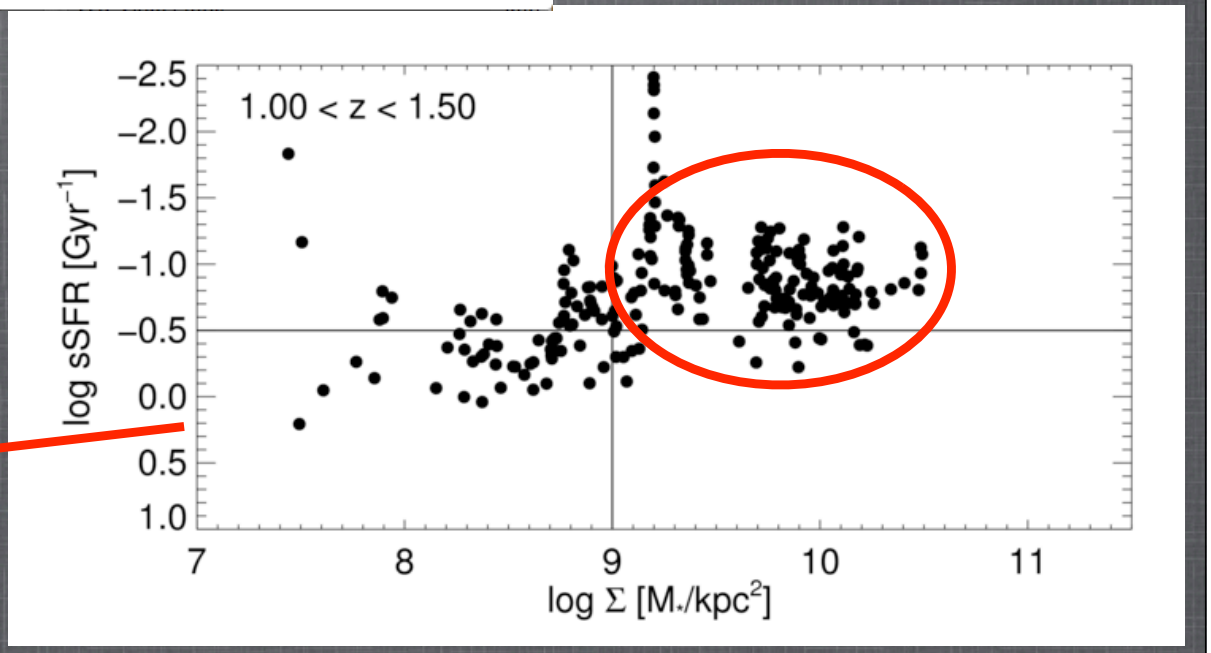
ZOLOTOV, TWEED, DEKEL + (IN PREP)

also: Lauren Porter's work with SAMs, Joel's talk



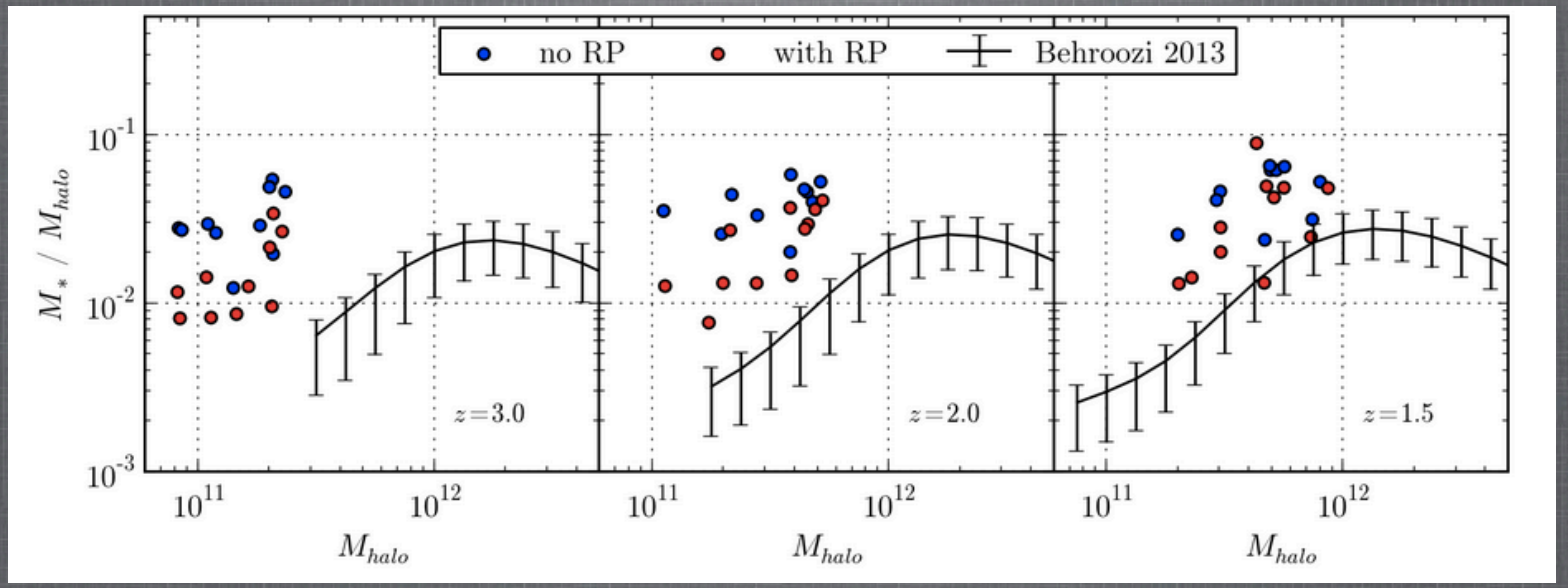
compact, SF galaxies at hi-z

compact, quiescent galaxies at low-z

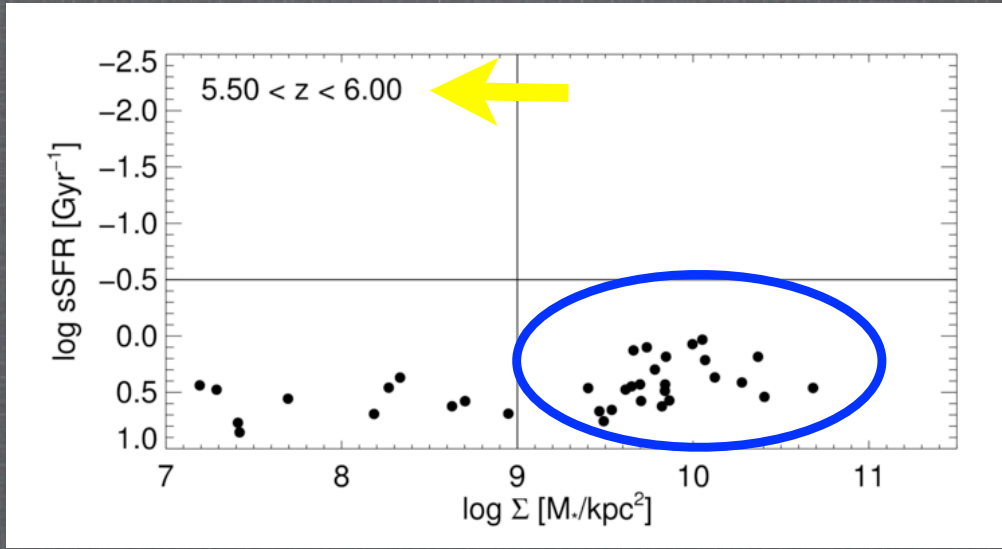


ZOLOTOV, TWEED, DEKEL + (IN PREP)

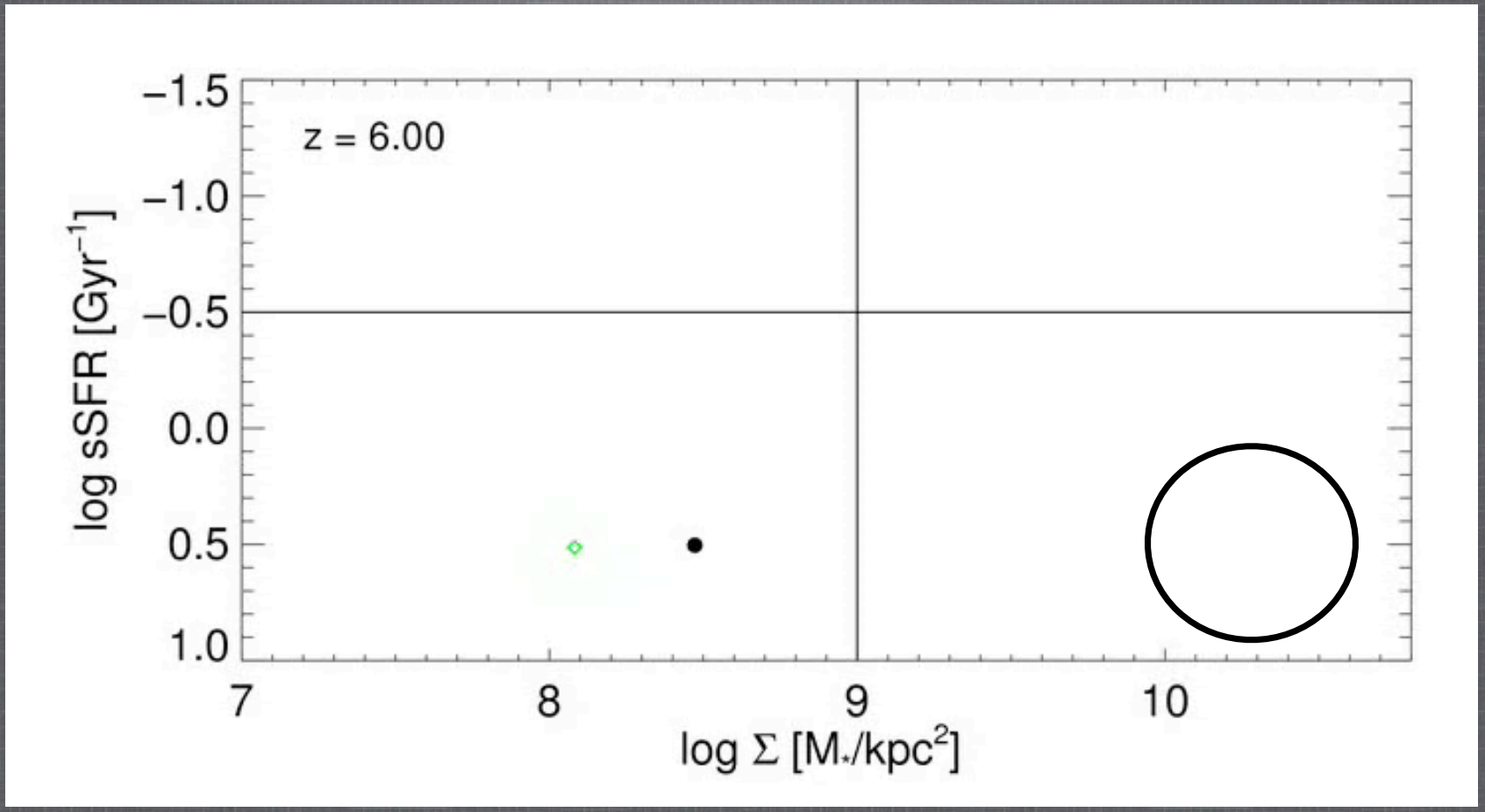
Caveat: Too much early star formation in simulations



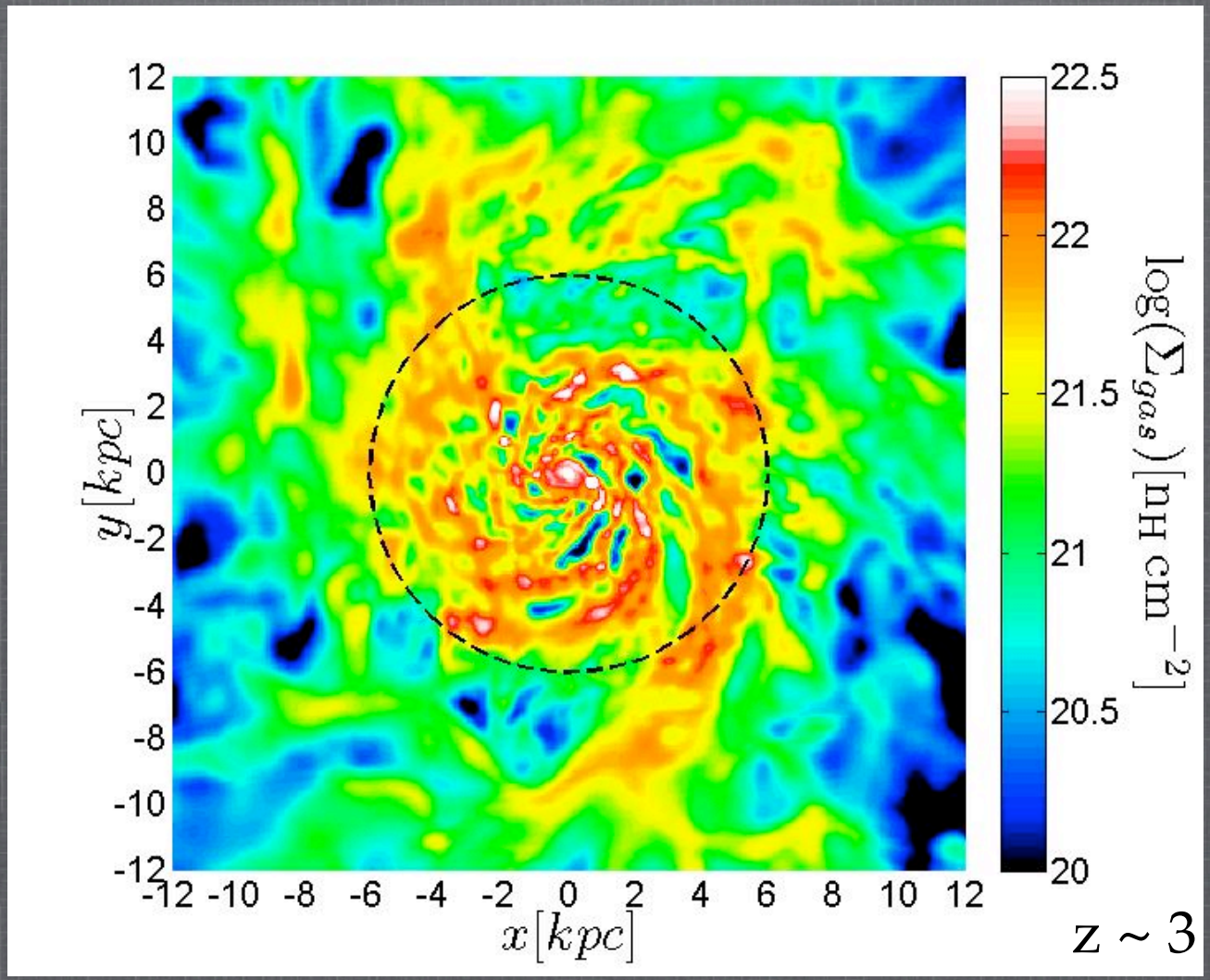
CHRIS MOODY



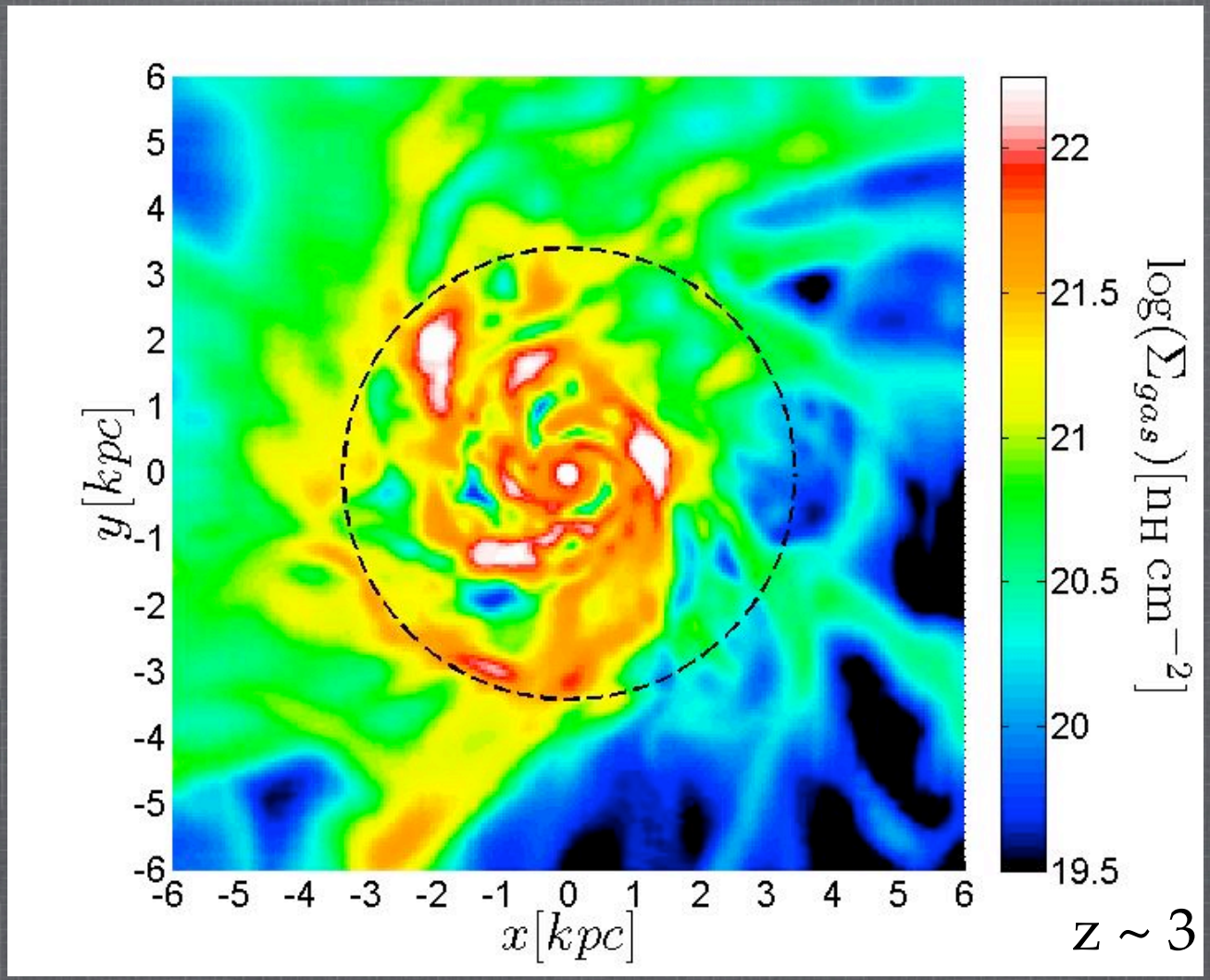
- 3 individual cases -



1. Galaxies become compact at high sSFR, then quench
2. Galaxy gradually quenches

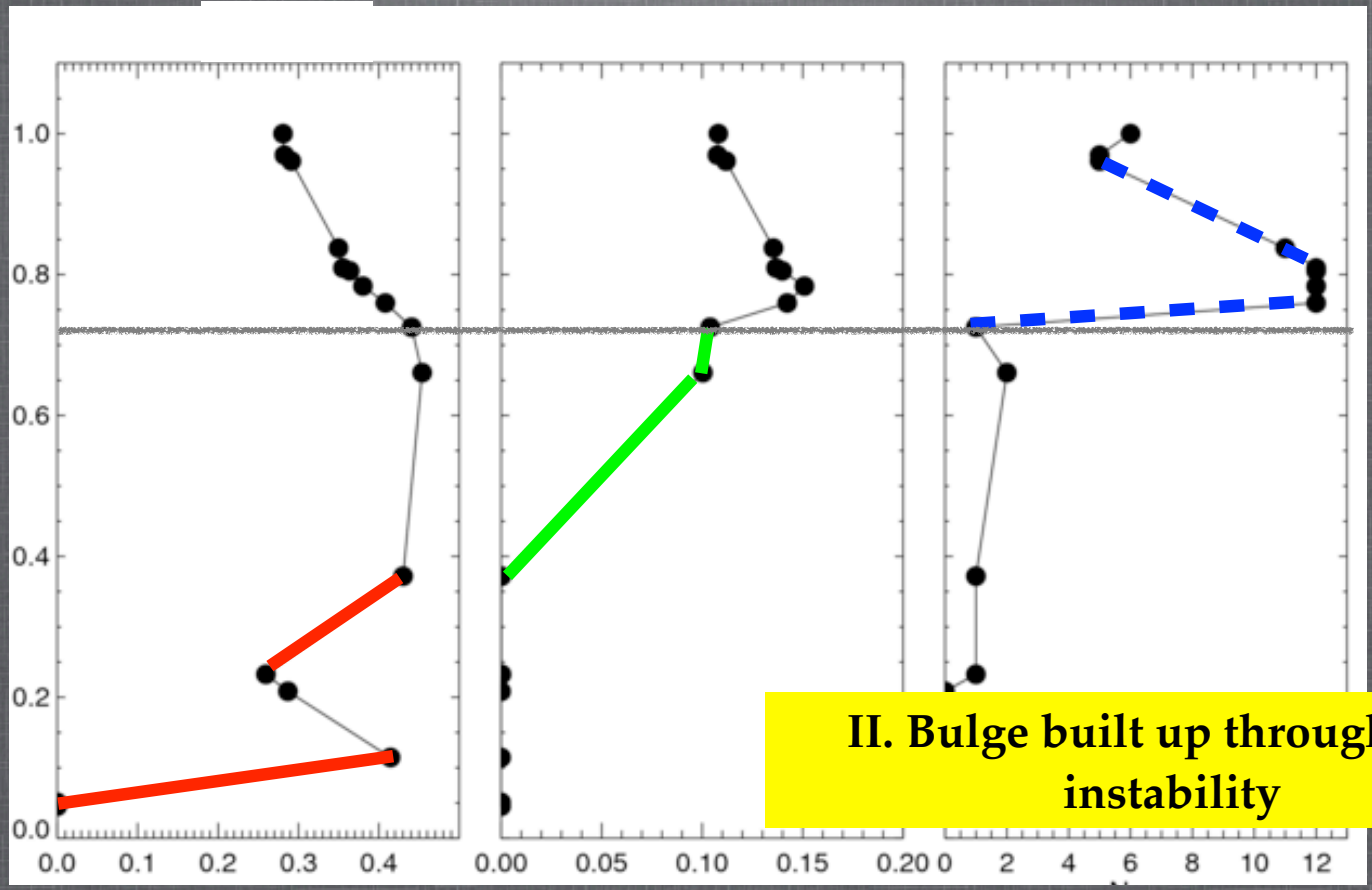


visualization by Nir Mandelker



visualization by Nir Mandelker

$M_{bulge} / M_{bulge,final}$



II. Bulge built up through disk instability

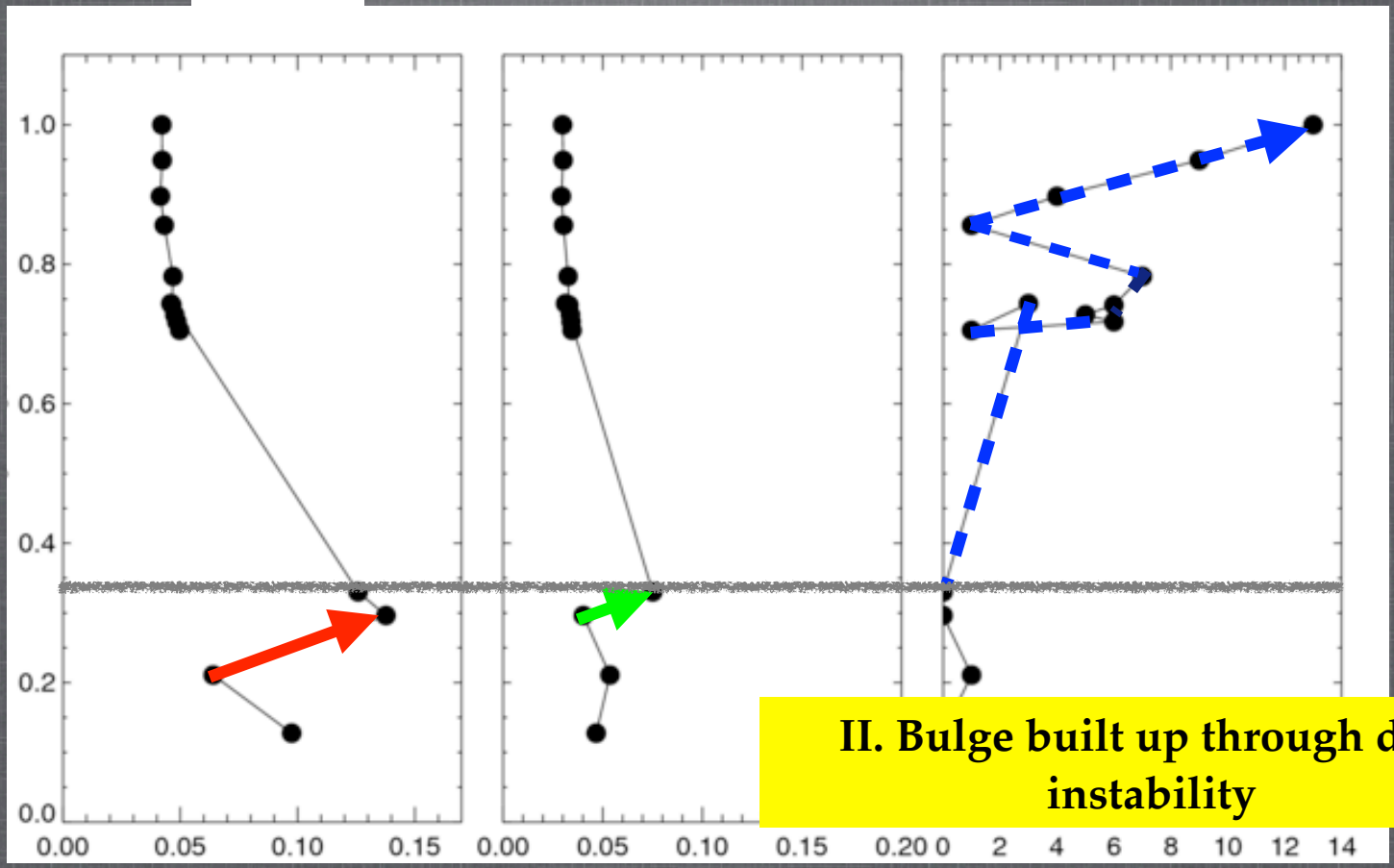
μ_3: Major Mergers

μ_{10}: Minor Mergers

N_{clumps}

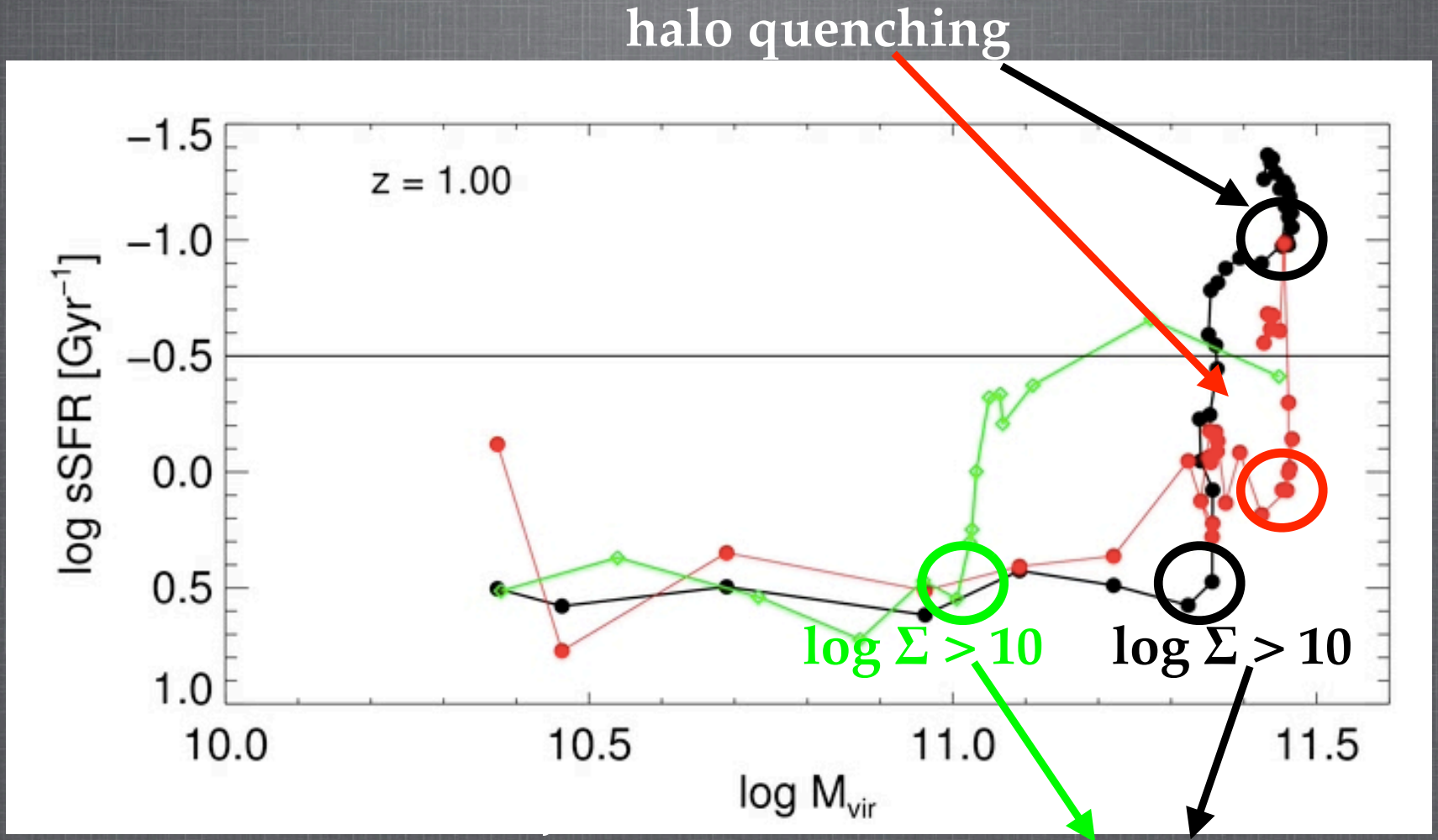
I. Bulge built up through mergers

μ_m = fraction of mass added in mergers of 1:m



μ_m = fraction of mass added in mergers of 1:m

Q2: WHAT TRIGGERS QUENCHING?



SUMMARY

- At high-z, 60% of bulge stellar mass formed in situ
- At low-z, 30% of bulge stellar mass formed in situ
- Strong inflow of gas through disk into the bulge
- What makes galaxies compact? wet inflow, indication that it's driven by turbulent and clumpy disks
- Both bulge and halo quenching taking place