

BLUE NUGGETS:

a critical transition phase in galaxy evolution

Sharon Lapiner (HUJI)

Avishai Dekel (HUJI)

Collaborators: Jonathan Freundlich (HUJI), Omri Ginzburg (HUJI), Fangzhou Jiang (HUJI), Michael Kretschmer (HUJI, Heidelberg), Santi Roca-Fabrega (HUJI), Sandro Tacchella (ETH Zurich), Daniel Ceverino (Heidelberg), Joel Primack (UCSC)

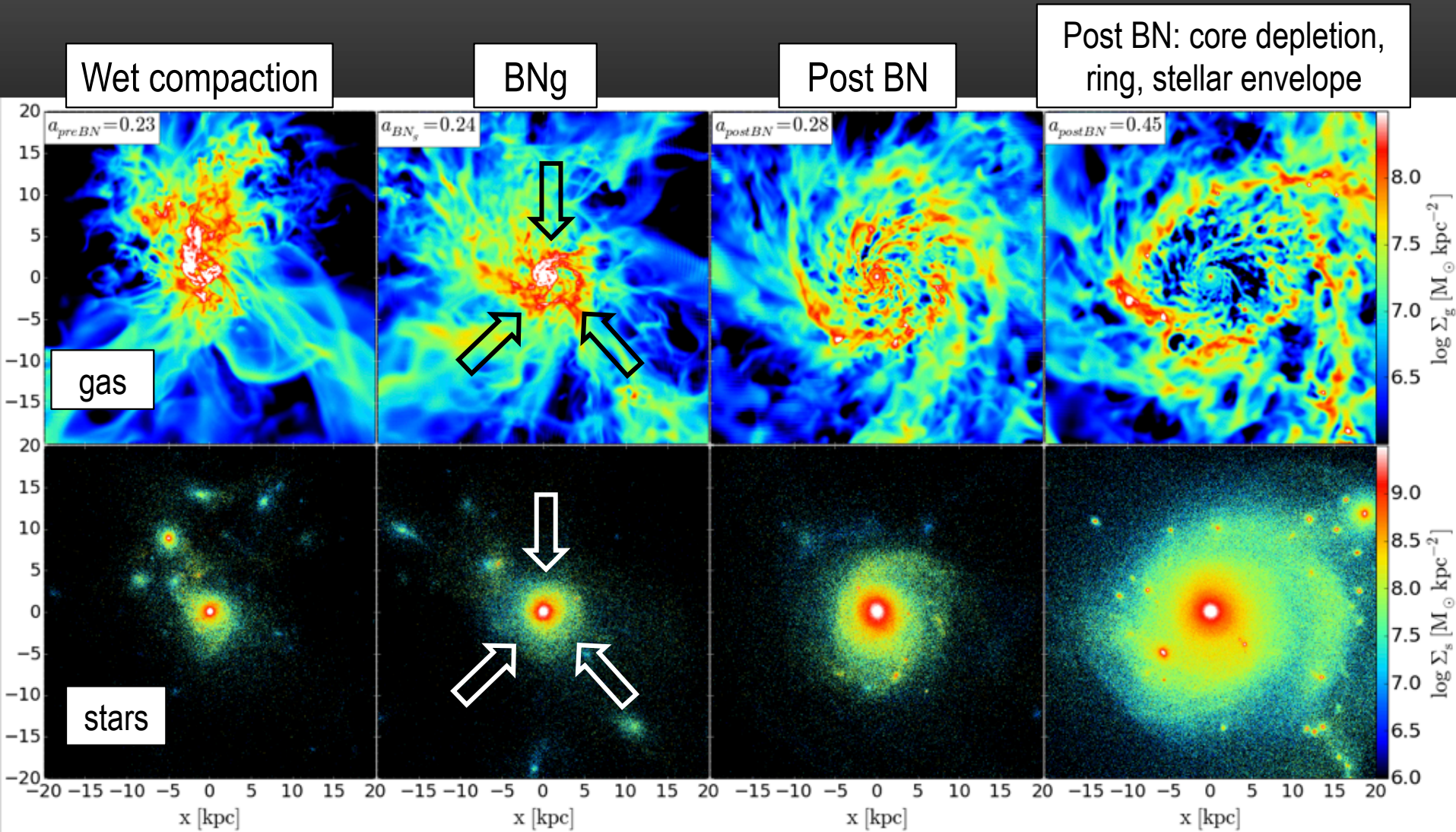
VELA by **Daniel Ceverino+**

Code: AMR ART (Kravtsov, Klypin)

Max resolution ~25 pc

Gen 3, 35 galaxies zoom-in

SN and radiative feedback



VELA by Daniel Ceverino+

Code: AMR ART (Kravtsov, Klypin)

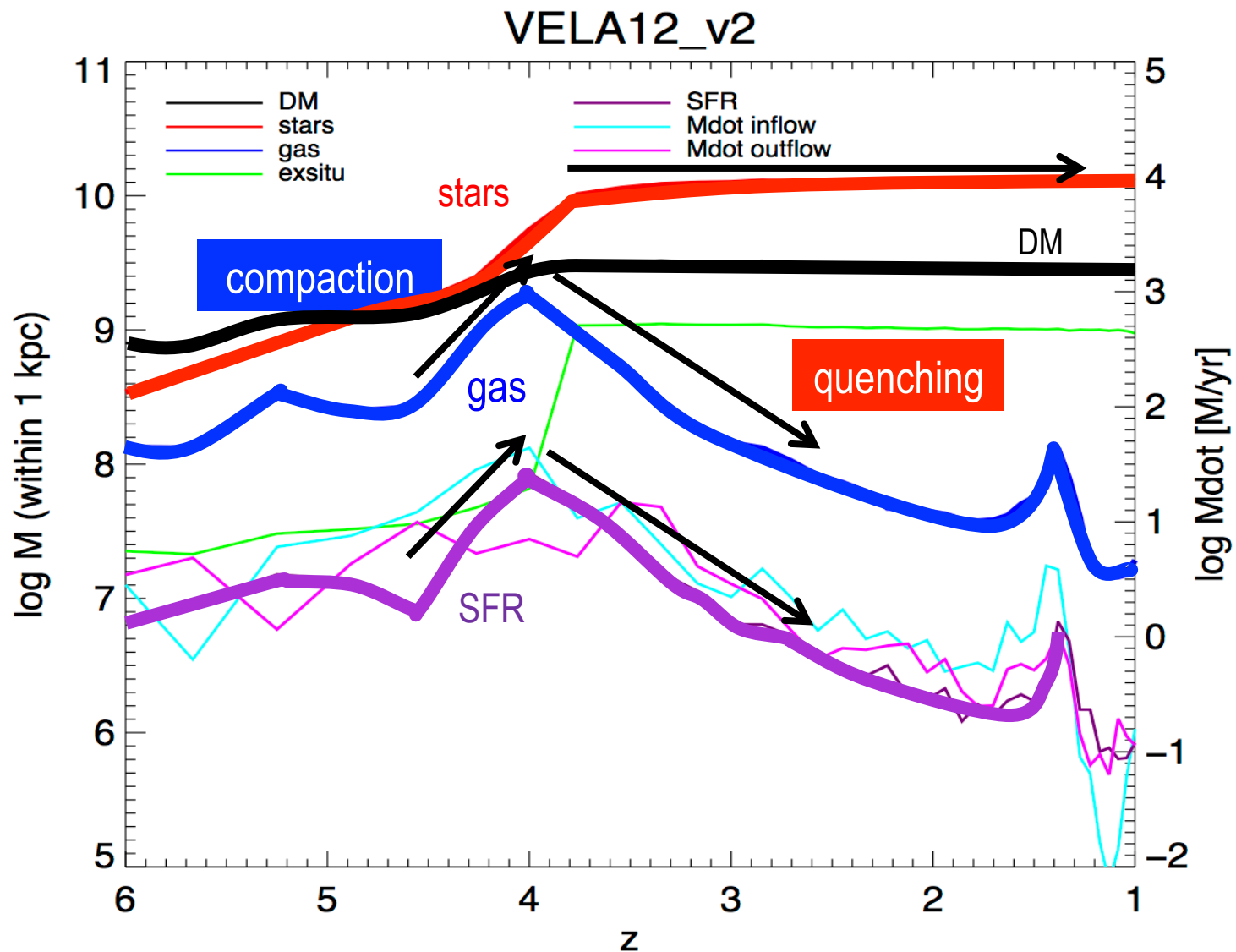
Max resolution ~ 25 pc

Gen3, 35 galaxies zoom-in

SN and radiative feedback

Face-on

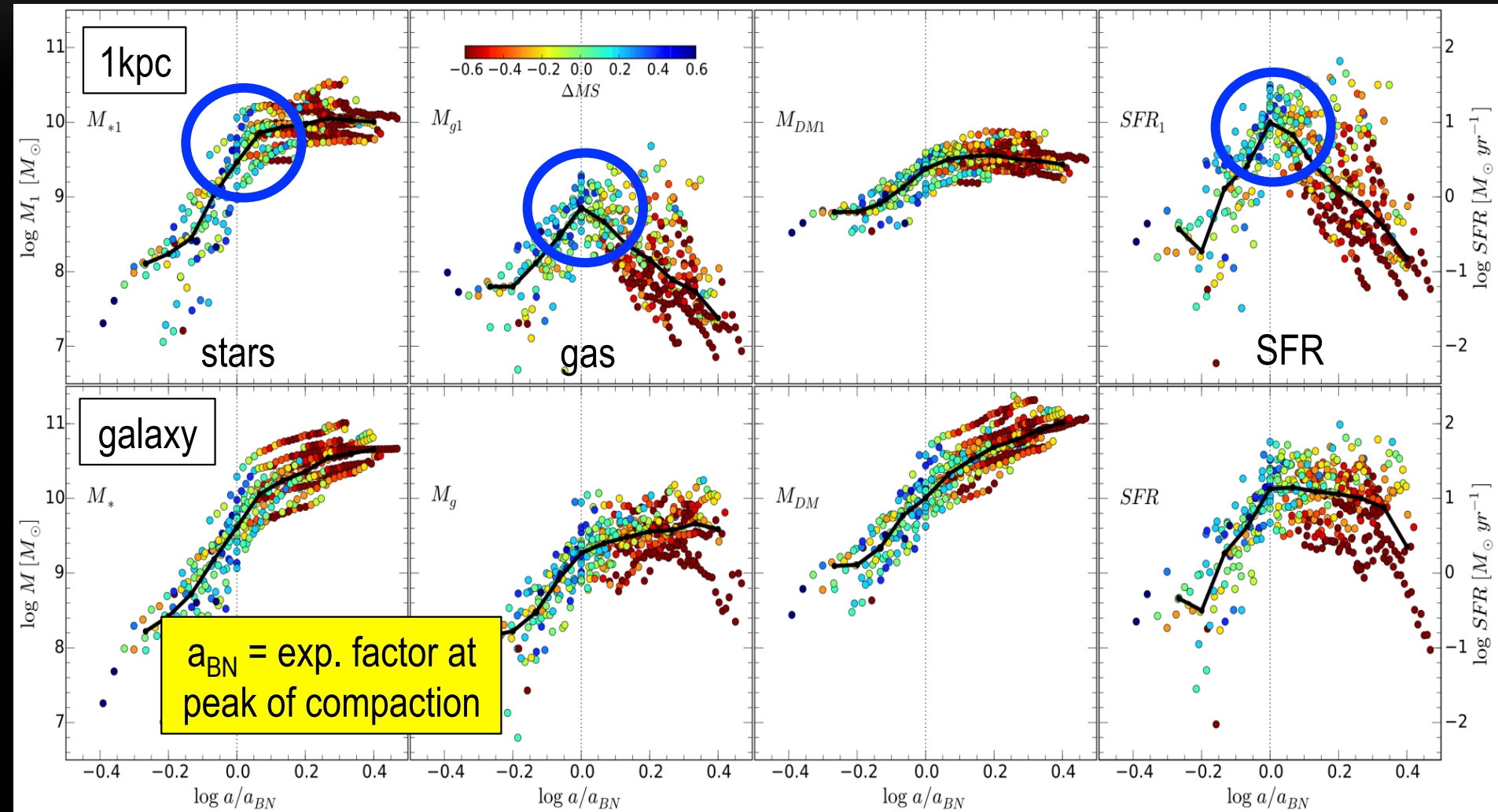
Compaction and quenching in the inner 1 kpc



Compaction and Quenching in the inner 1 kpc

High-mass subsample stacked with respect to BN

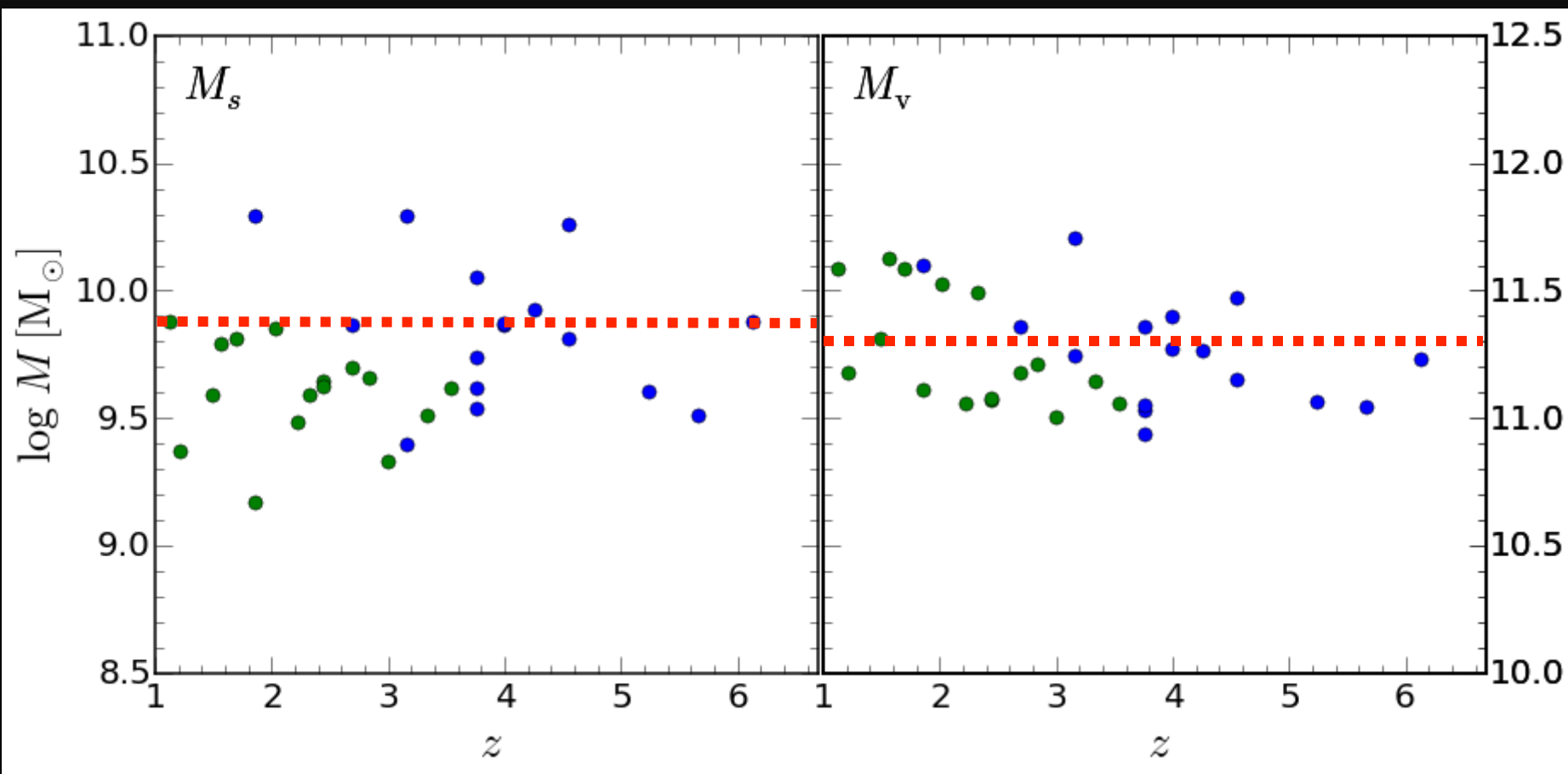
Dekel+17



a Critical Mass for BN (at all z)

$$M_{\text{star}} \sim 10^{10} M_{\odot}$$

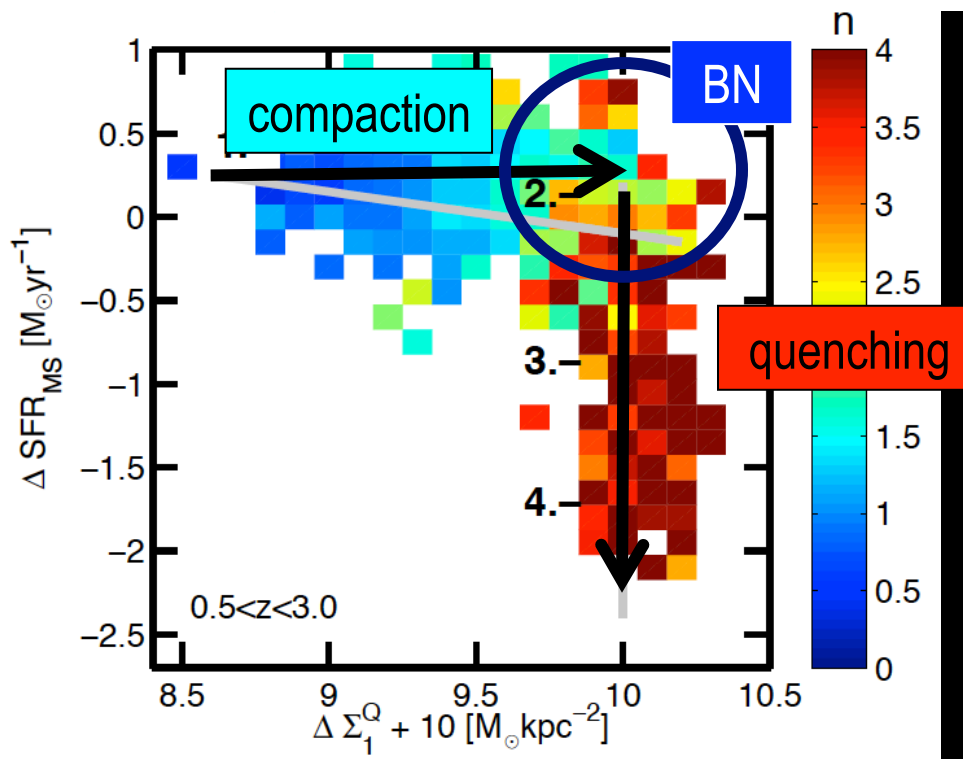
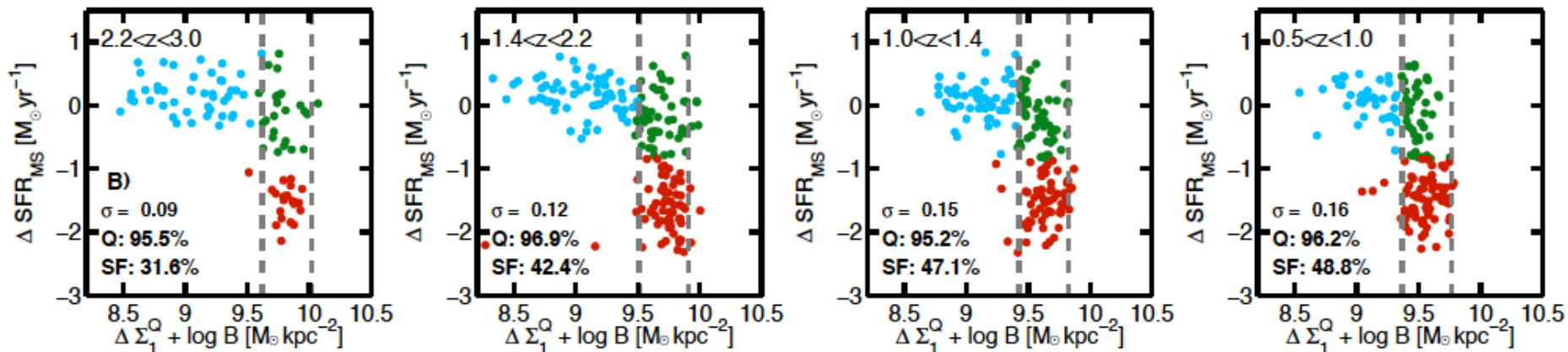
$$M_{\text{vir}} \sim 10^{11.5} M_{\odot}$$



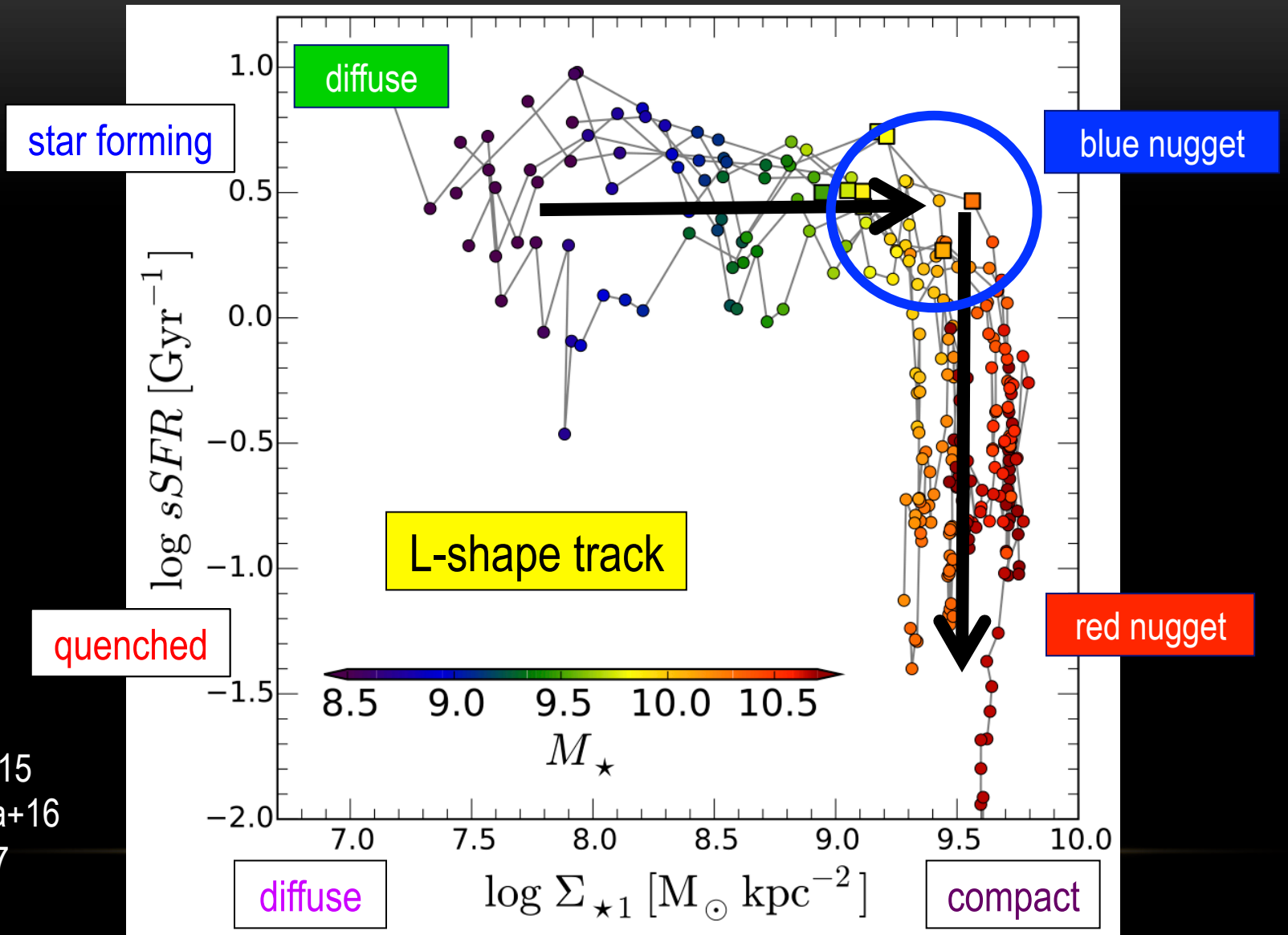
L-Shape Track

Observed L-Shape Track

Barro+17



Compaction and Quenching in VELA Simulations

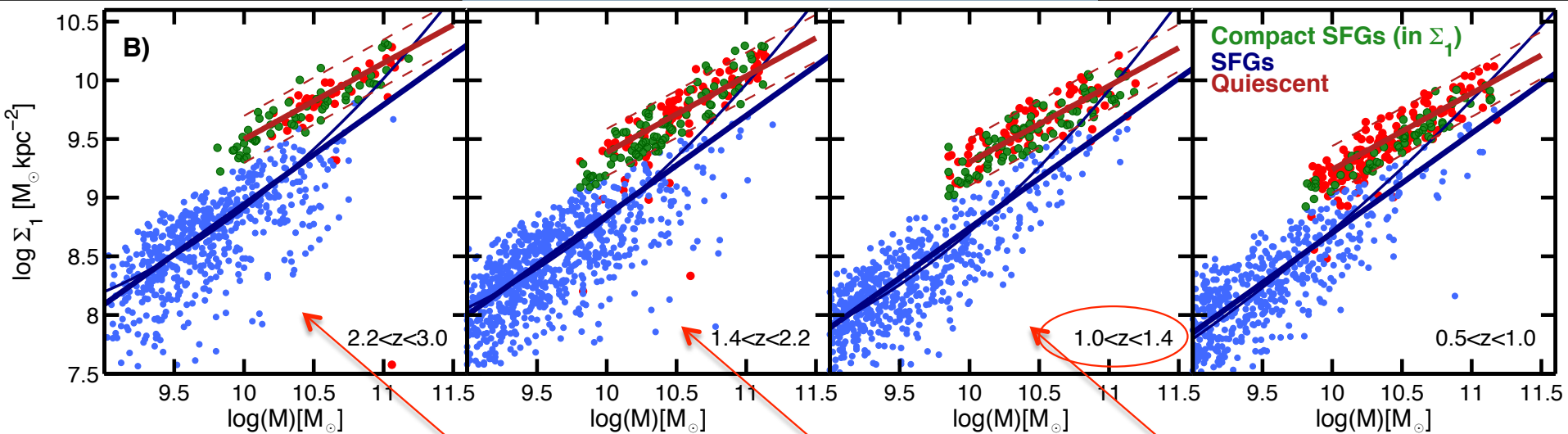


Zolotov+15
Tacchella+16
Dekel+17

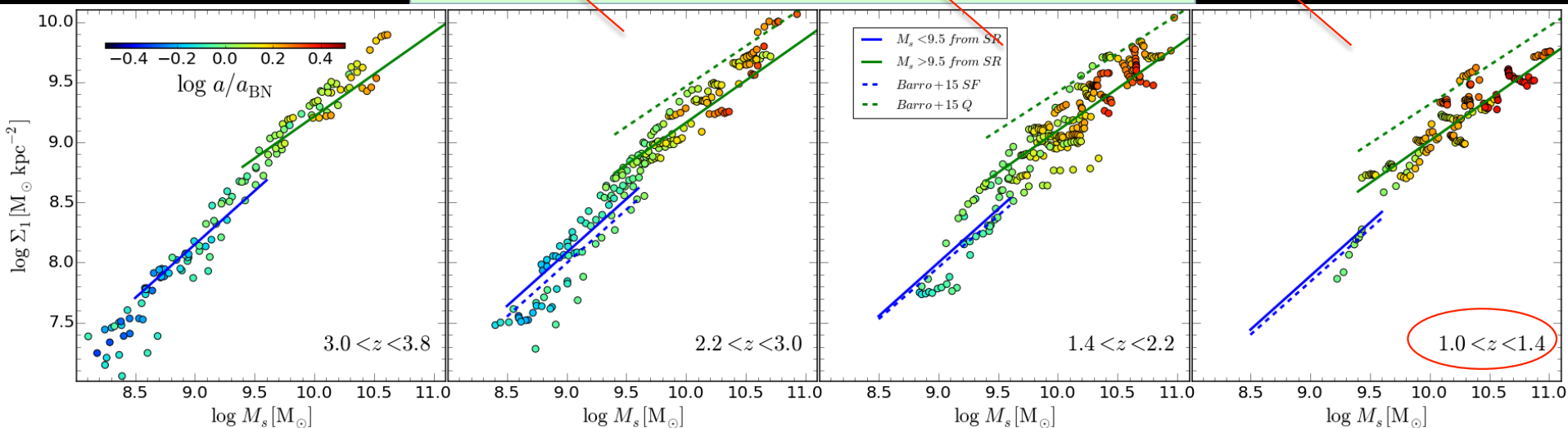
$$\Sigma_1 - M_{\text{Star}}$$
A horizontal orange glow line is positioned below the equation, extending across the width of the page.

Observed $\Sigma_1 - M_{\text{star}}$

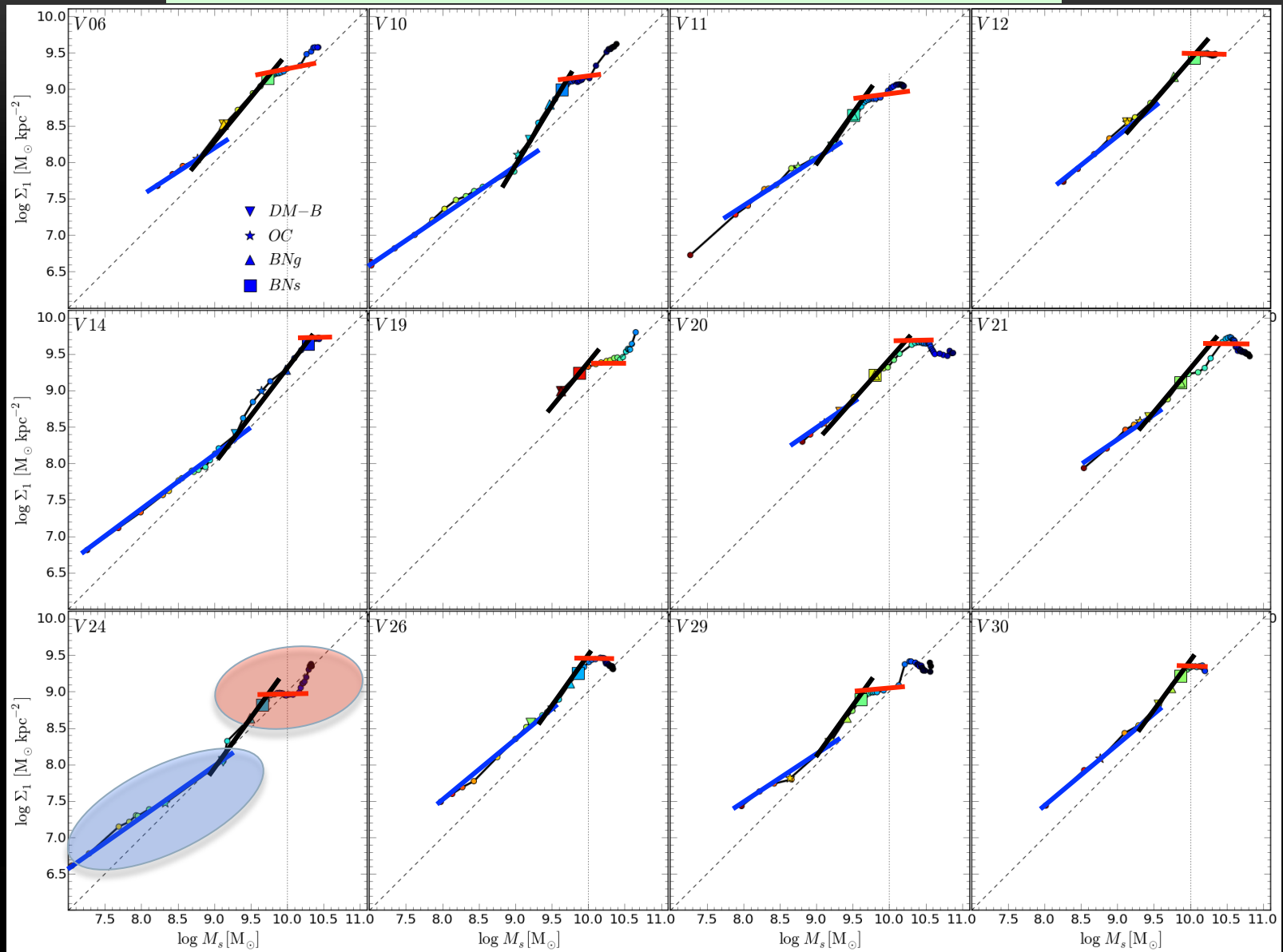
Barro+17

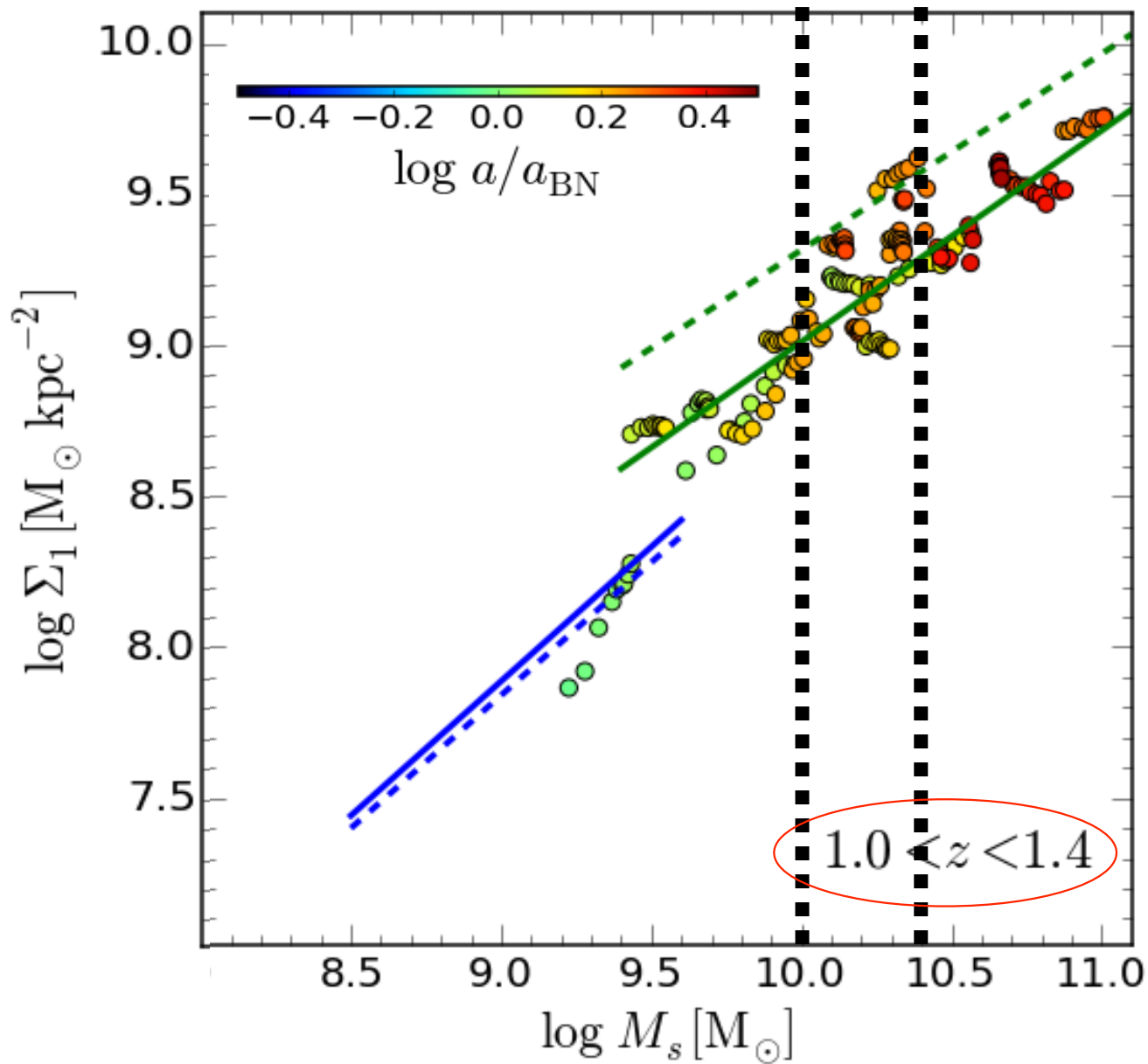


VELA simulations $\Sigma_1 - M_{\text{star}}$



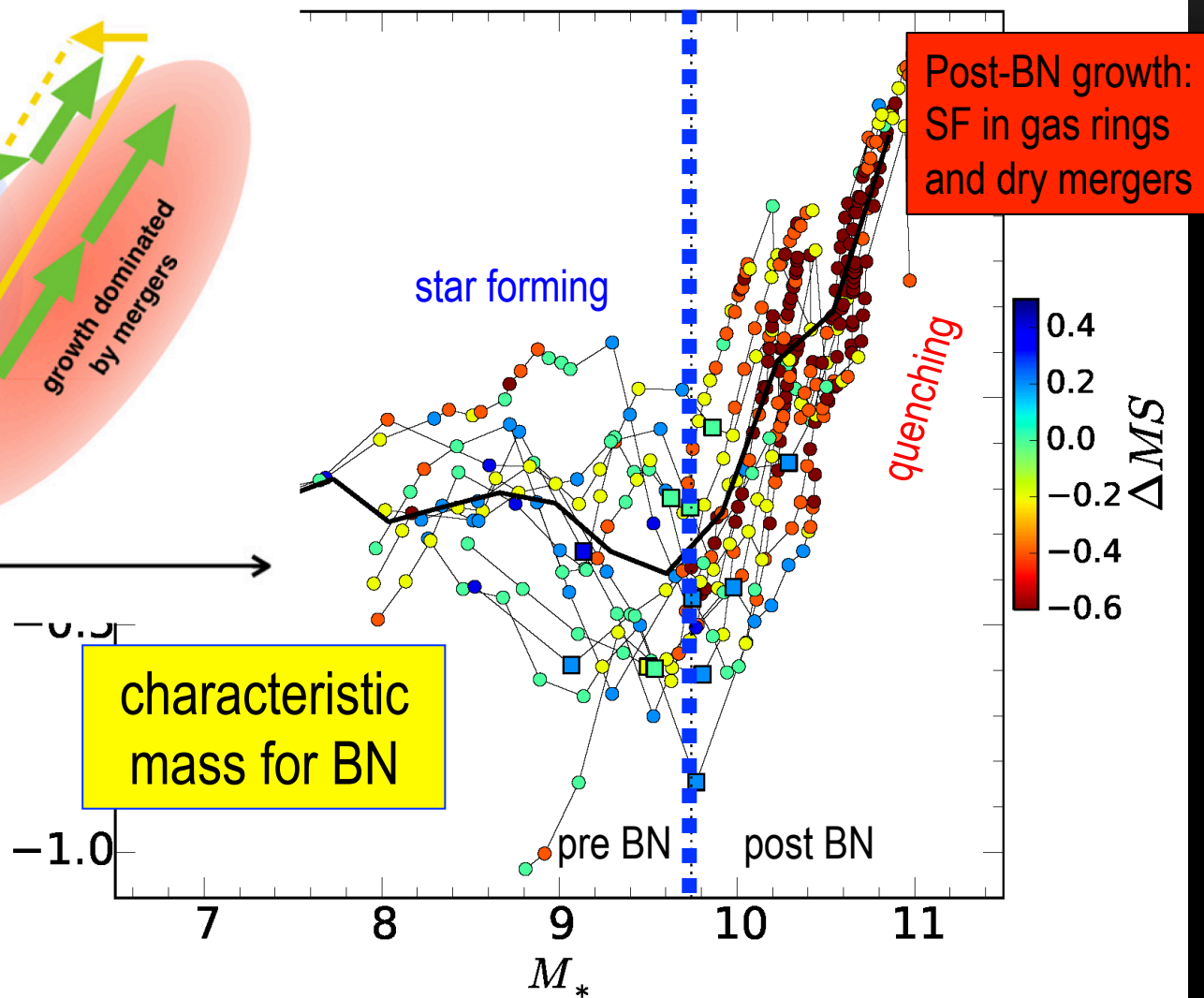
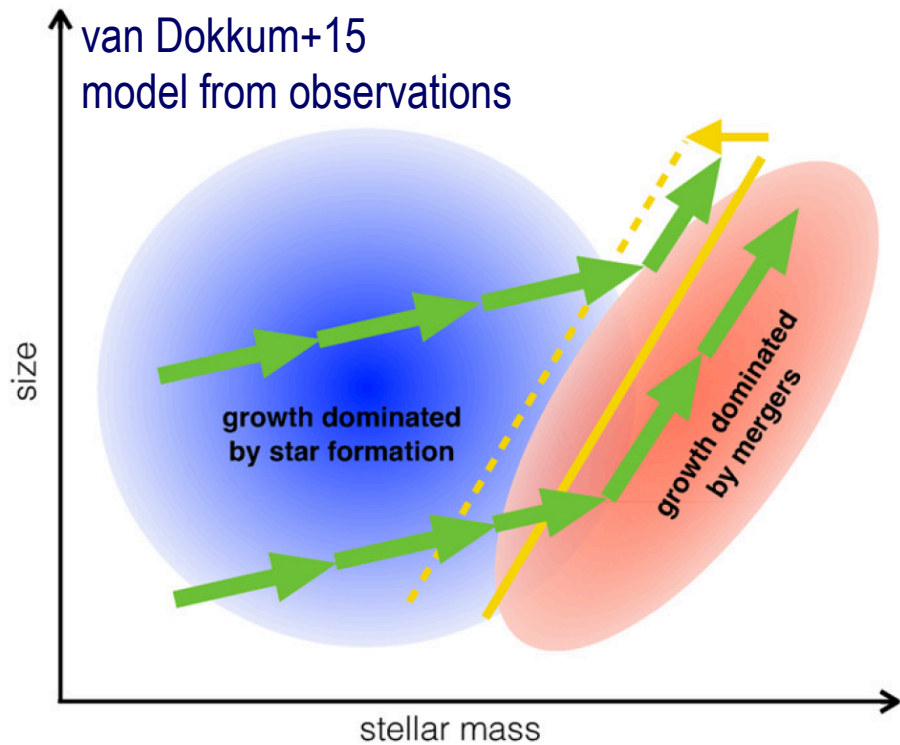
Compaction in $\Sigma_1 - M_{\text{star}}$





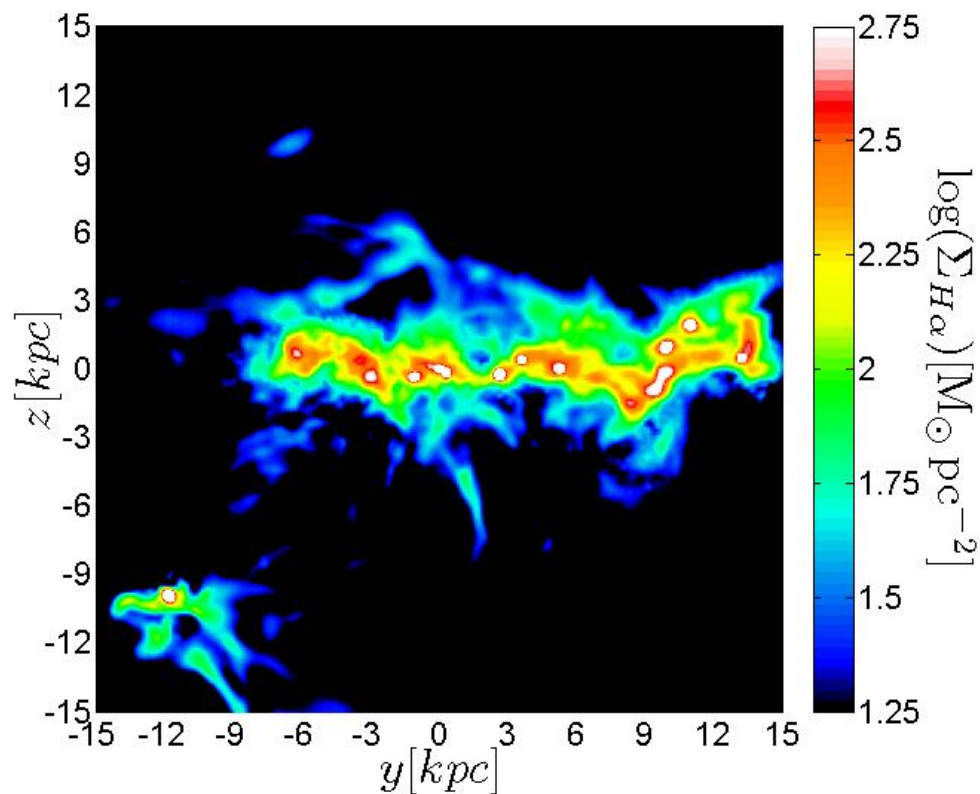
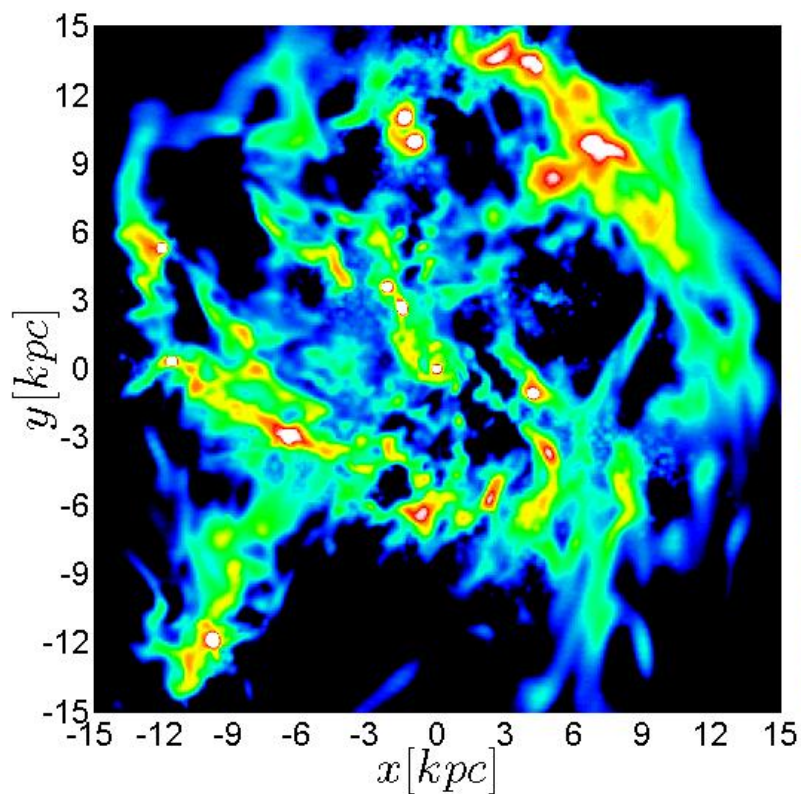
Size – Mass

Evolution in $R_{\text{eff}} - M_{\text{star}}$ Stacked



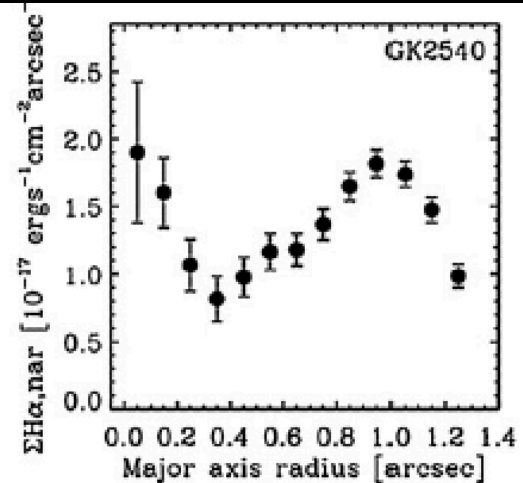
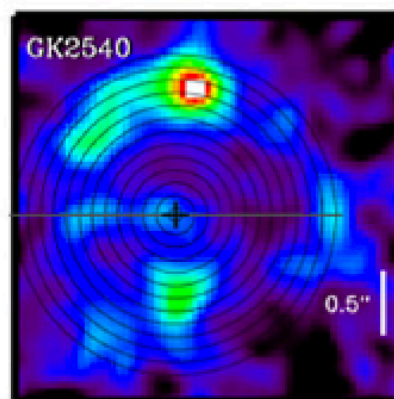
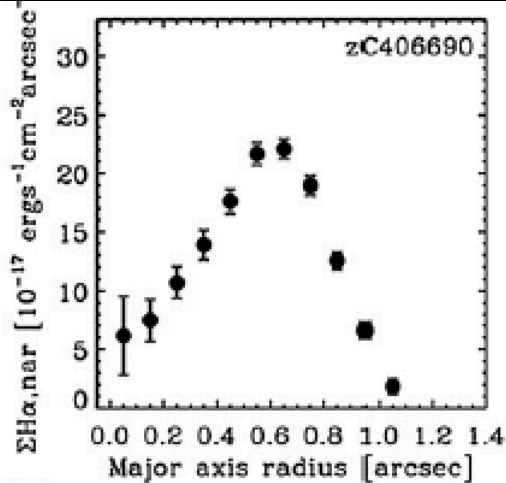
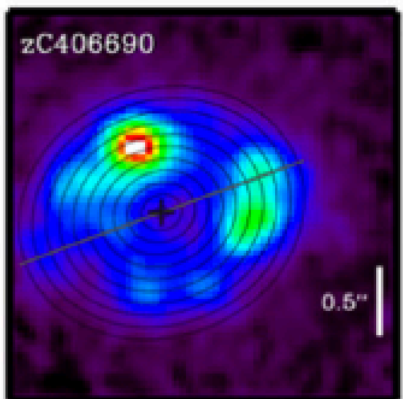
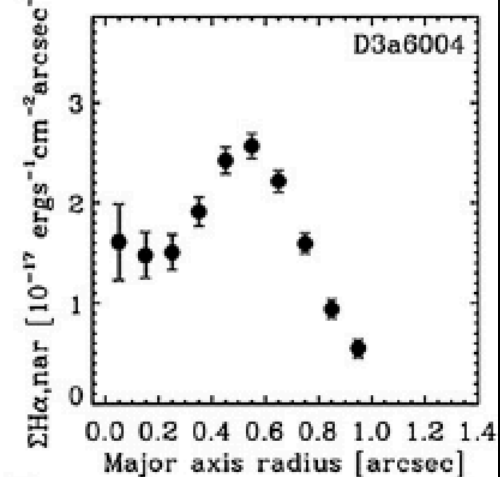
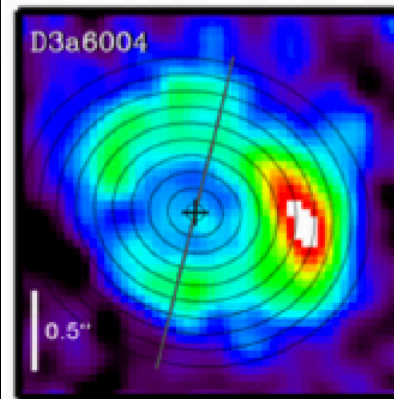
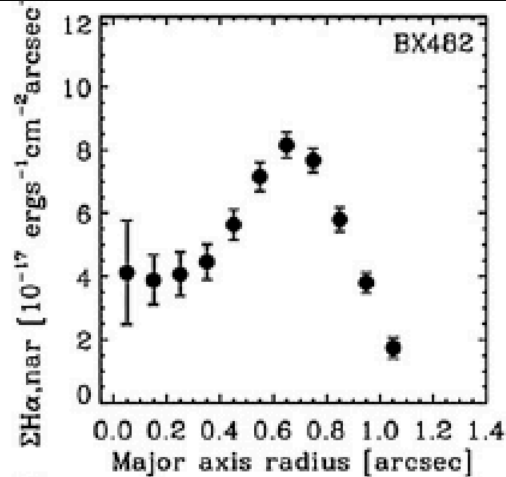
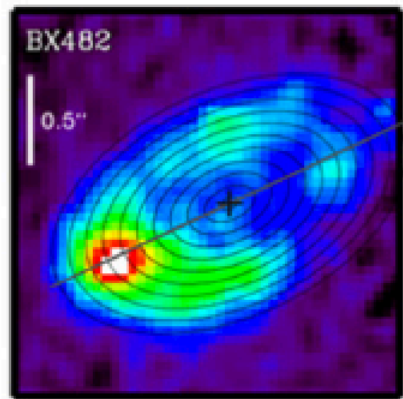
Post-BN Extended Ring

Post-BN in Simulations: An Extended Clumpy Gas Ring around a Passive Core

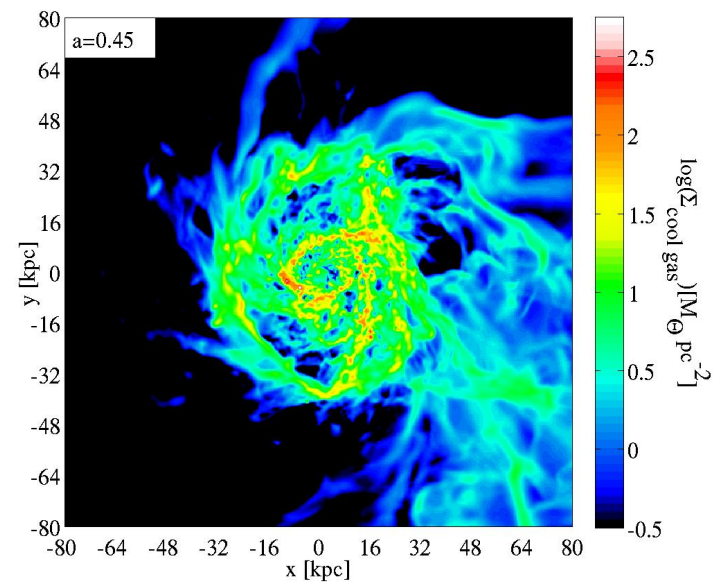
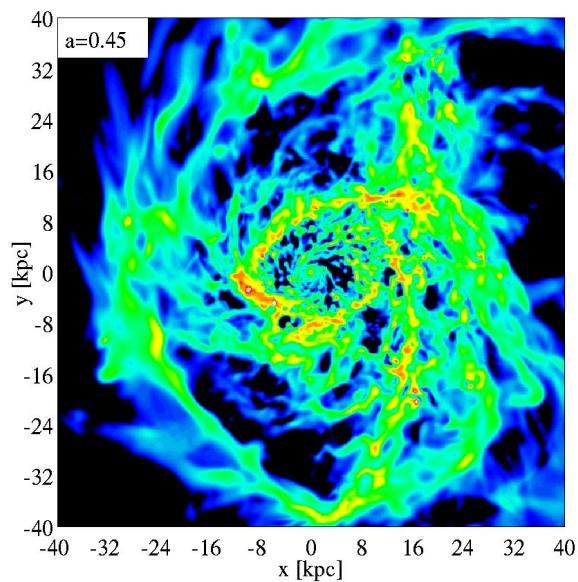
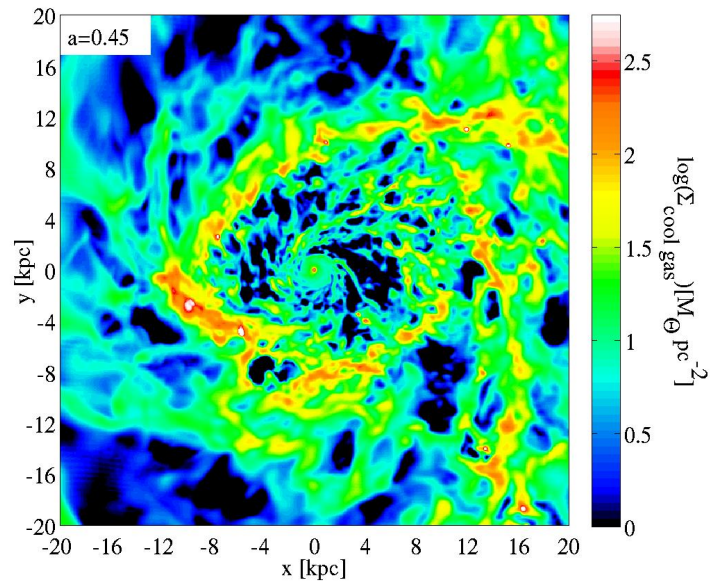
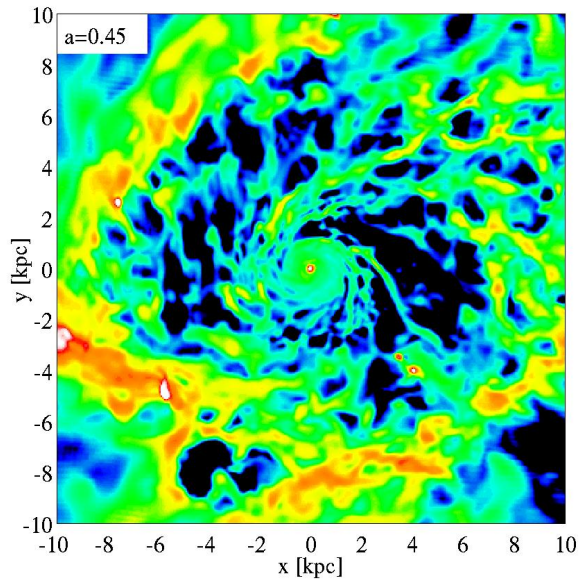


Observed H α rings

Genzel+ 14



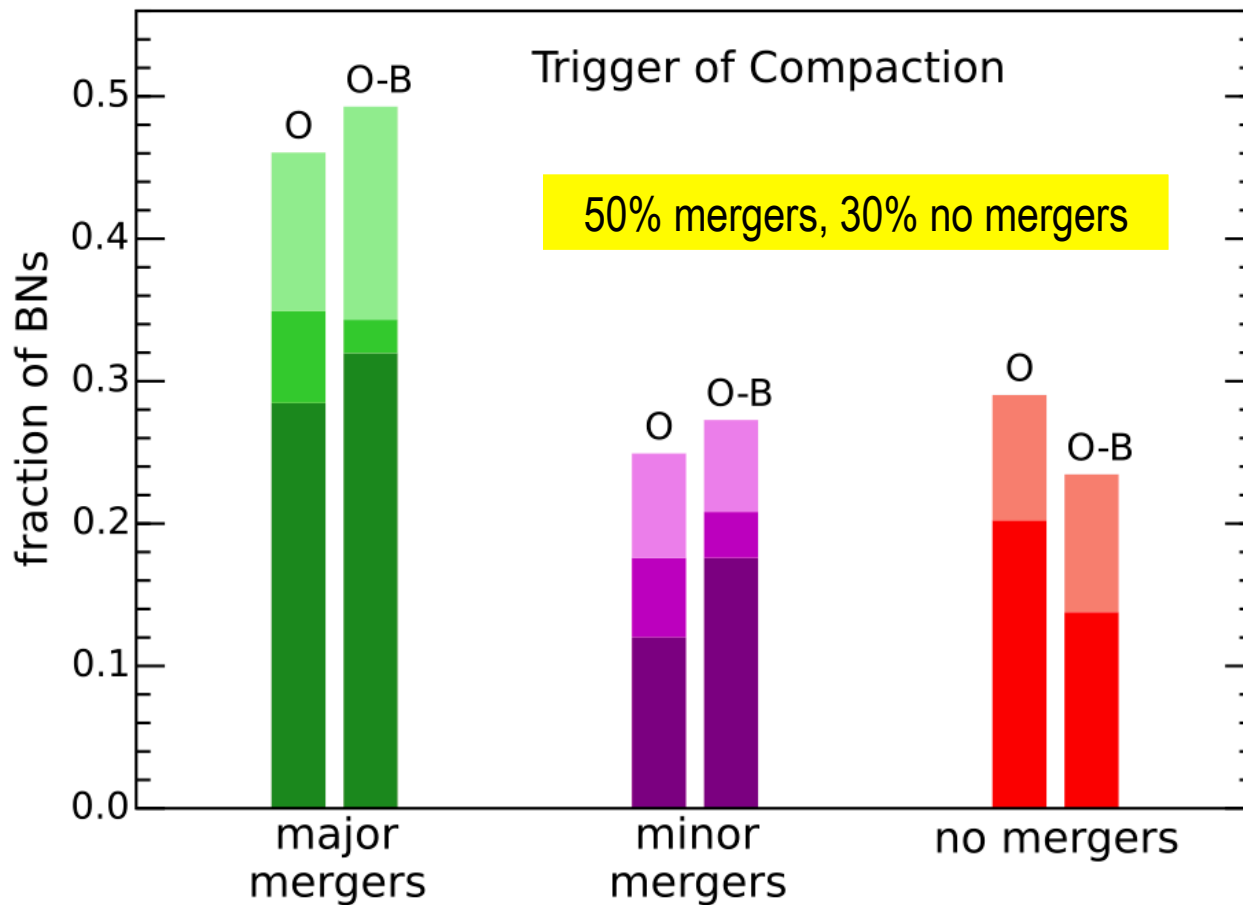
Ring of fresh gas spiraling-in



Zolotov+15
Tacchella+16
Dekel+17
Lapiner+17

Triggers of compaction

Dekel + 2017



CONCLUSIONS

- The compaction to a Blue Nugget is a **dramatic transition phase** in the history of many galaxies
- The BN marks **transitions in most galaxy properties**, global and profiles: **mass, size**, kinematics, SFR, shape, gas frac., DM frac., metallicity, dust...
- The last and major compaction to a BN occur at a **typical stellar mass** $M_s \sim 10^{10} M_\odot$ ($M_v \sim 10^{11.5-12} M_\odot$, $V_v \sim 100 \text{ km s}^{-1}$) when SN feedback becomes ineffective (Dekel & Silk 86)
- The **BN triggers an inside-out quenching attempt**, confined to the MS, and full quenching by hot halo + AGN fdbk when $M_{\text{halo}} > M_{\text{crit}} \sim 10^{11.5-12} M_\odot$
- Post-BN: **buildup of extended disc** by SFR in clumpy gas rings and/or by buildup of stellar envelopes