Image: TNG Collaboration

Using the metal content of galaxies to inform stellar feedback modeling

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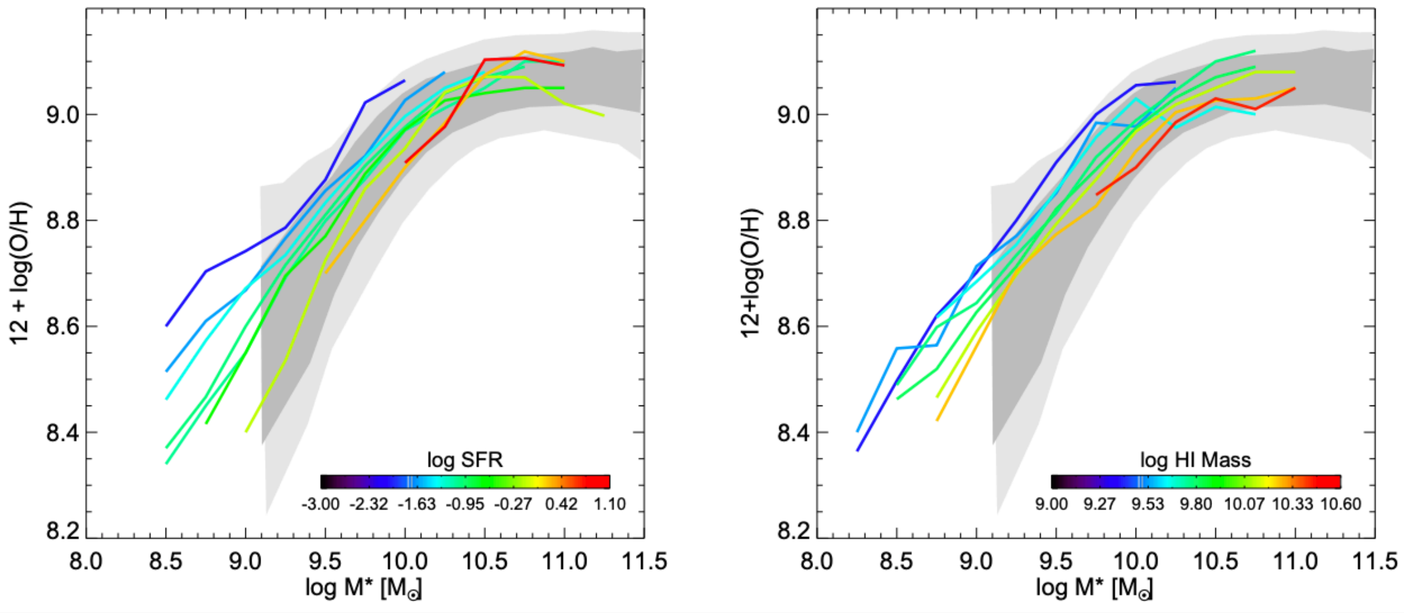
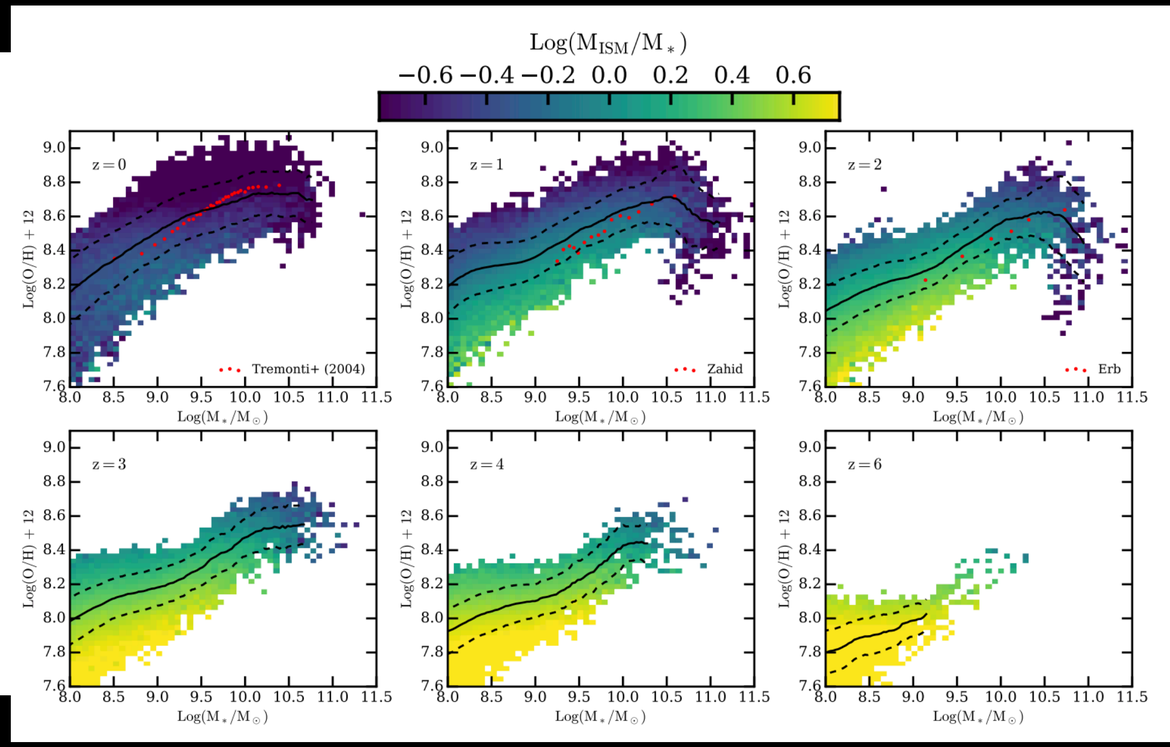
Mass-Metallicity Relation

Correlated scatter with Gas-phase metals

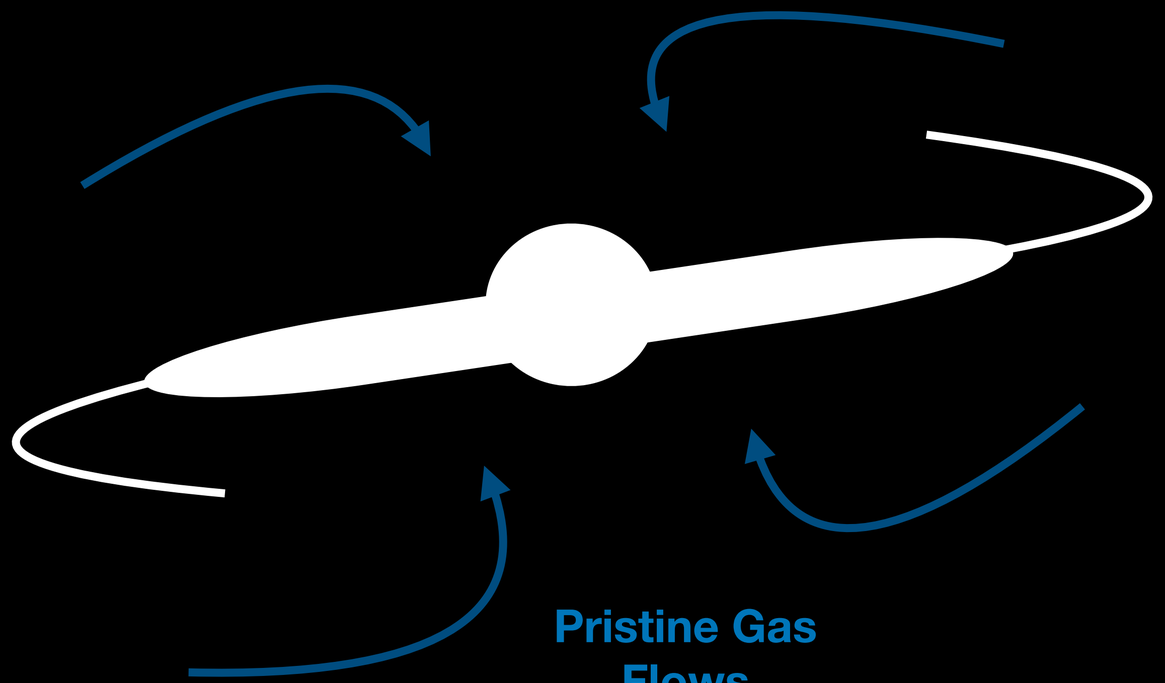


Bothwell+2013



Torrey+2019

Physics behind correlated scatter



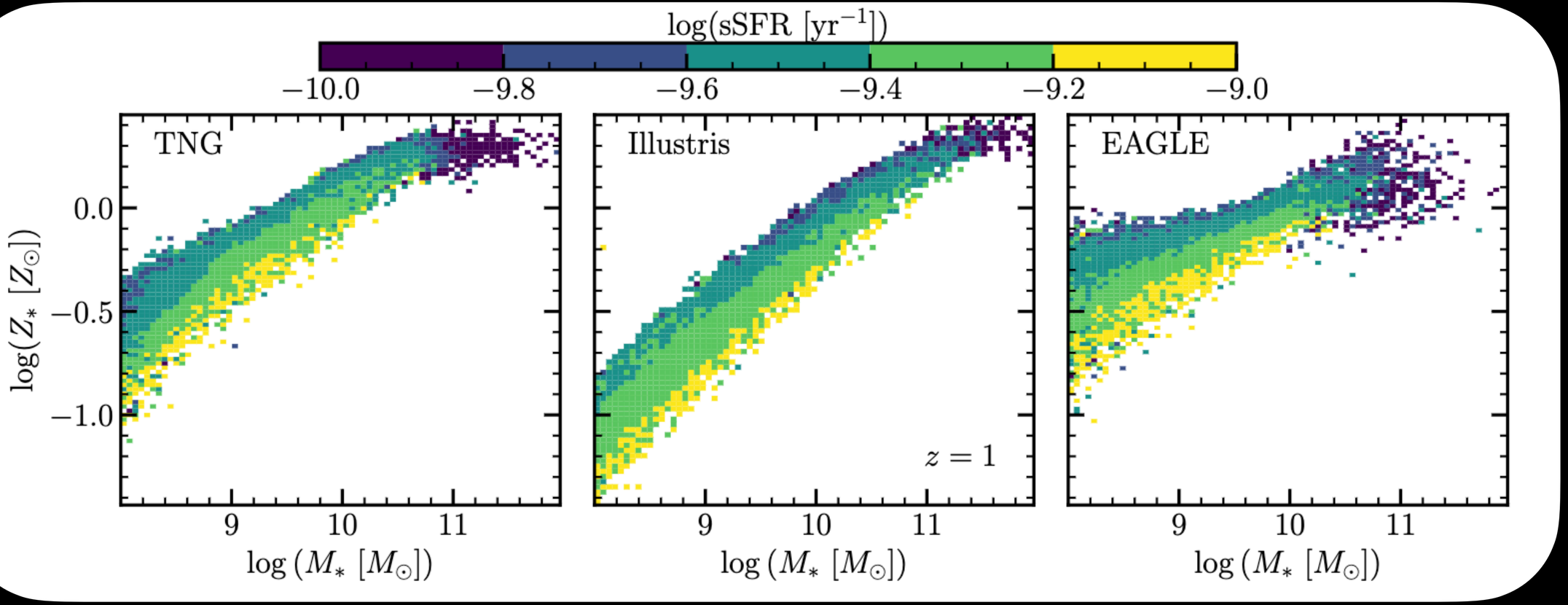
Increased pristine gas content:

- Decreases the metallicity
- SFR increases! (Ellison+2008)

Stellar metallicities are not *directly* impacted by gas accretion!

On global scales

So what *do* the stellar metallicities do?



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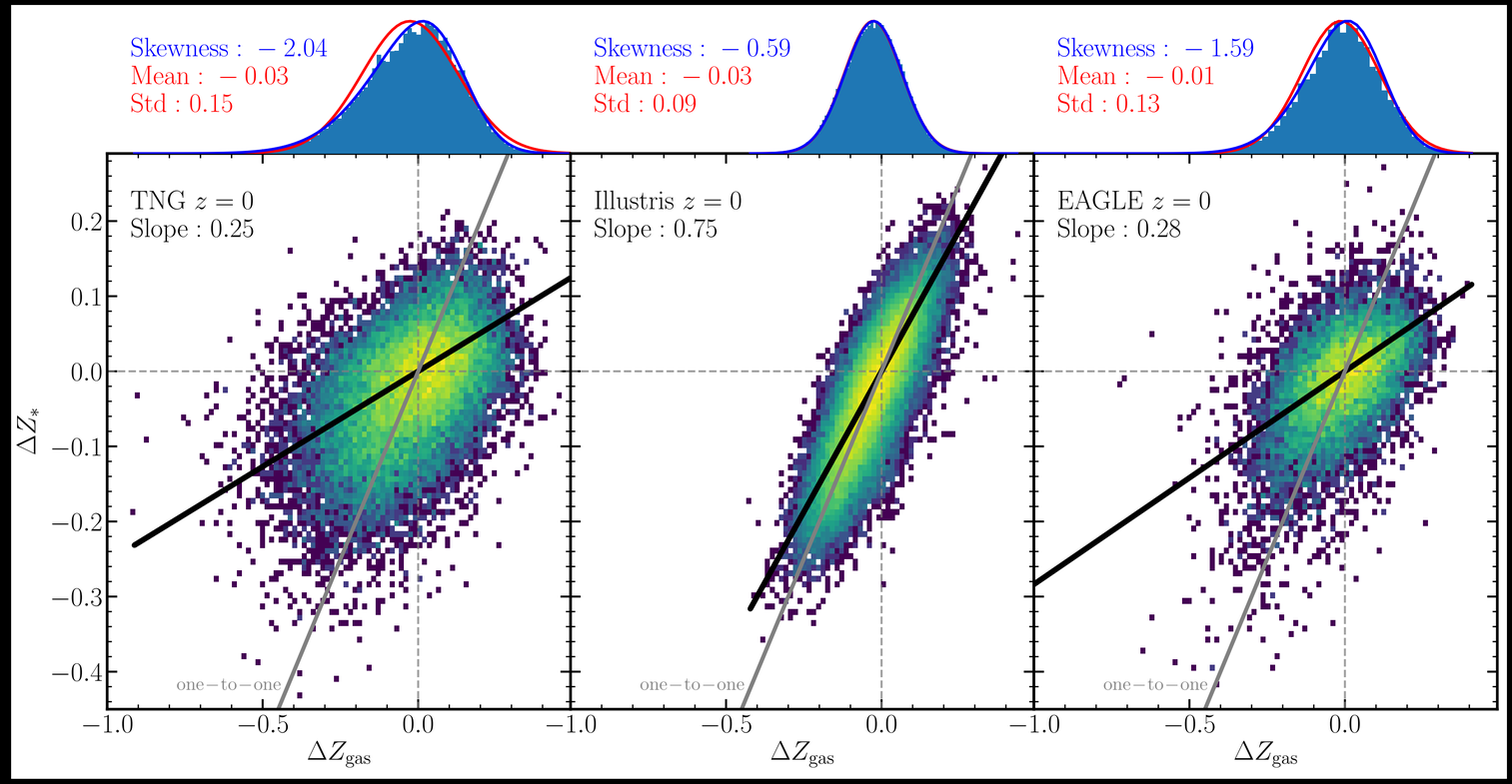
We find evidence for an analogous residual correlation for stellar metallicities

Where does this residual correlation originate?

Though not *directly* influenced, stars will feel the effects of gas accretion over time

A galaxy's offset from both the stellar MZR and gas-phase MZR are correlated

The more tightly correlated stellar and gas-phase metals are: the steeper the relationship



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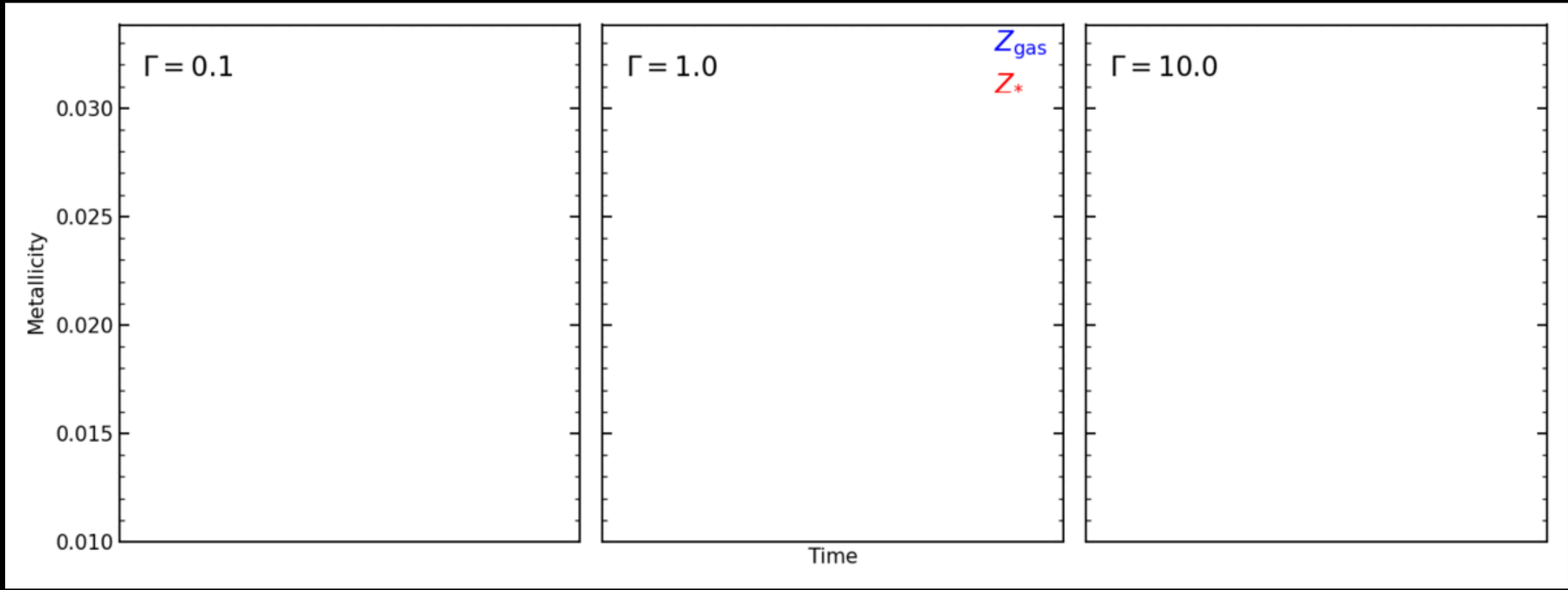
Tightness of correlation

Coherence timescale -> timescale on which gas-phase metals change

Star formation timescale -> timescale on which gas makes new stars

$$\Gamma = \frac{\tau_{\text{coherence}}}{\tau_{\text{SF}}}$$



BUT! This (likely) depends on the model

Gentle Feedback

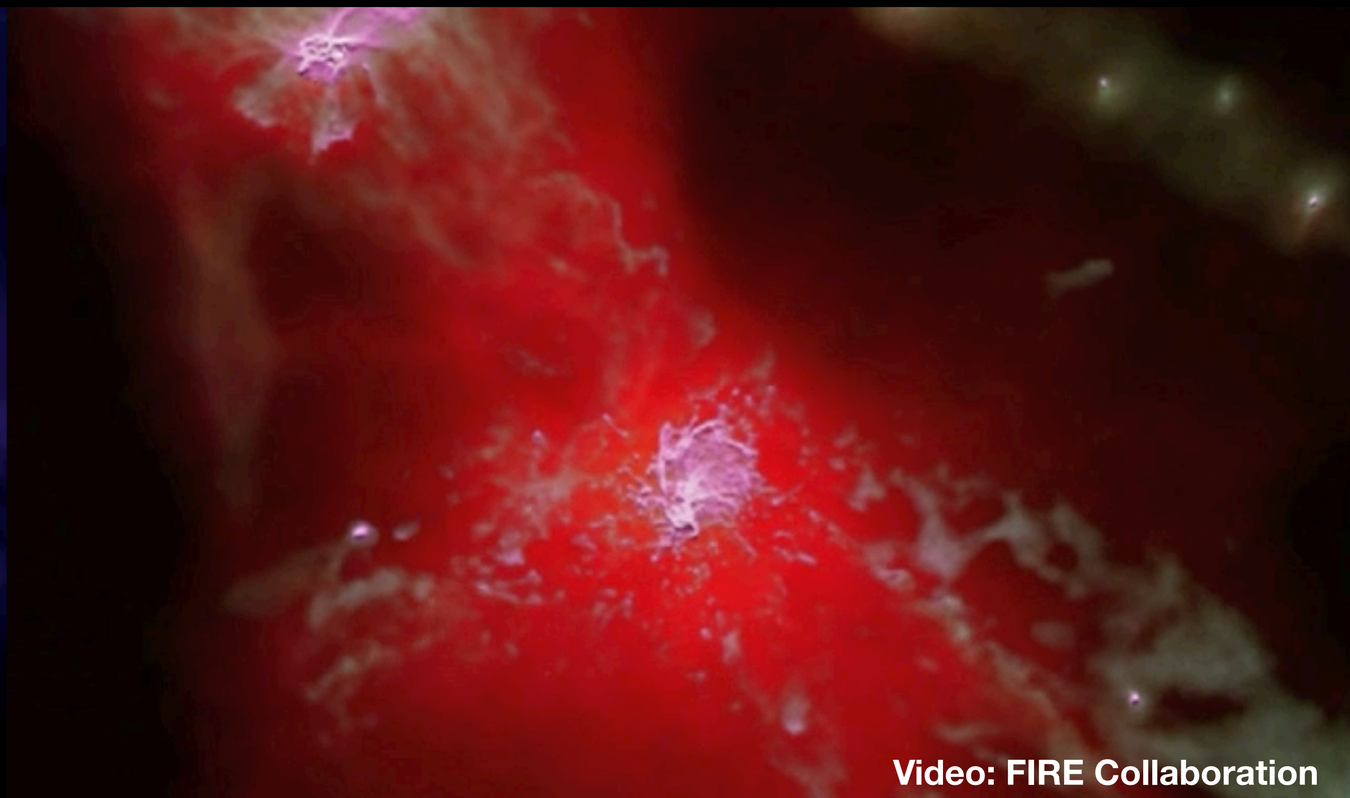
Implicitly assumed

Allow system to respond

Bursty Feedback

Bursts likely interrupt/stop processes!

Video: TNG Collaboration



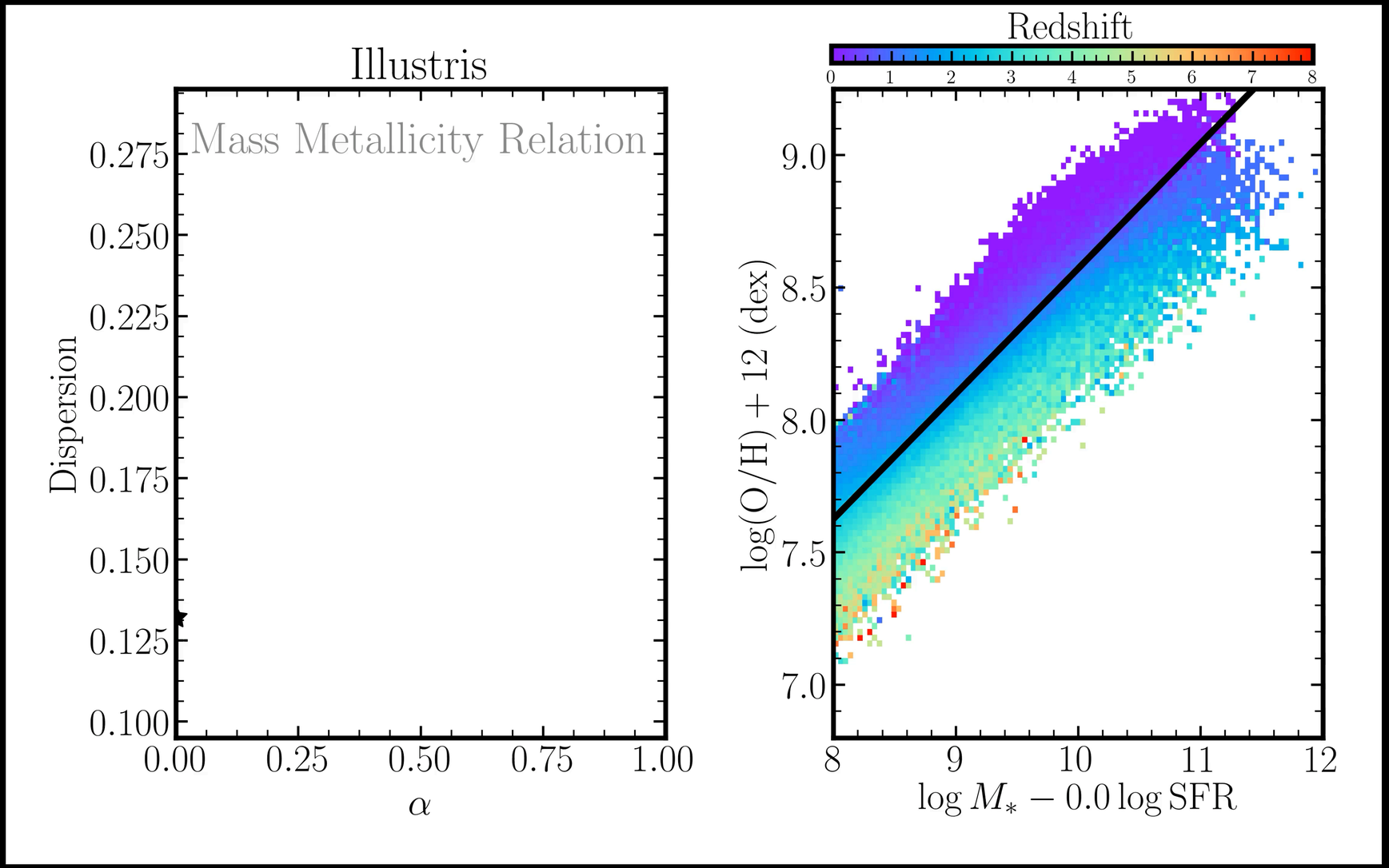
Video: FIRE Collaboration

Fundamental Metallicity Relation

Correlated scatter with Gas-phase metals

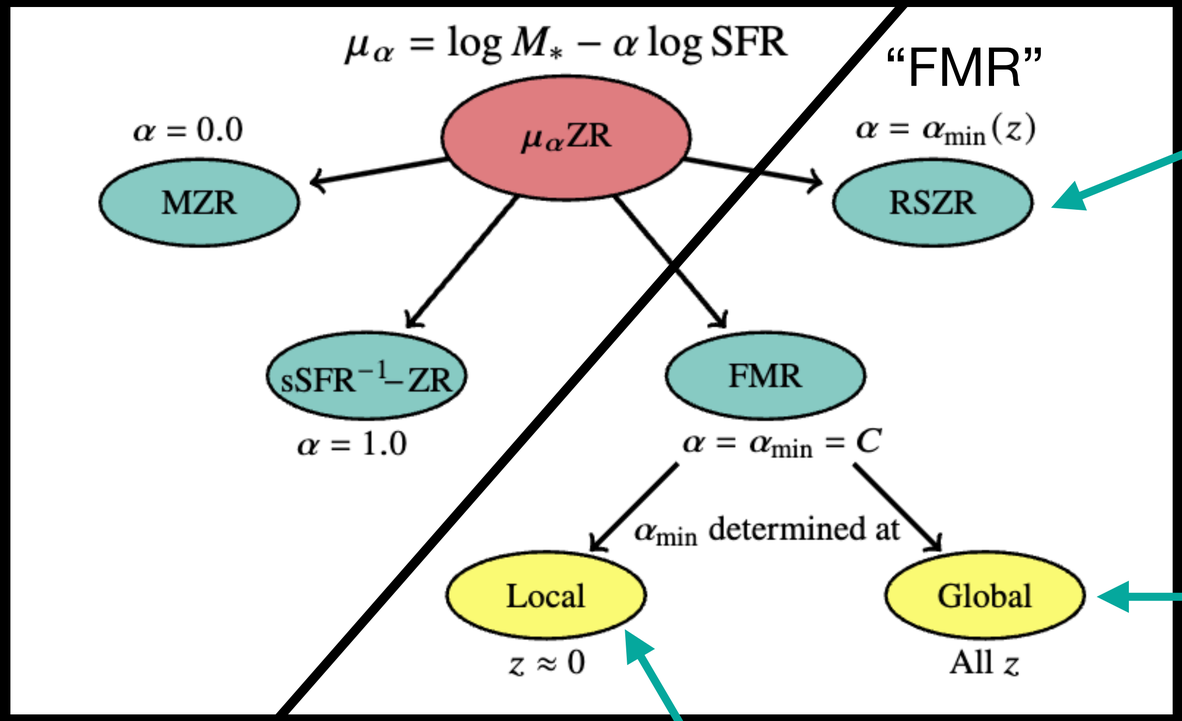
Mannucci+(2010)

$$\mu_\alpha = \log M_* - \alpha \log \mathrm{SFR}$$



What exactly do we mean “FMR?”

$$\mu_\alpha = \log M_* - \alpha \log \mathrm{SFR}$$



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“Reduced Scatter Metallicity Relation”

A mass-metallicity-fgas relation exists at each redshift

“Global FMR”

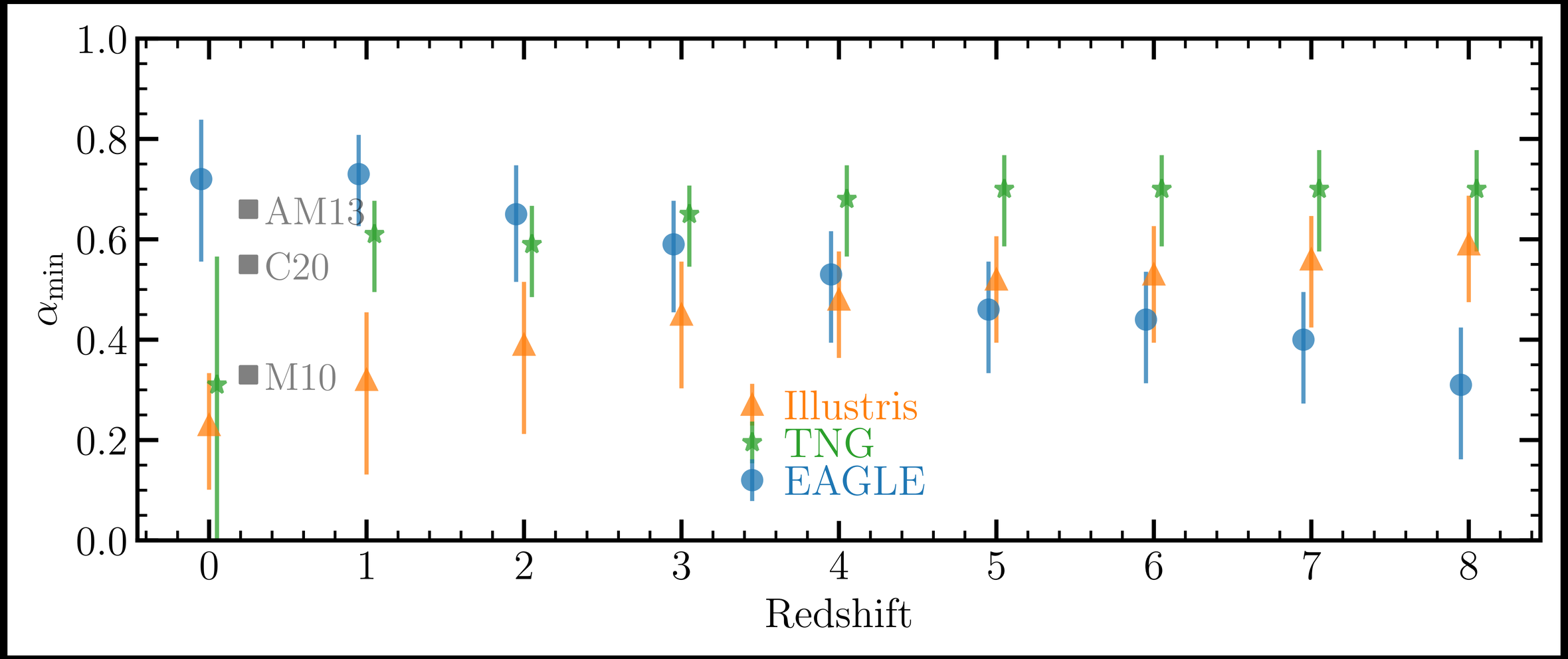
The relation exists and it does not evolve with time

“Local FMR”

The relation exists and it is always the same as the z=0 relation

Reduced Scatter Relation

How does the scatter about the MZR change with redshift?



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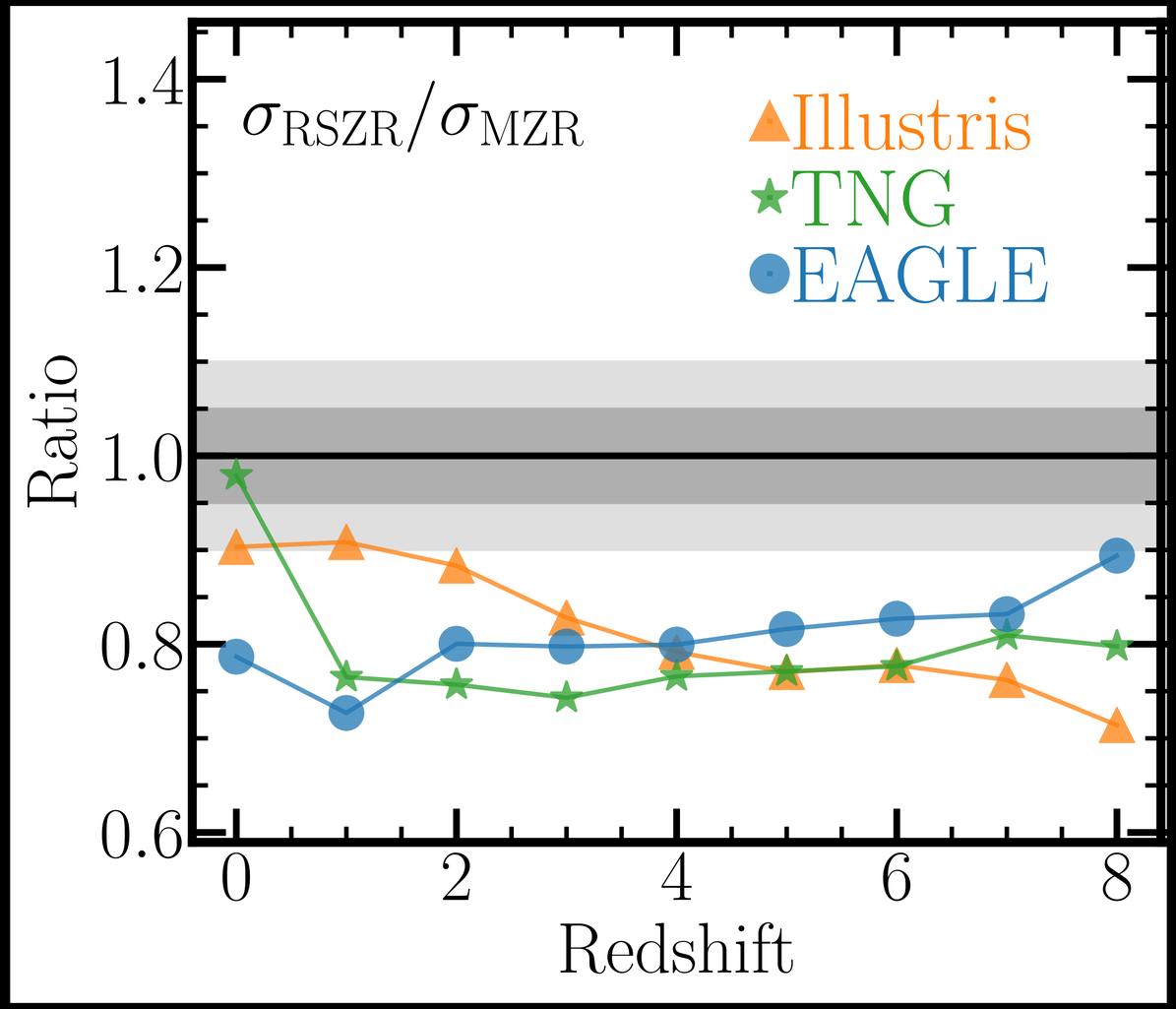
How much scatter reduction do we get?



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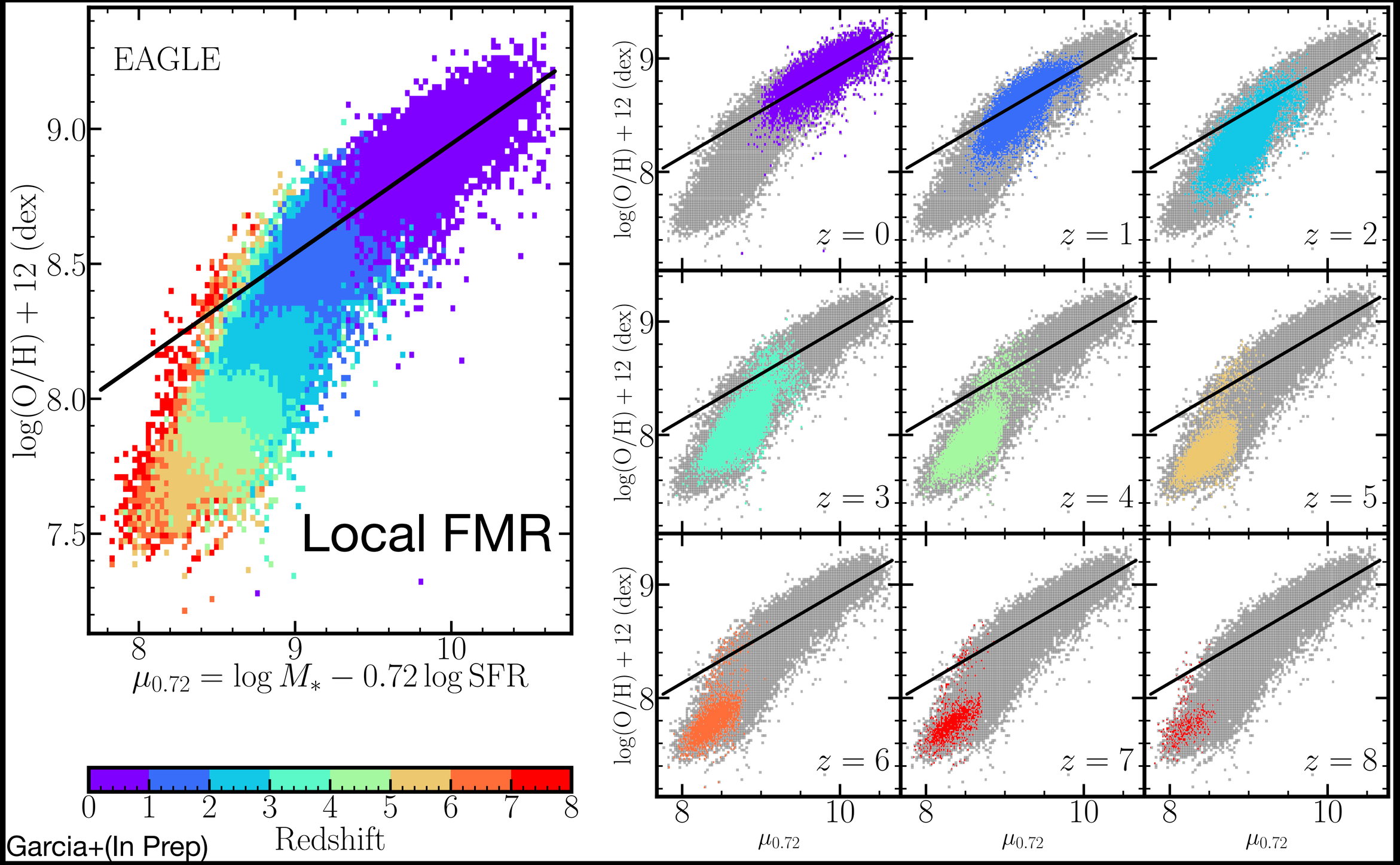

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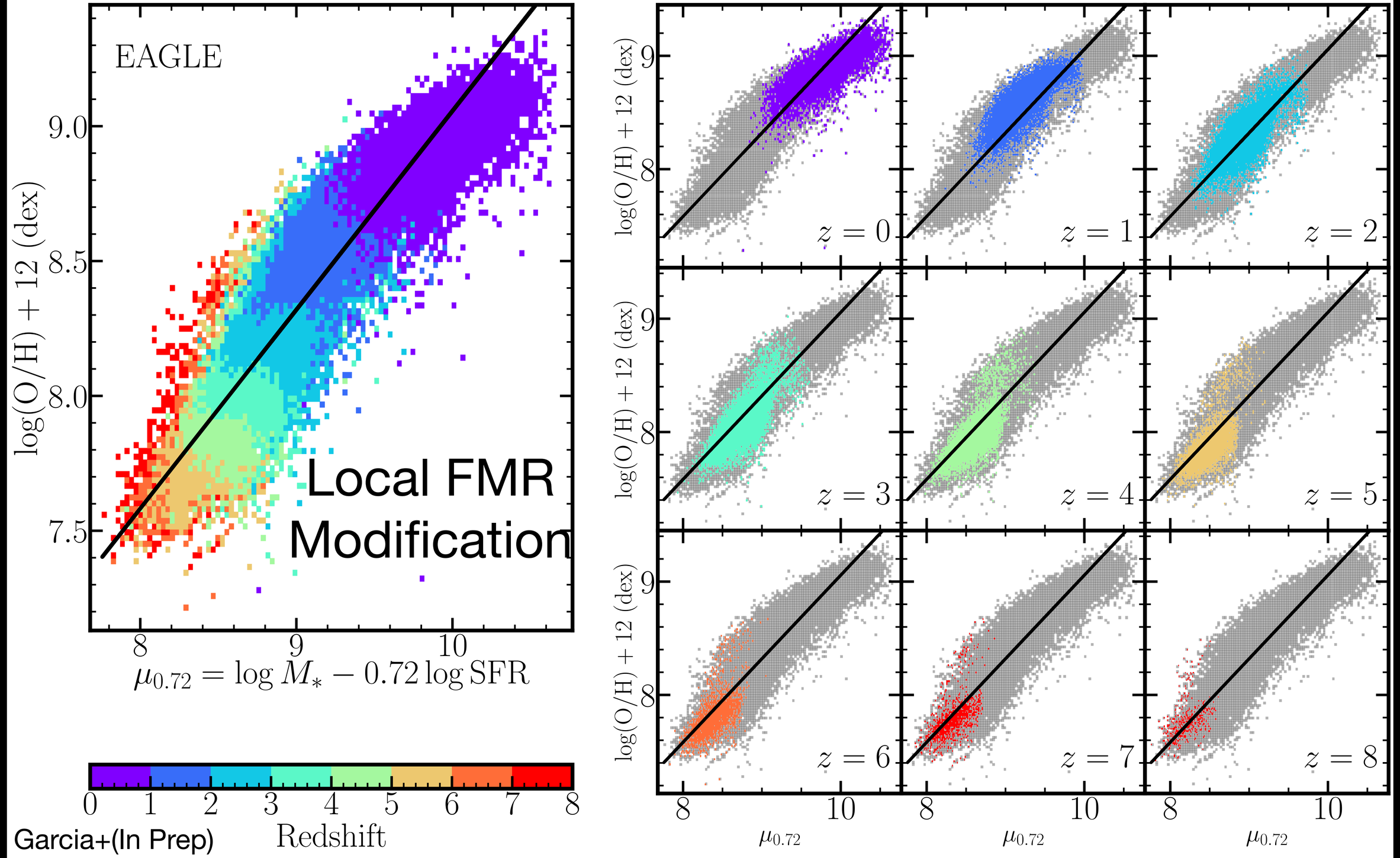
EAGLE
Local FMR Modification
$\log(\mathrm{O/H}) + 12$ (dex)
$\mu_{0.72} = \log M_* - 0.72 \log \mathrm{SFR}$
Redshift
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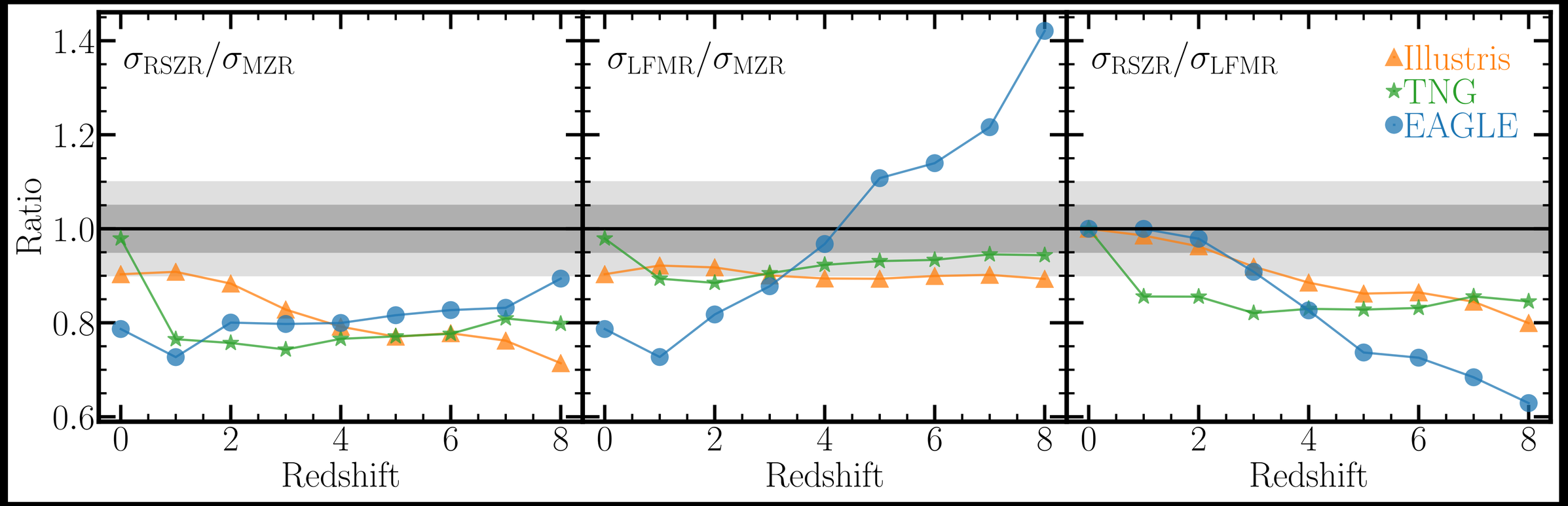
$z = 0$
$z = 1$
$z = 2$
$z = 3$
$z = 4$
$z = 5$
$z = 6$
$z = 7$
$z = 8$

How much worse is a local FMR?



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