MOONZ–z: Chronicling the cosmic chemical evolution of passive galaxies with VLT/MOONS

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1824
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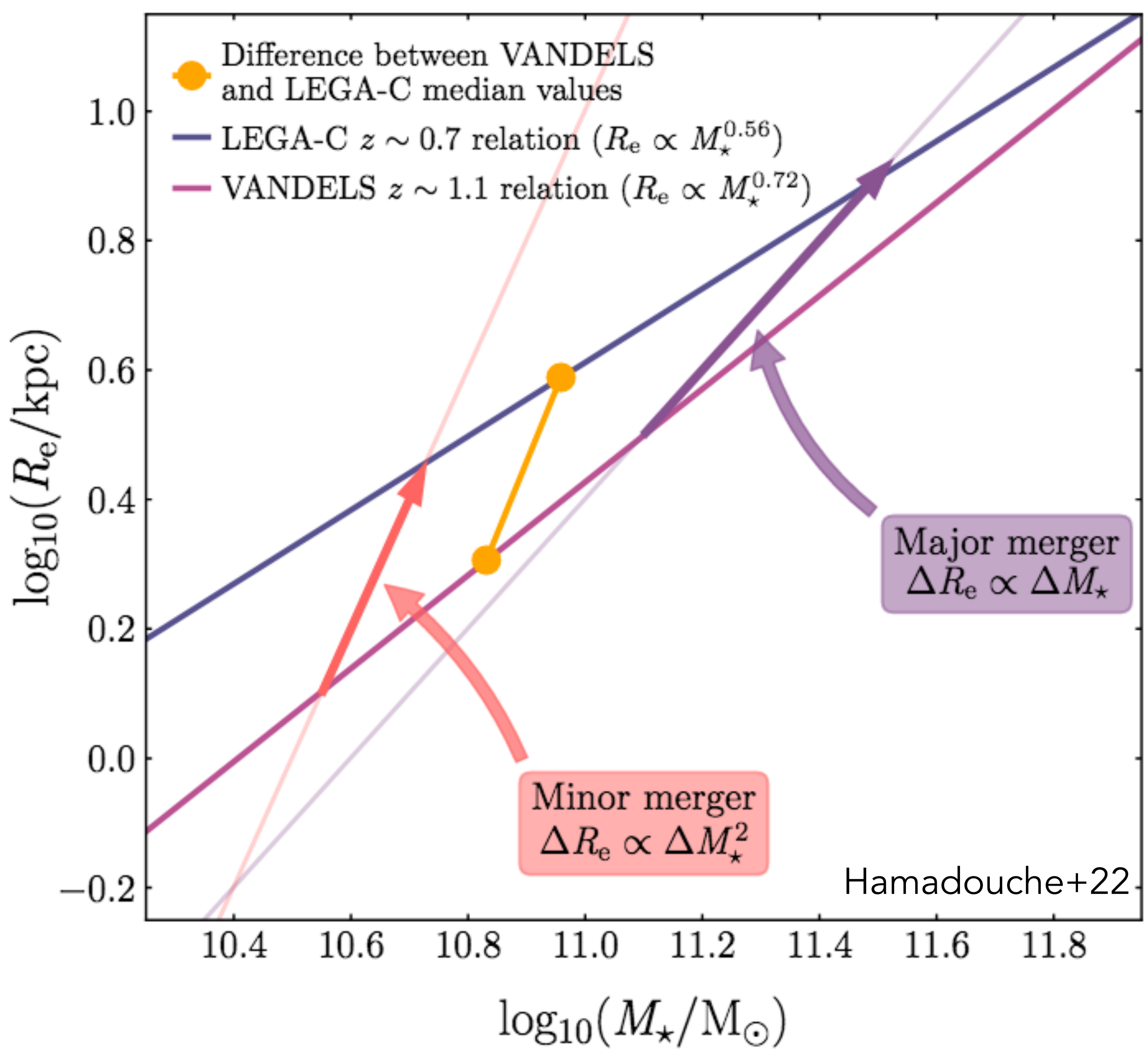
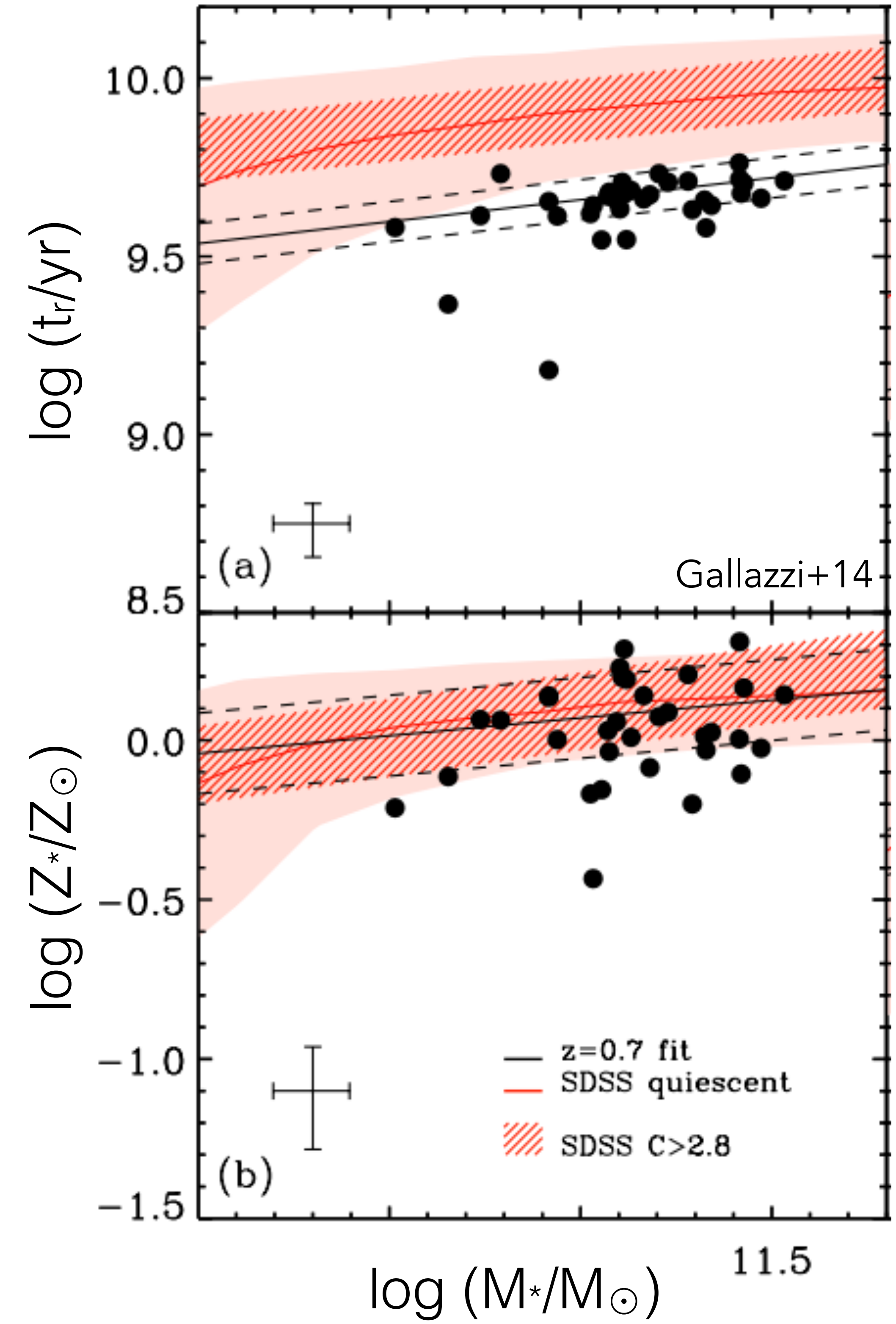
Maiolino+20

The evolution of passive galaxies

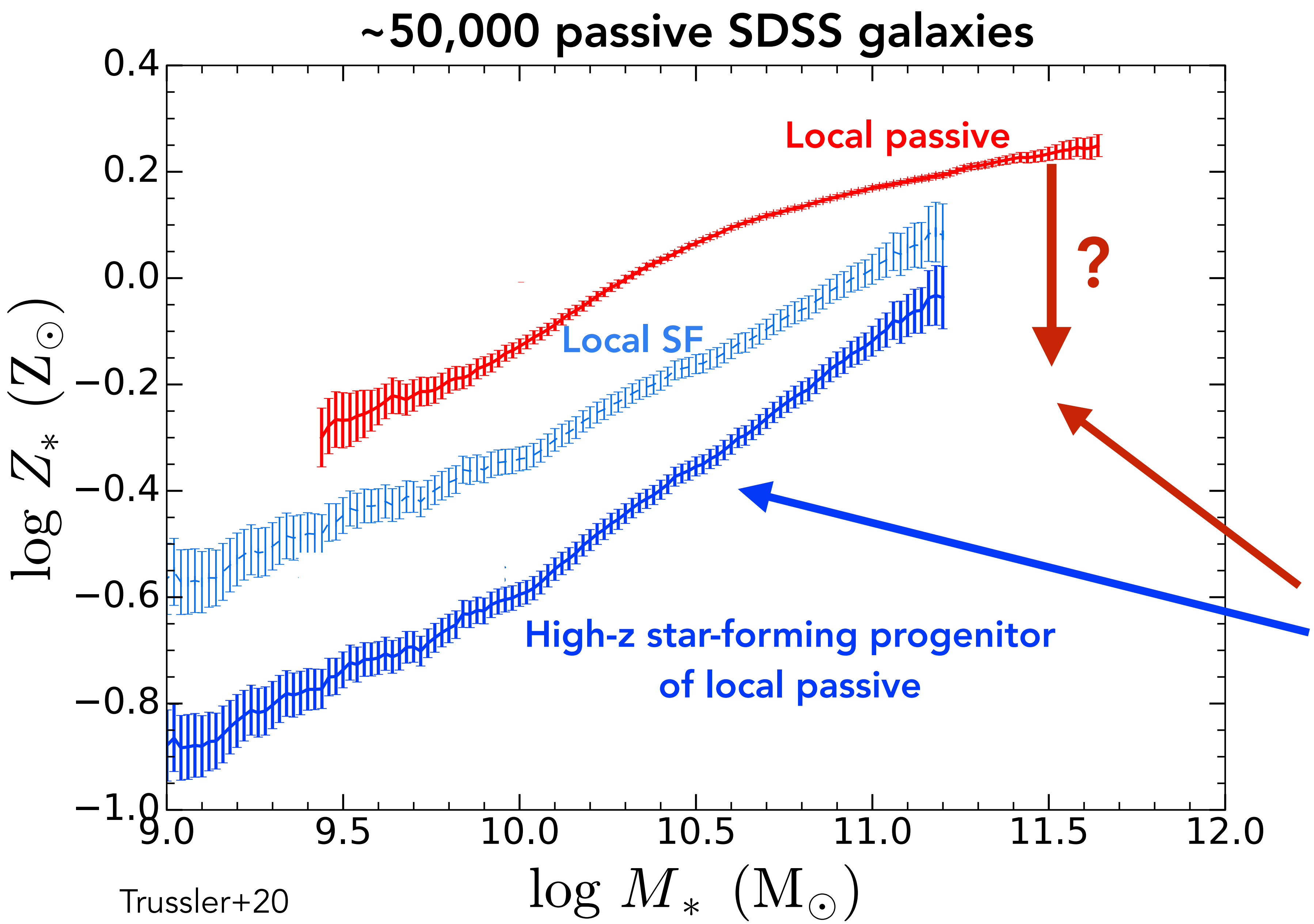
Structural evolution



Stellar population evolution



SDSS: z~0



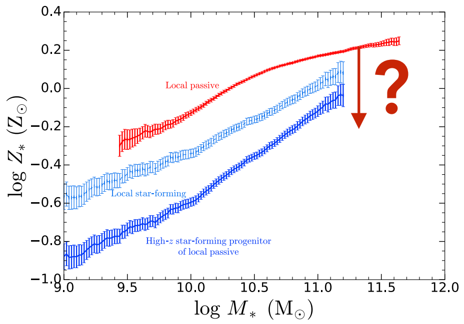
Trussler+20

How does this **chemistry** of **passive galaxies evolve** with cosmic time?

With **MOONS**, we will be able to directly make these measurements

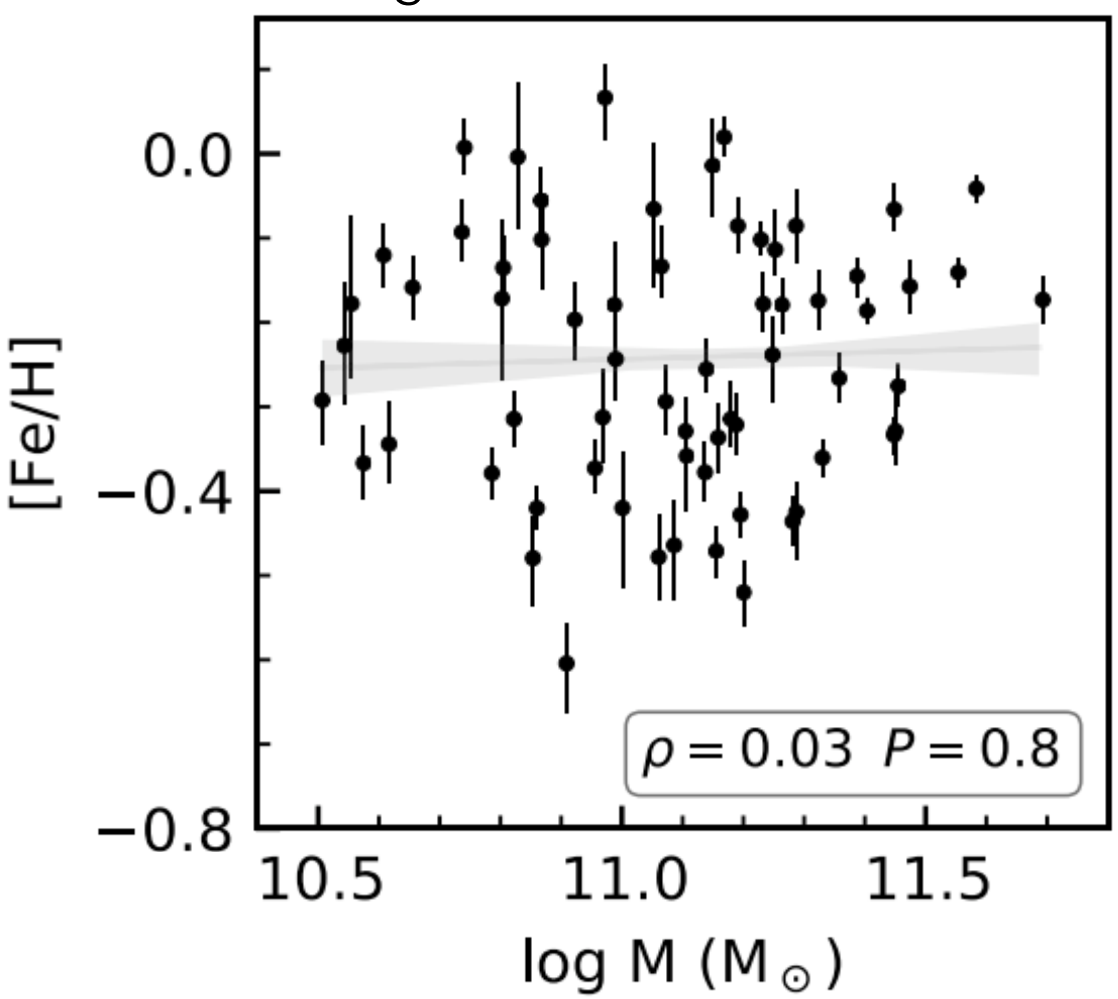
Passive galaxies are considerably more **metal-rich** than **star-forming galaxies** of the same stellar mass

LEGA-C: z~0.7

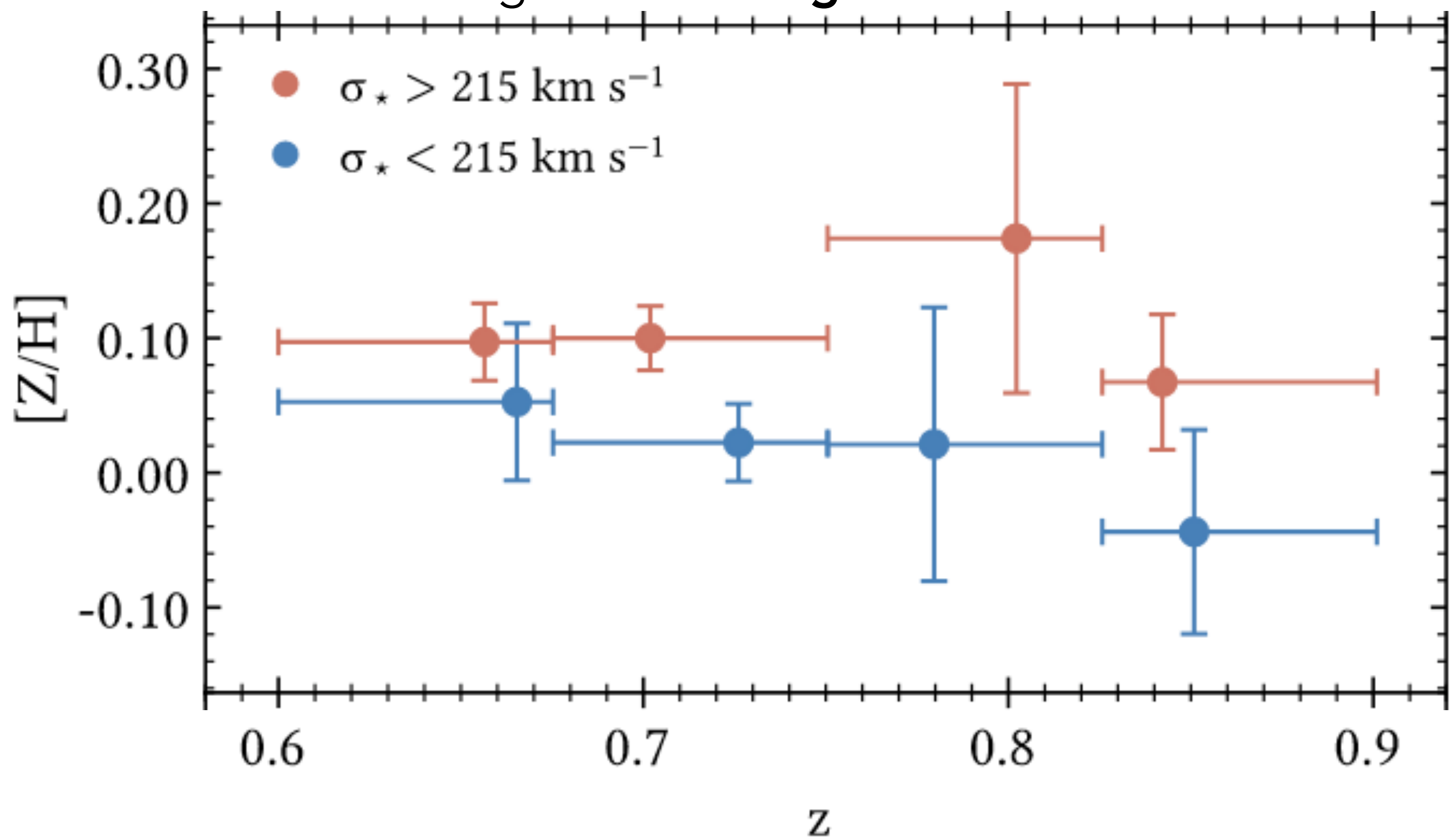


~1000 passive LEGA-C galaxies

Beverage+21: **0.2 dex lower at z=0.7**

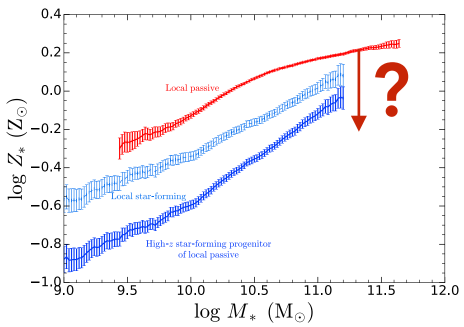


Borghi+22: **No significant evolution**

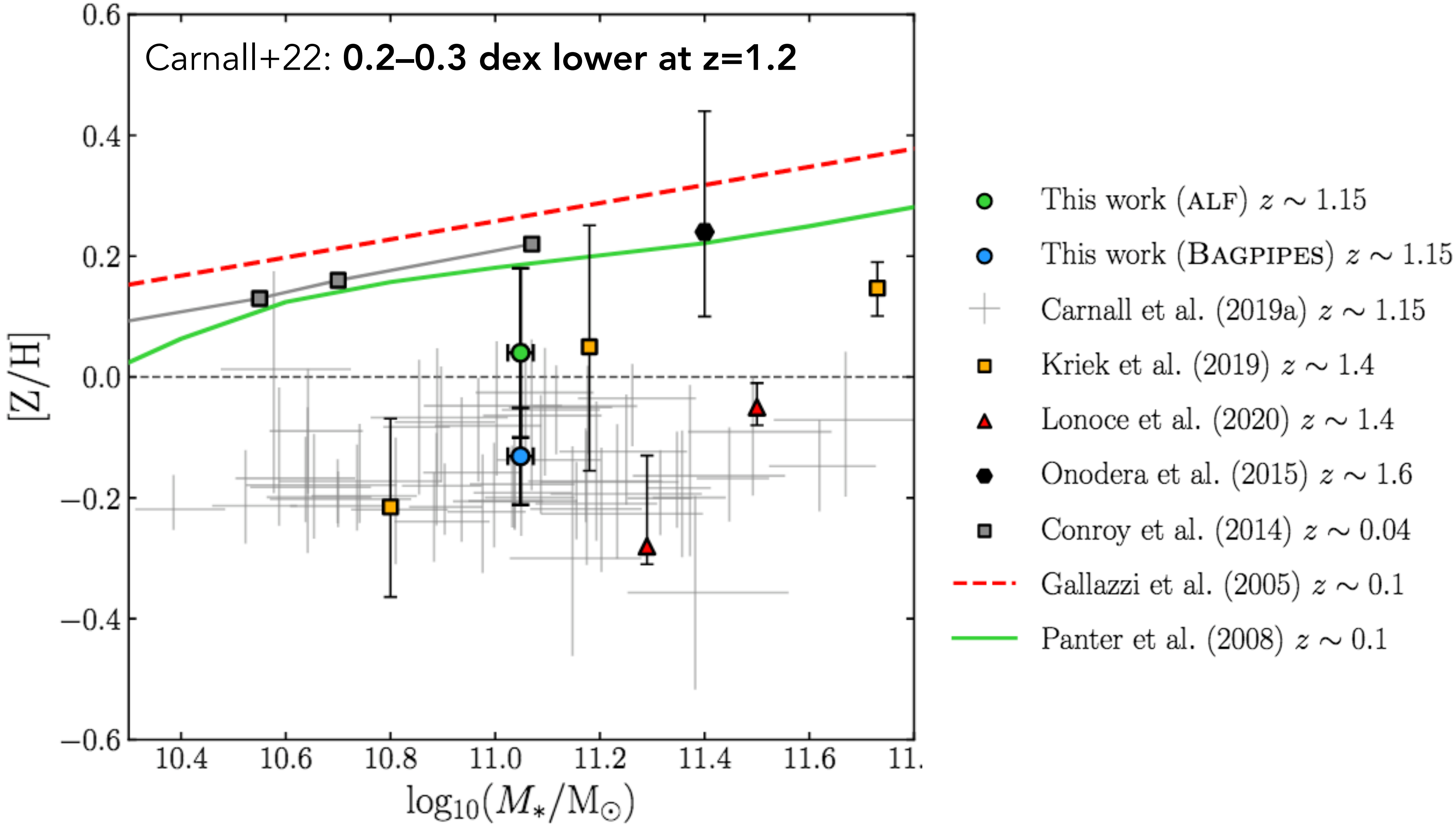


Are higher-z **passive galaxies** more **metal-poor** than their local counterparts?

VANDELS z~1.2



~300 passive VANDELS galaxies



Are higher-z **passive galaxies** more **metal-poor** than their local counterparts?

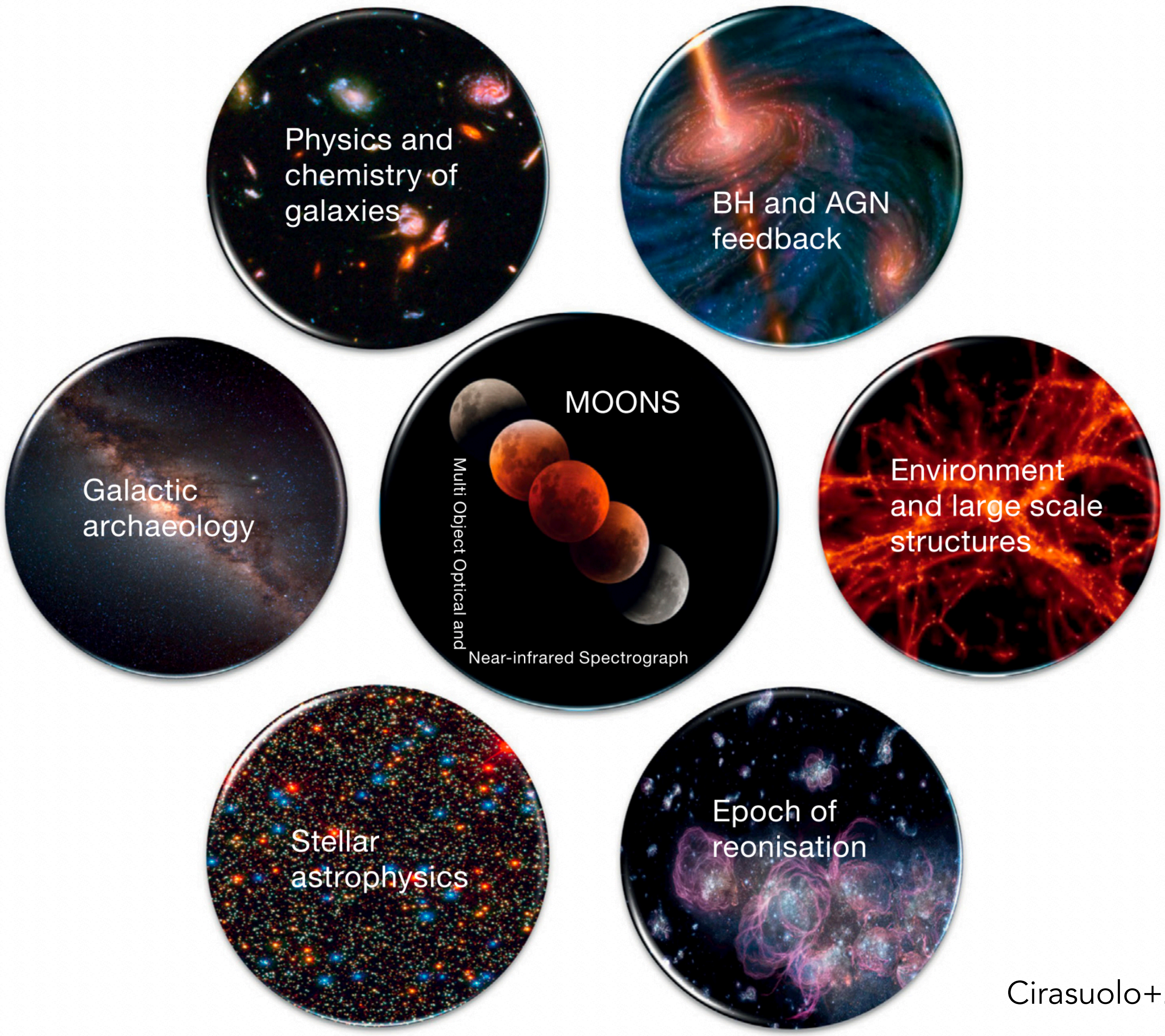
MOONS

MOONS:
Multi-Object Optical and Near-infrared Spectrograph

Adapted from Cirasuolo+20

Parameter	Value
Telescope	VLT, 8 m
Field of view	500 $arcmin^2$
Multiplex	1001
On-sky aperture of each fibre	1.2 arc seconds
Spectral channels	*RI*, *YJ* and *H* bands observed simultaneously
Low-res simultaneous spectral coverage	0.64–1.80 μm
Low-res spectral resolution	R_{RI} = 4100, R_{YJ} = 4300, R_H = 6600
Throughput	> 30% in low resolution
Continuum sensitivity (1 h, 5σ)	23 AB mag, after rebinning to R = 1000
Emission line sensitivity (1 h, 5σ)	2×10^{-17} erg s^{-1} cm^{-2}

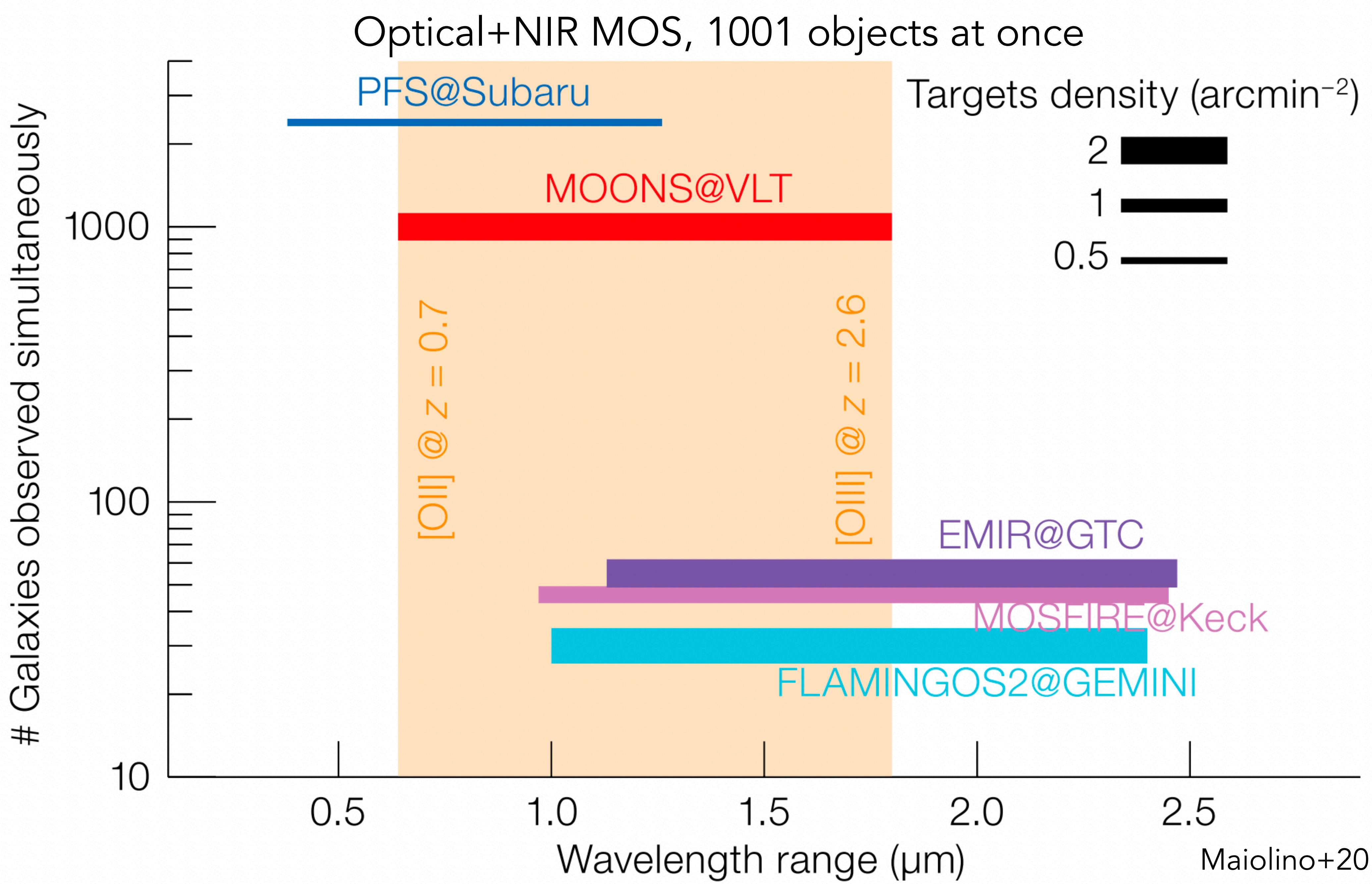
MOONS



Cirasuolo+20

MOONRISE: z~1–2.5

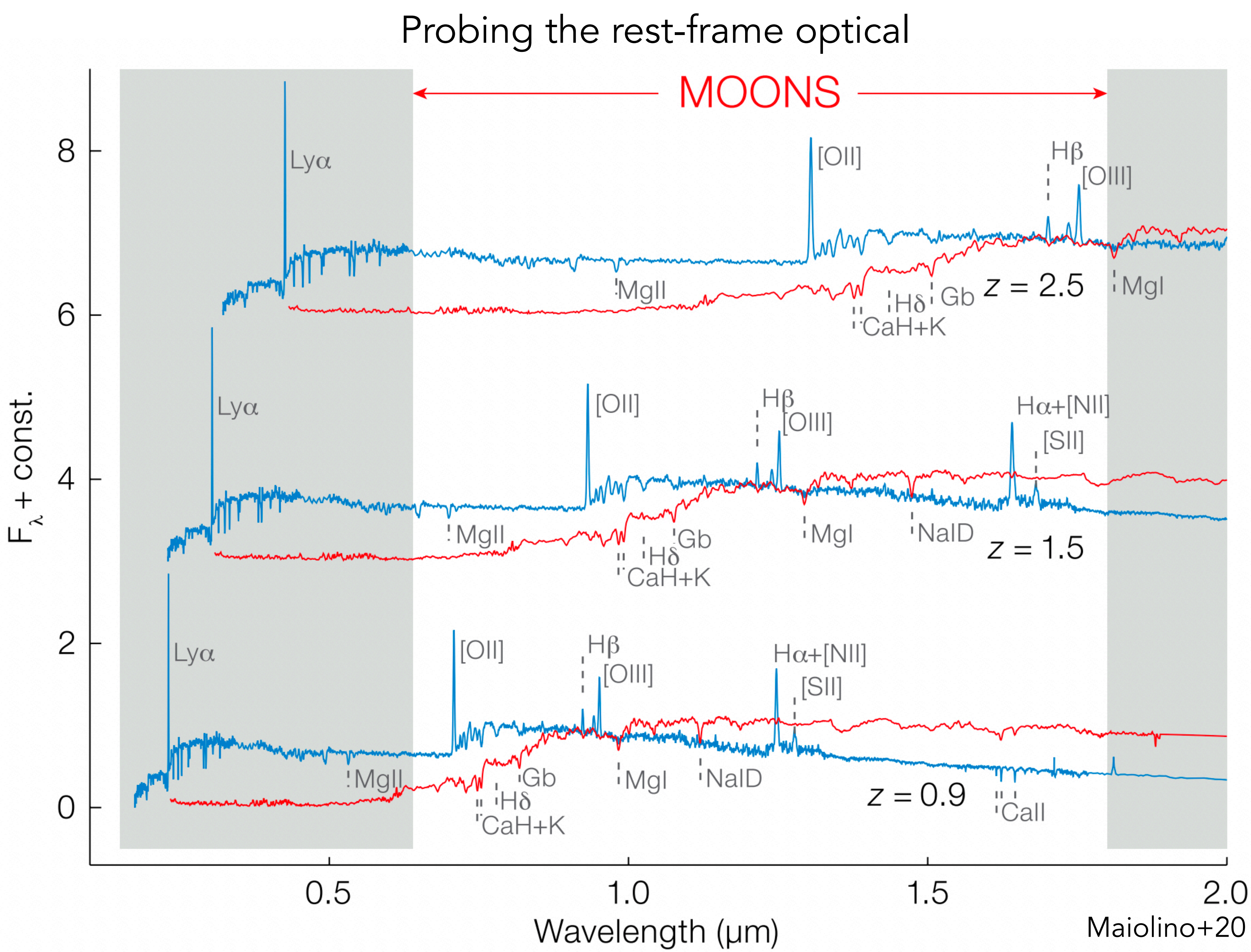
MOONRISE: MOONS extragalactic GTO survey



Maiolino+20

MOONRISE: z~1–2.5

MOONRISE: MOONS extragalactic GTO survey



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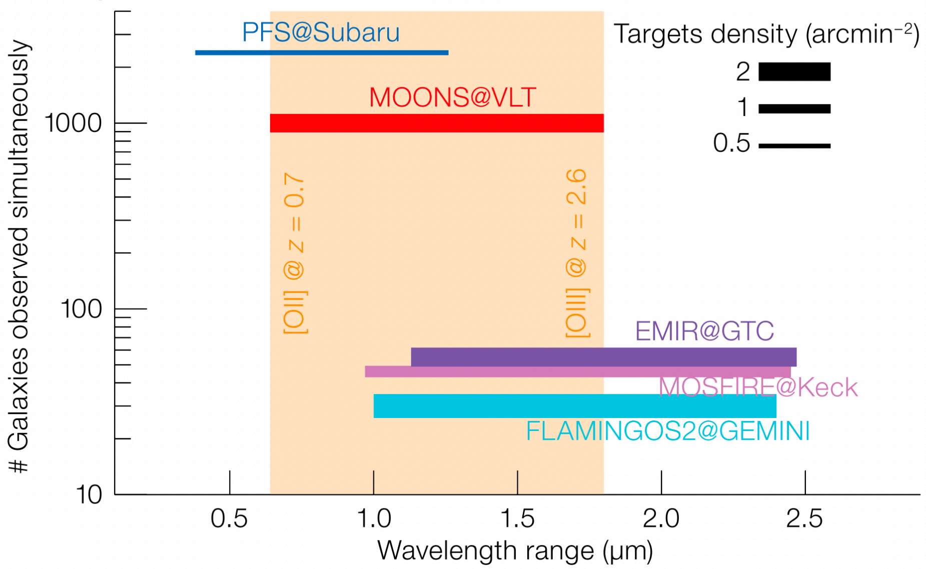
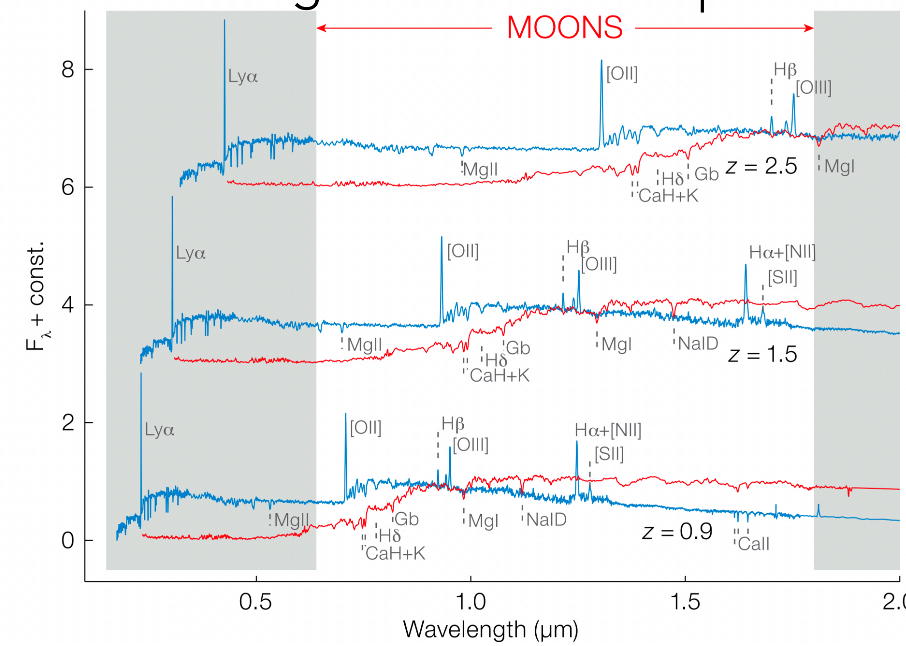
MOONRISE: z~1–2.5

MOONRISE: MOONS extragalactic GTO survey

Optical+NIR MOS, 1001 objects at once



Probing the rest-frame optical

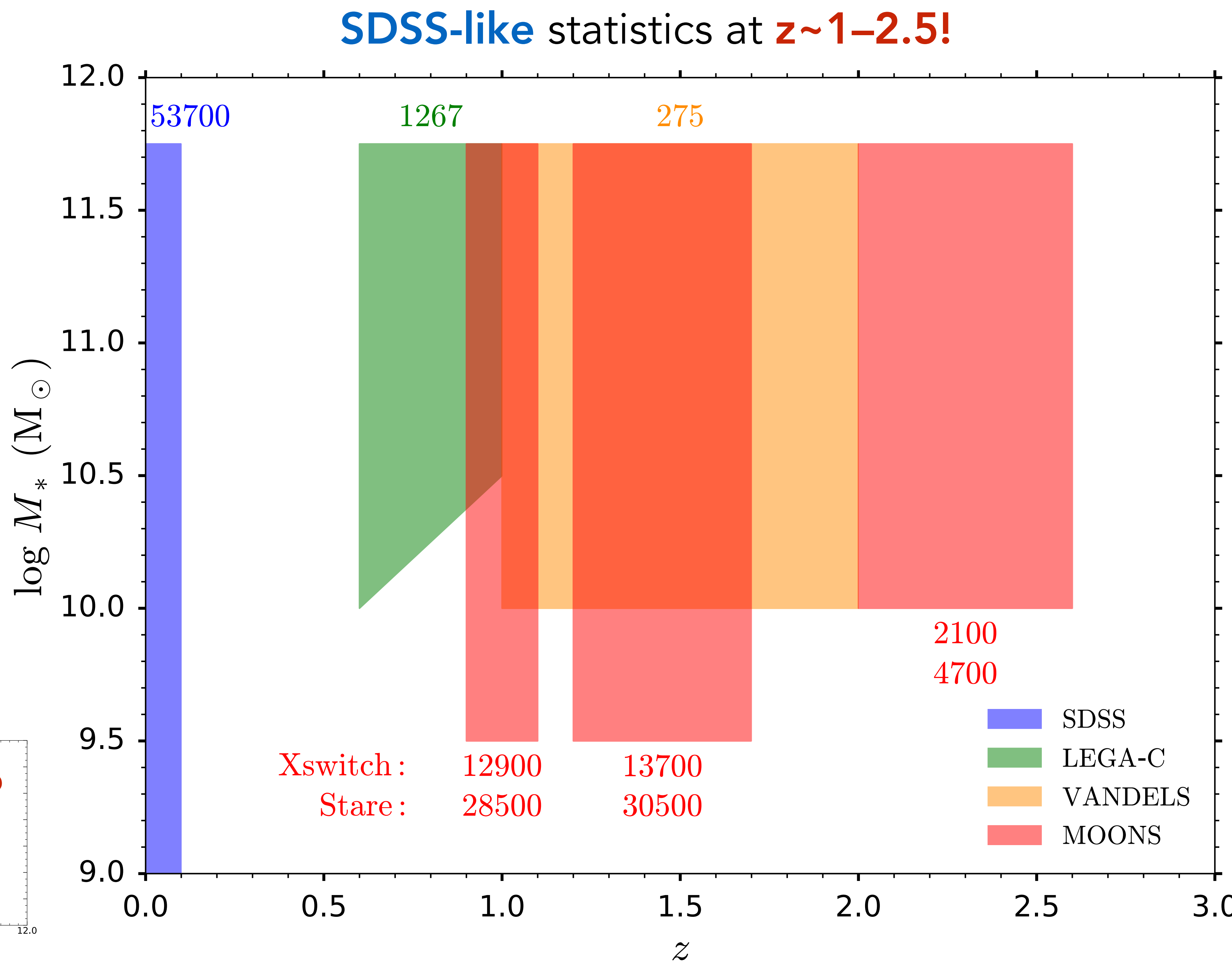


= SDSS-like statistics and science at cosmic noon!

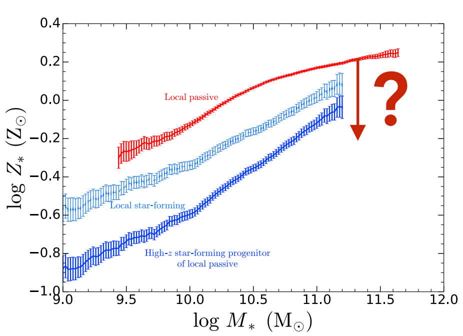
Redshift range	Main spectral features	Selection	Number of galaxies* Xswitch (4 square degrees)	Stare (7 square degrees)
$0.9 < z < 1.1$	[OII], Hβ, [OIII], Hα, [NII], [SII] CaH+K, Hδ, Gb, Mgb, NaID, CaII	$H_{AB} < 23$ or $\log(M_*) > 9.5$	33 900 12 900	75 300 28 500
$1.2 < z < 1.7$	[OII], Hβ, [OIII], Hα, [NII], [SII] MgII, CaH+K, Hδ, Gb, Mgb, NaID	$H_{AB} < 23.5$ or $\log(M_*) > 9.5$	88 700 13 700	197 100 30 500
$2.0 < z < 2.6$	[OII], Hβ, [OIII] MgII, CaH+K, Hδ, Gb, Mgb	$H_{AB} < 24$ or $\log(M_*) > 10$	54 500 2100	121 100 4700
$5 < z$	Lyα, NV, HeII, CIV, CIII]	$H_{AB} < 26$	2000	4500
Total			207 800	461 700

Maiolino+20

MOONRISE: z~1–2.5

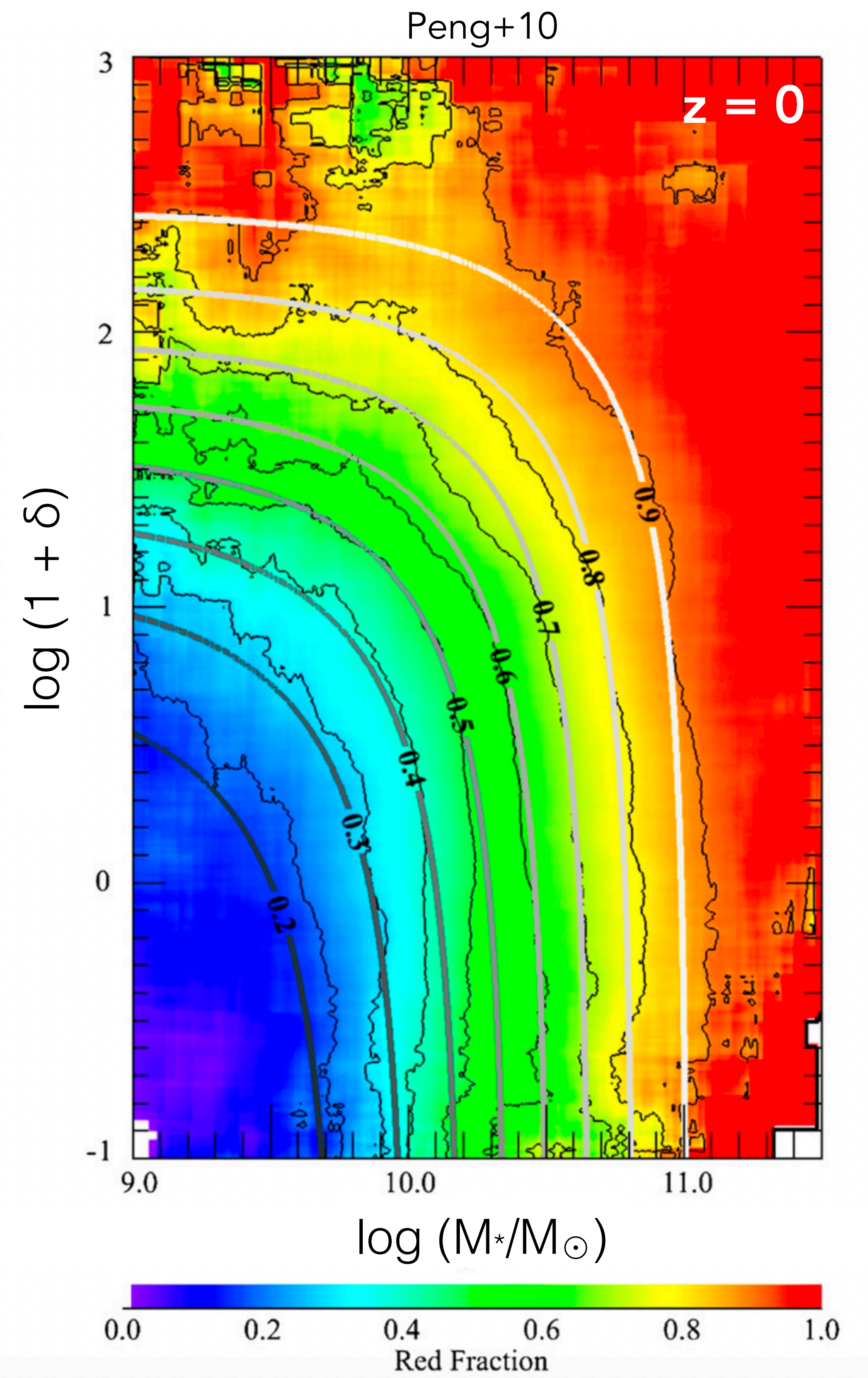


Assuming the Maiolino+20 MOONRISE survey design



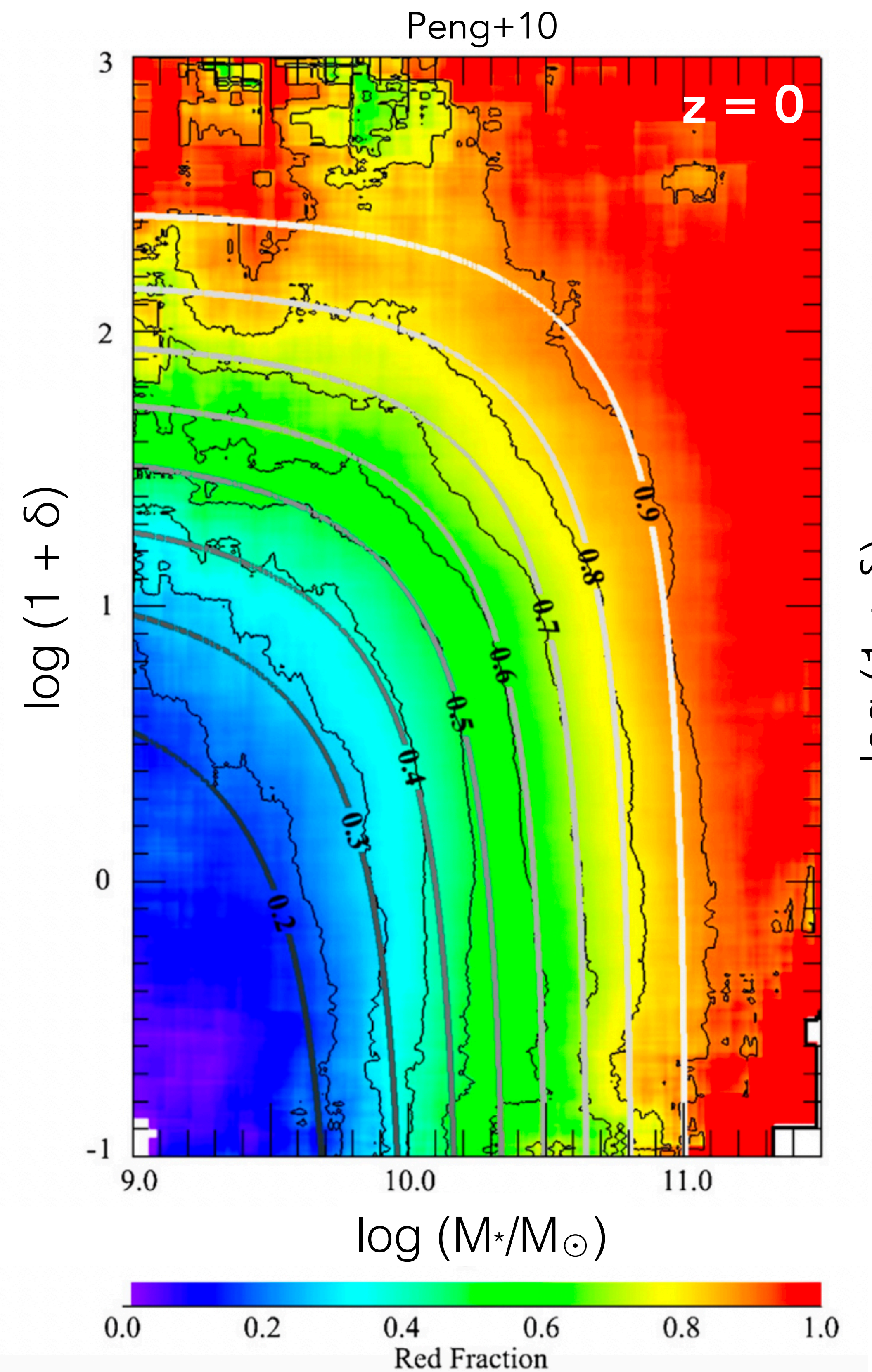
MOONRISE enables an investigation into the **mass**-, **environment**- and **structural**-dependence of the **passive** **Z–z relation**

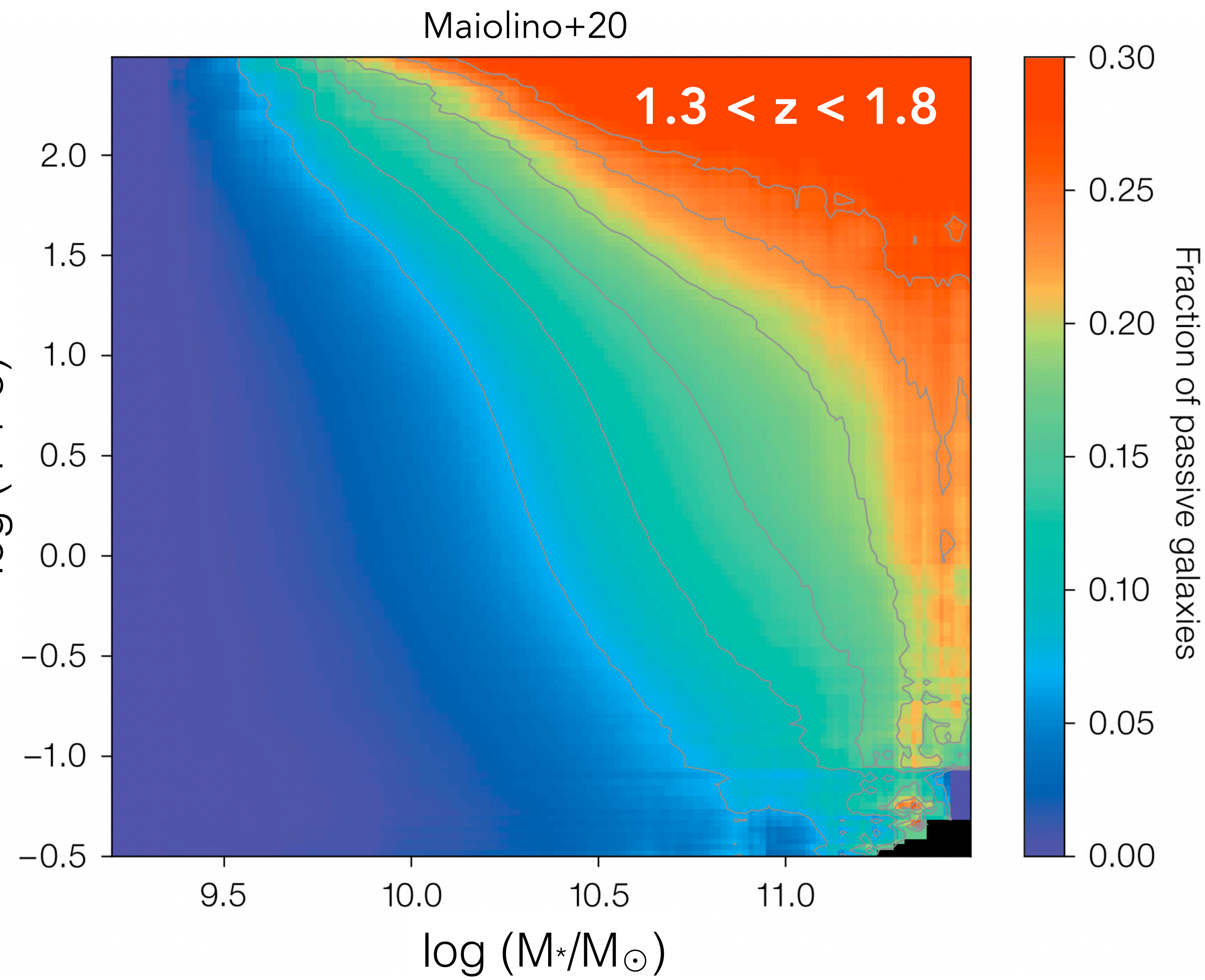
Quenched fraction: SDSS



Both mass and environment
drive galaxy quenching at z = 0

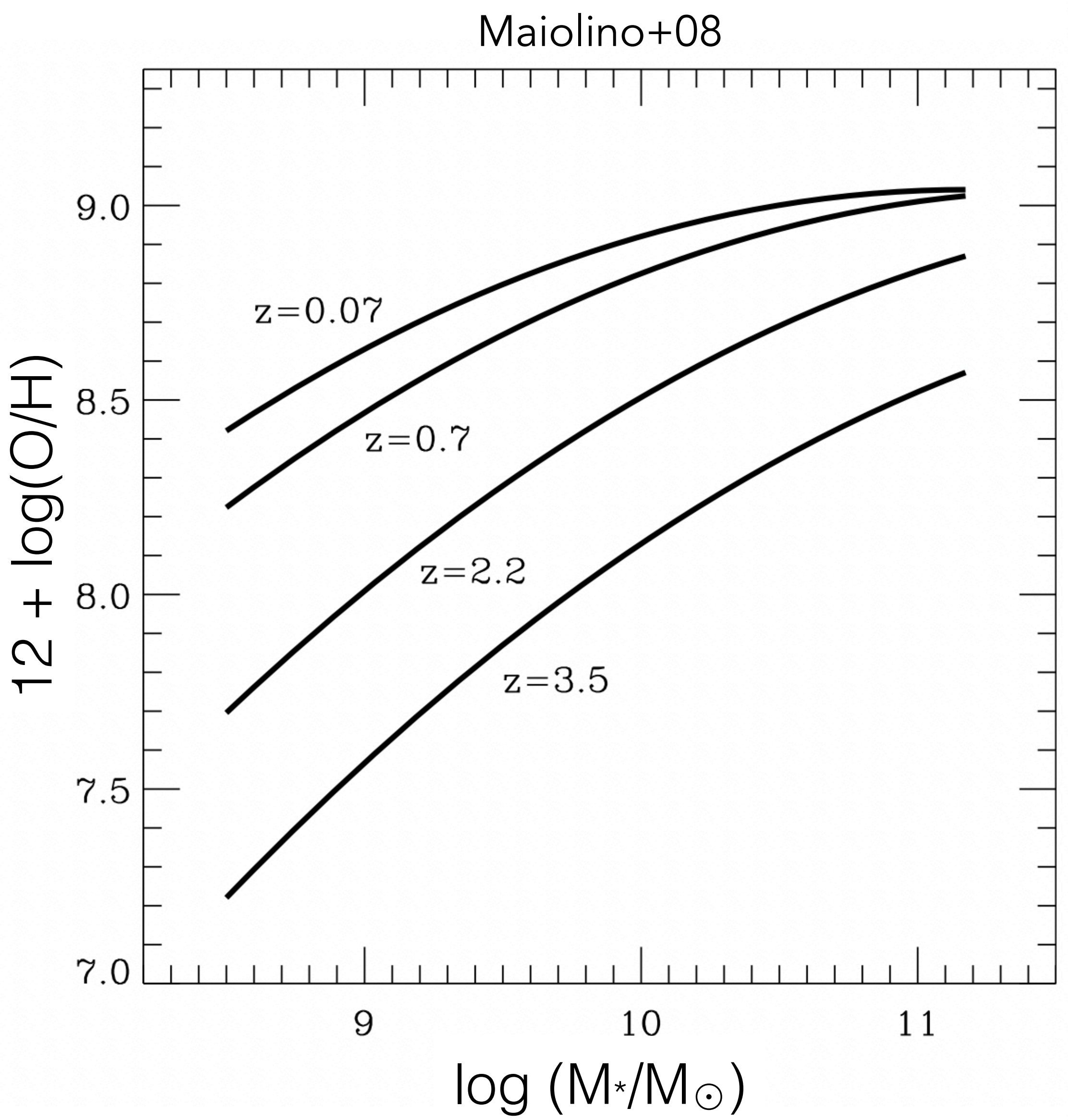
Quenched fraction: MOONRISE

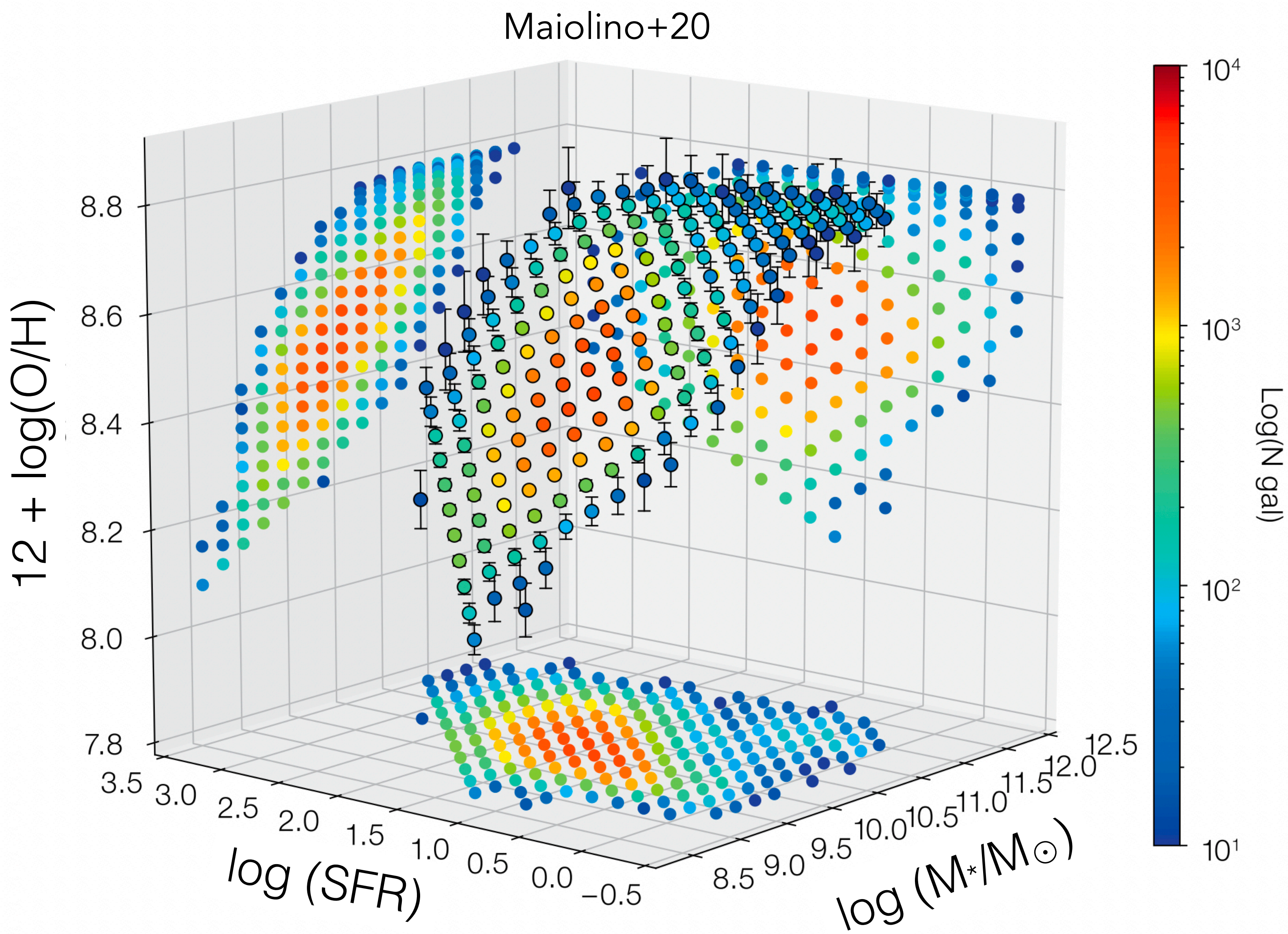




What is the **primary driver** of galaxy quenching around **cosmic noon?**

Gas-phase metallicity: FMR

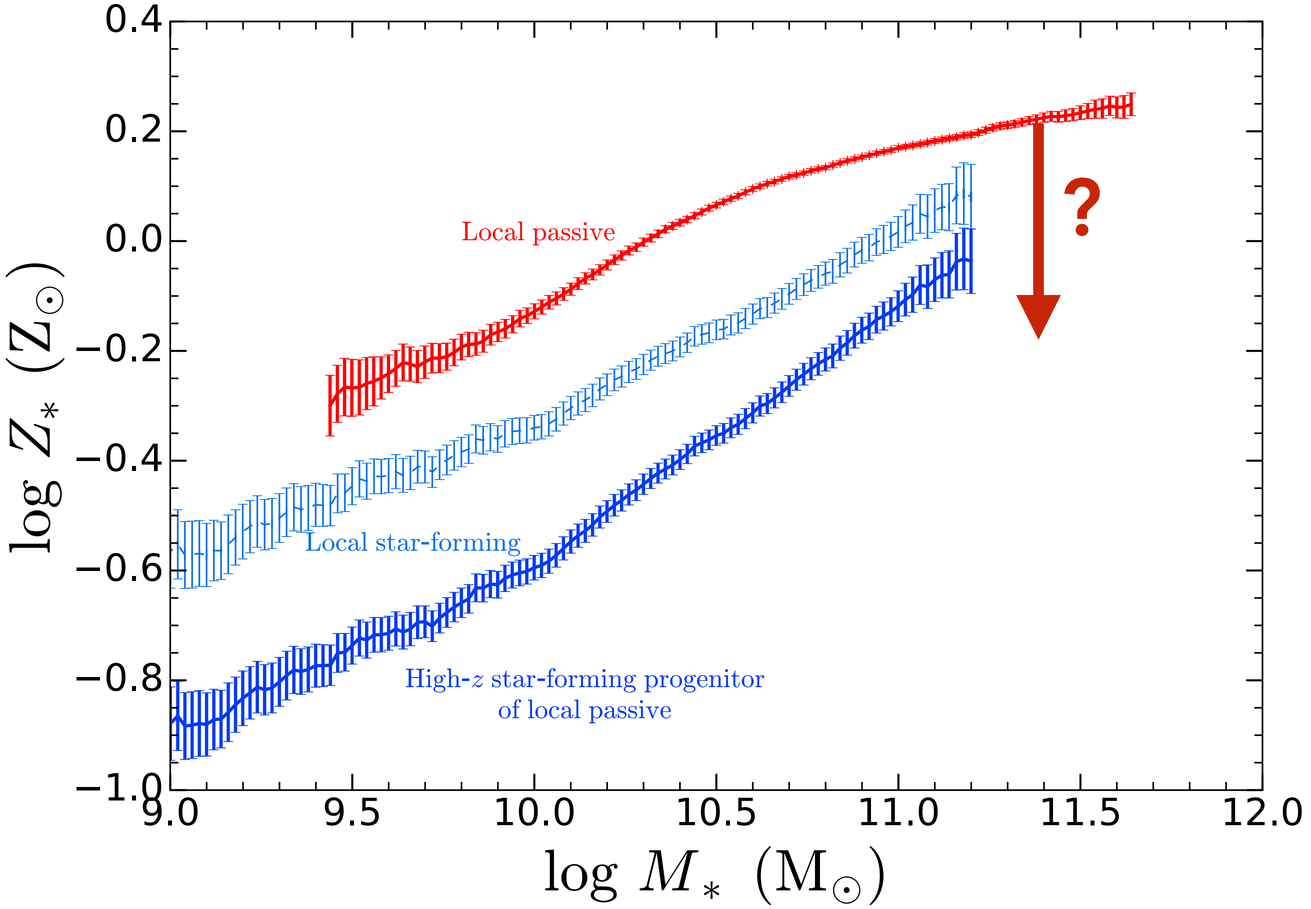




Star-forming galaxies at higher-z are **more metal-poor** than their low-z counterparts

How are **metallicity**, **mass** and **SFR** connected (`FMR') around **cosmic noon?**

MOONZ–z



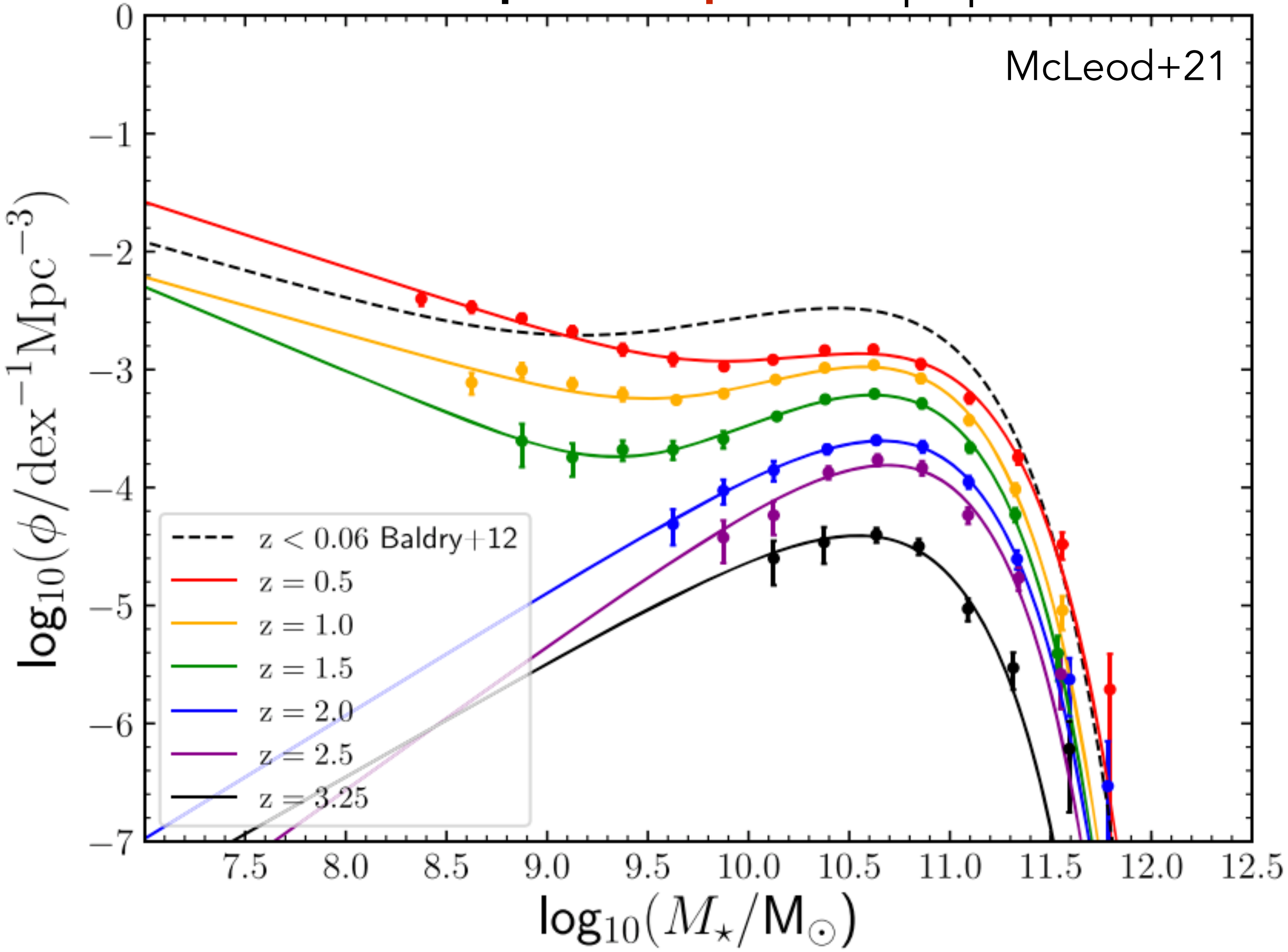
The redshift-evolution of the **MZR** for **passive galaxies** will be driven by:

- The **build-up** of the **passive** population
  - ★ Evolution of their **star-forming progenitors**
  - ★ Evolution of **galaxy quenching**

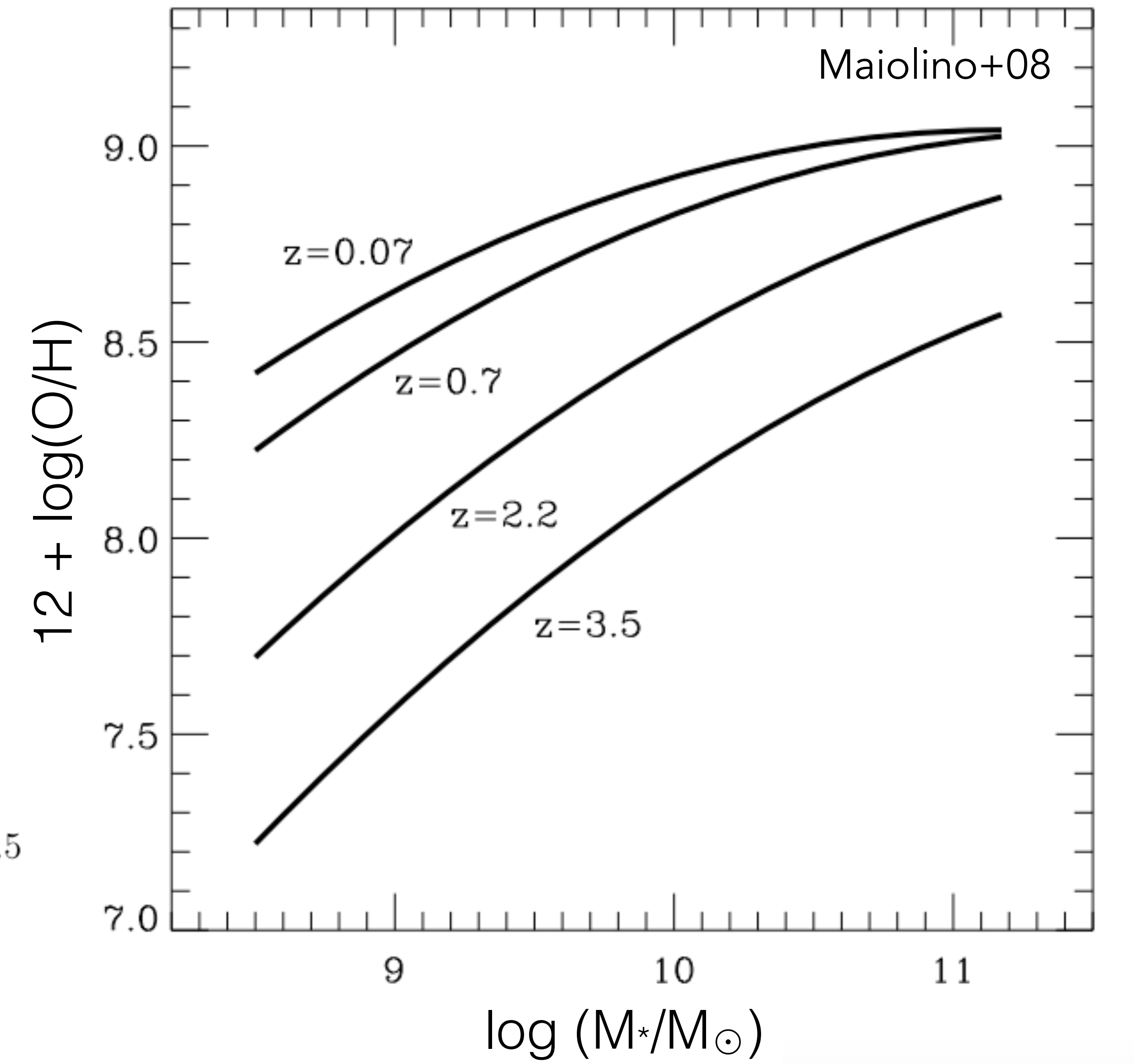
- **Post-quenching** evolution
  - ★ **Rejuvenation**
  - ★ **Dry mergers**

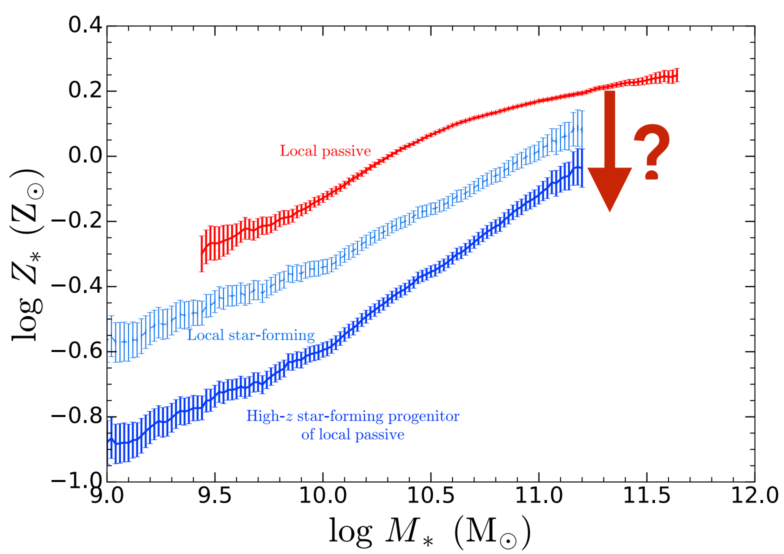
Star-forming progenitors

The **build-up** of the **passive** population



The **evolution** of the **star-forming** population

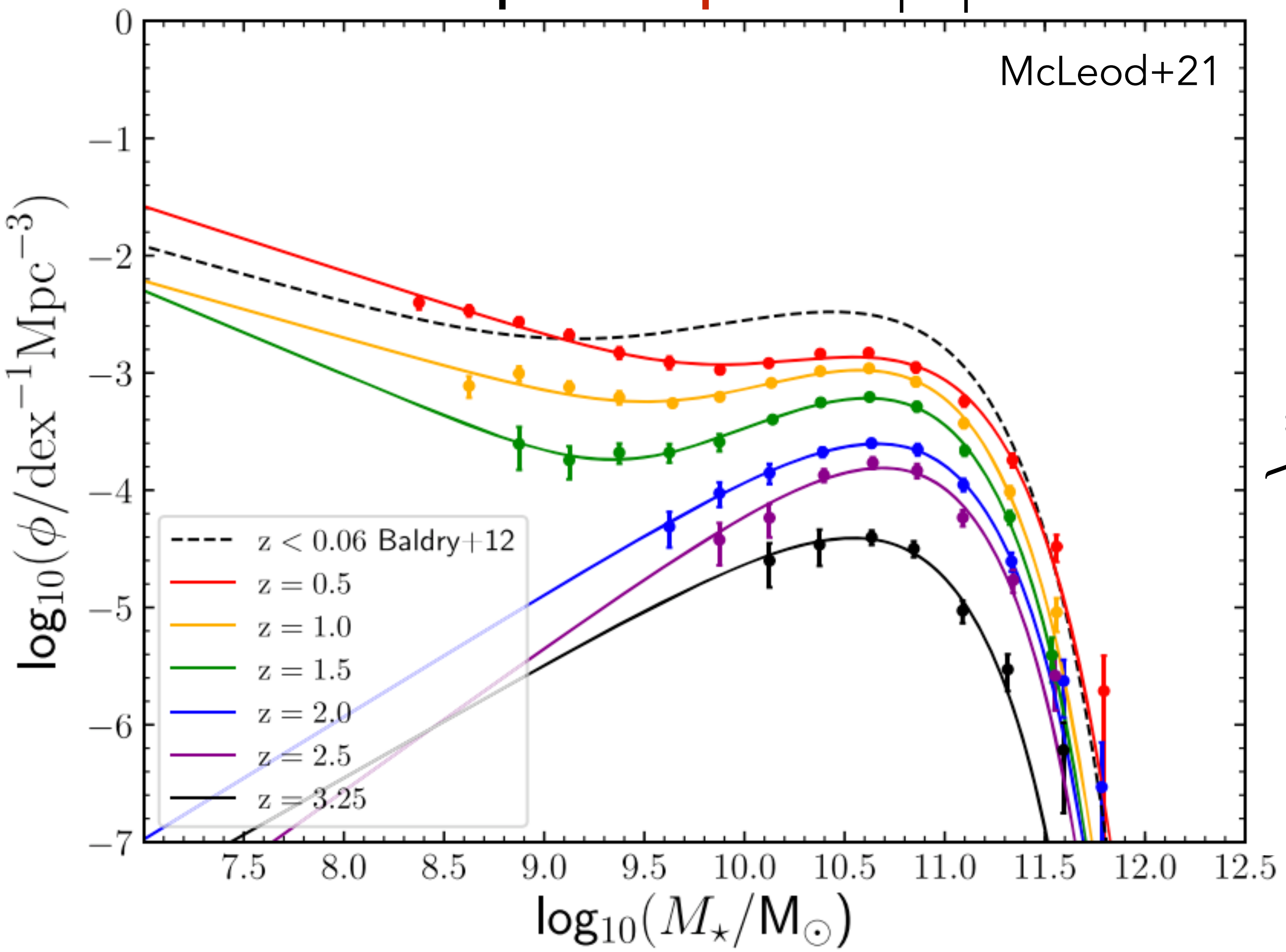




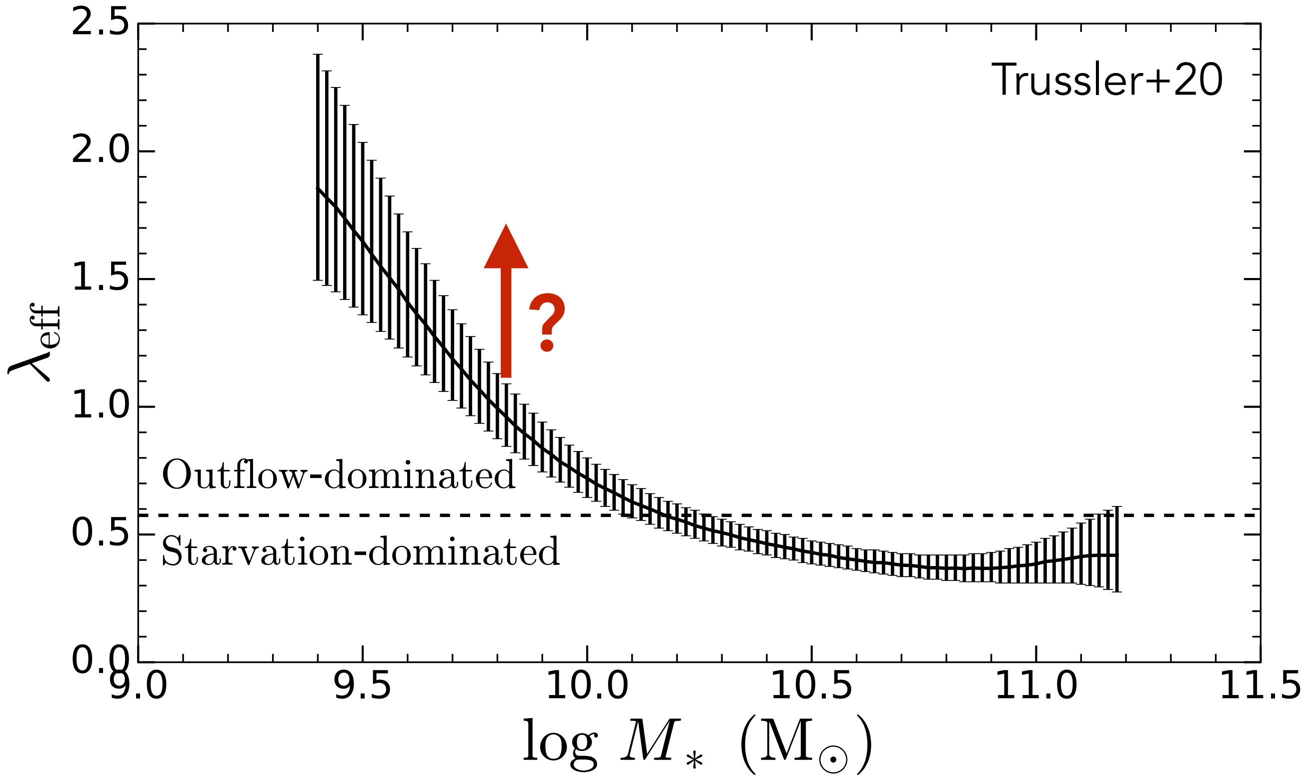
Is the potential evolution in the **passive** **MZR** perhaps due to the **rising gas-phase metallicities** in **star-forming galaxies?**

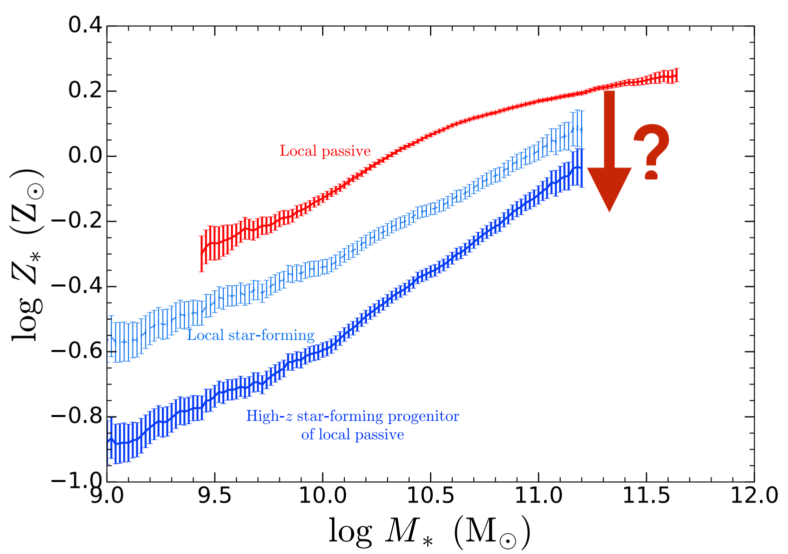
Galaxy quenching

The **build-up** of the **passive** population

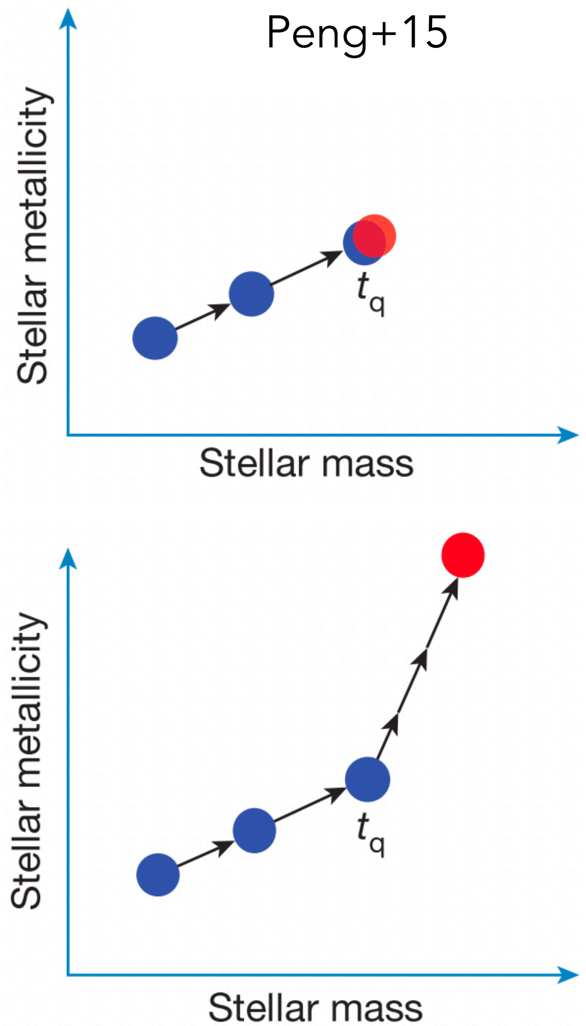


The **evolution** of **galaxy quenching?**





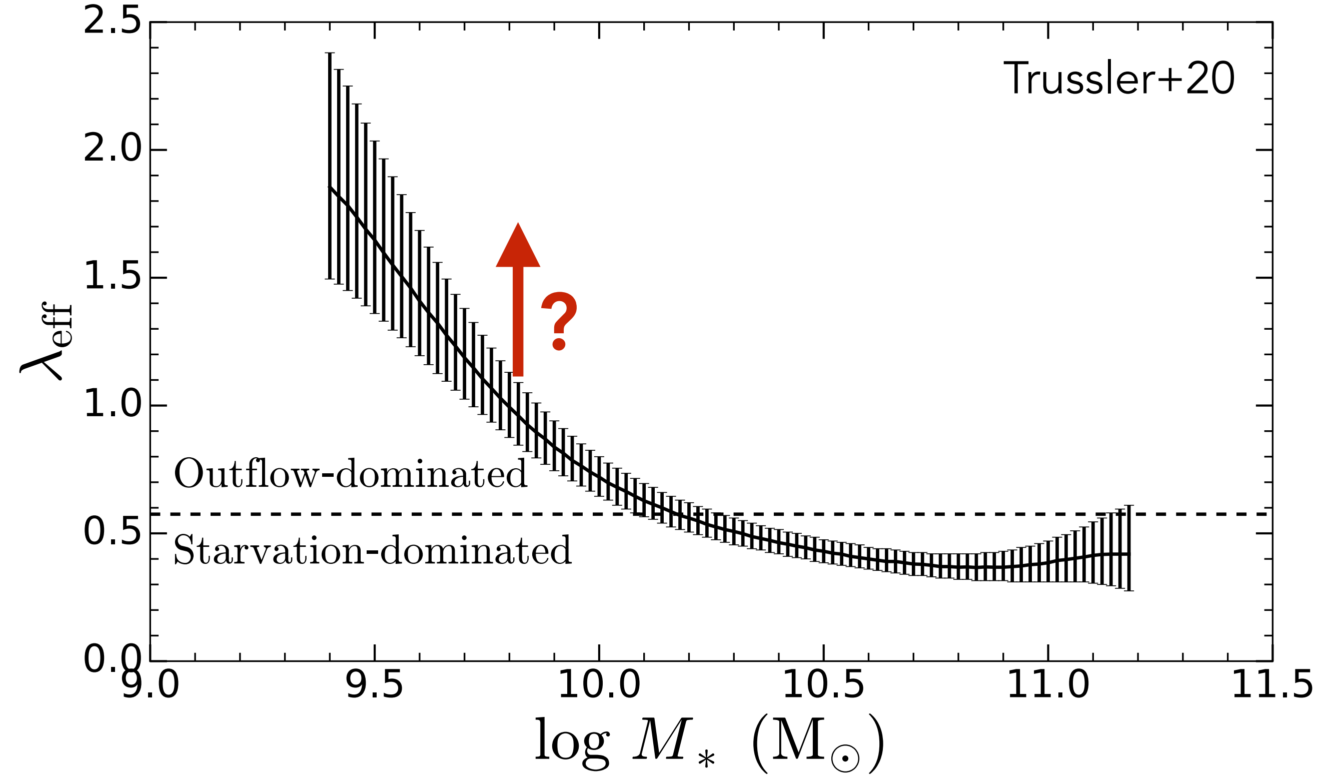
Galaxy quenching

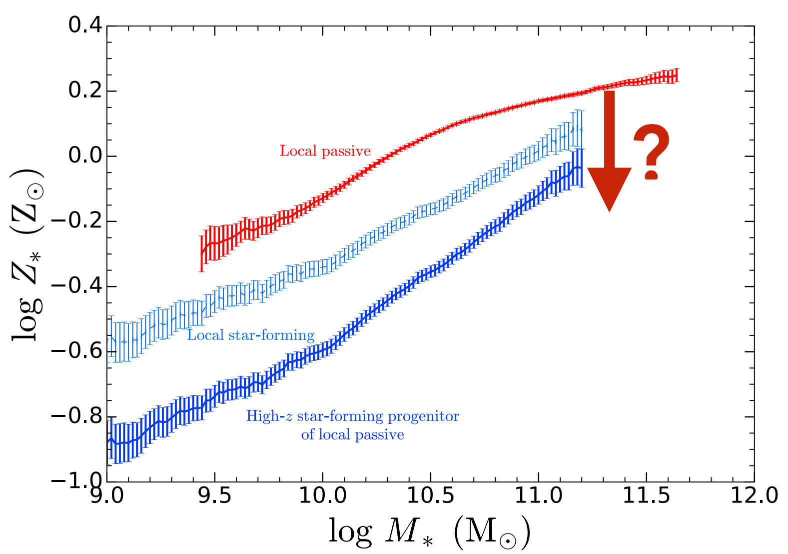


Quenching by **outflows**:
Small ΔZ*

Quenching by **starvation**:
Large ΔZ*

The **evolution** of **galaxy quenching?**





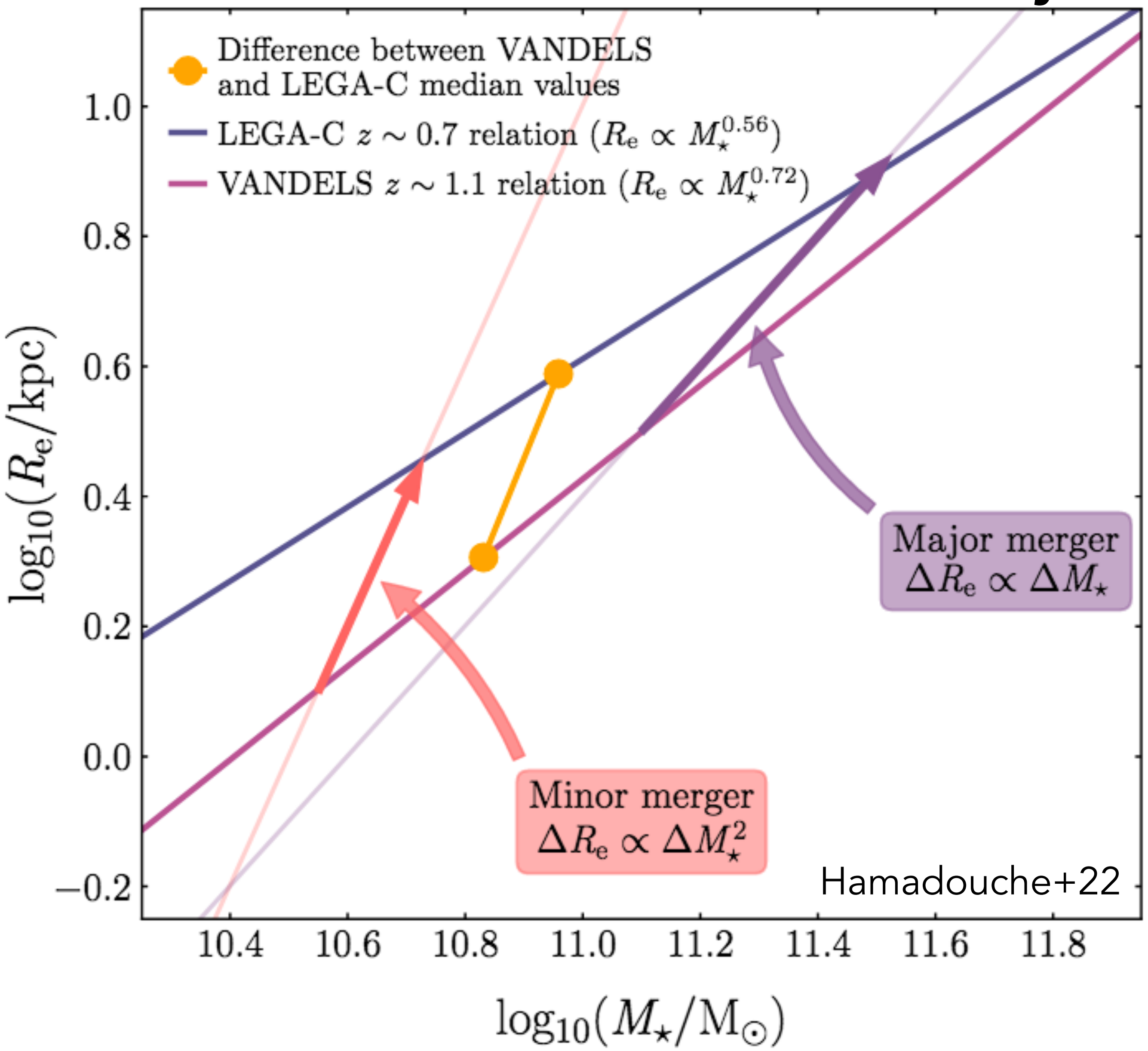
What are the relative roles of **starvation** and **outflows** in driving quenching at higher-z?

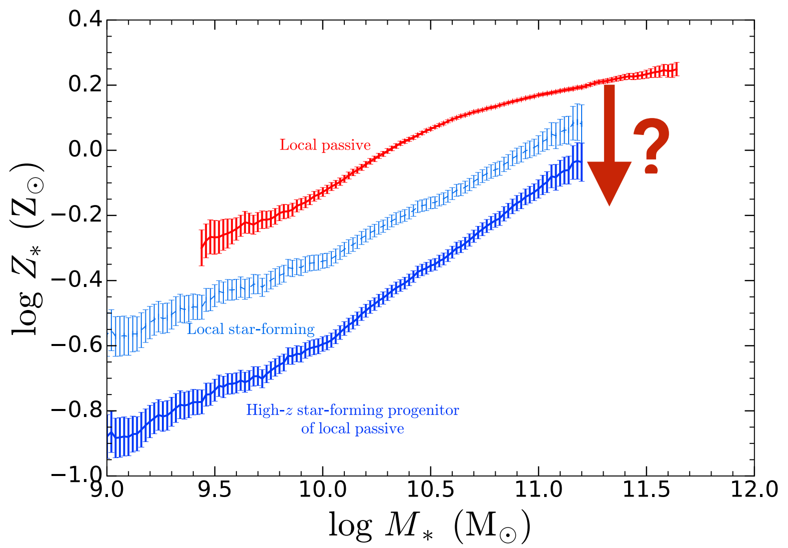
Can this help explain the (non-)evolution of the **passive MZR?**

Post-quenching evolution

Can we identify the **chemical signatures** of **mergers** in **passive galaxies?**

Structural evolution + metallicity?

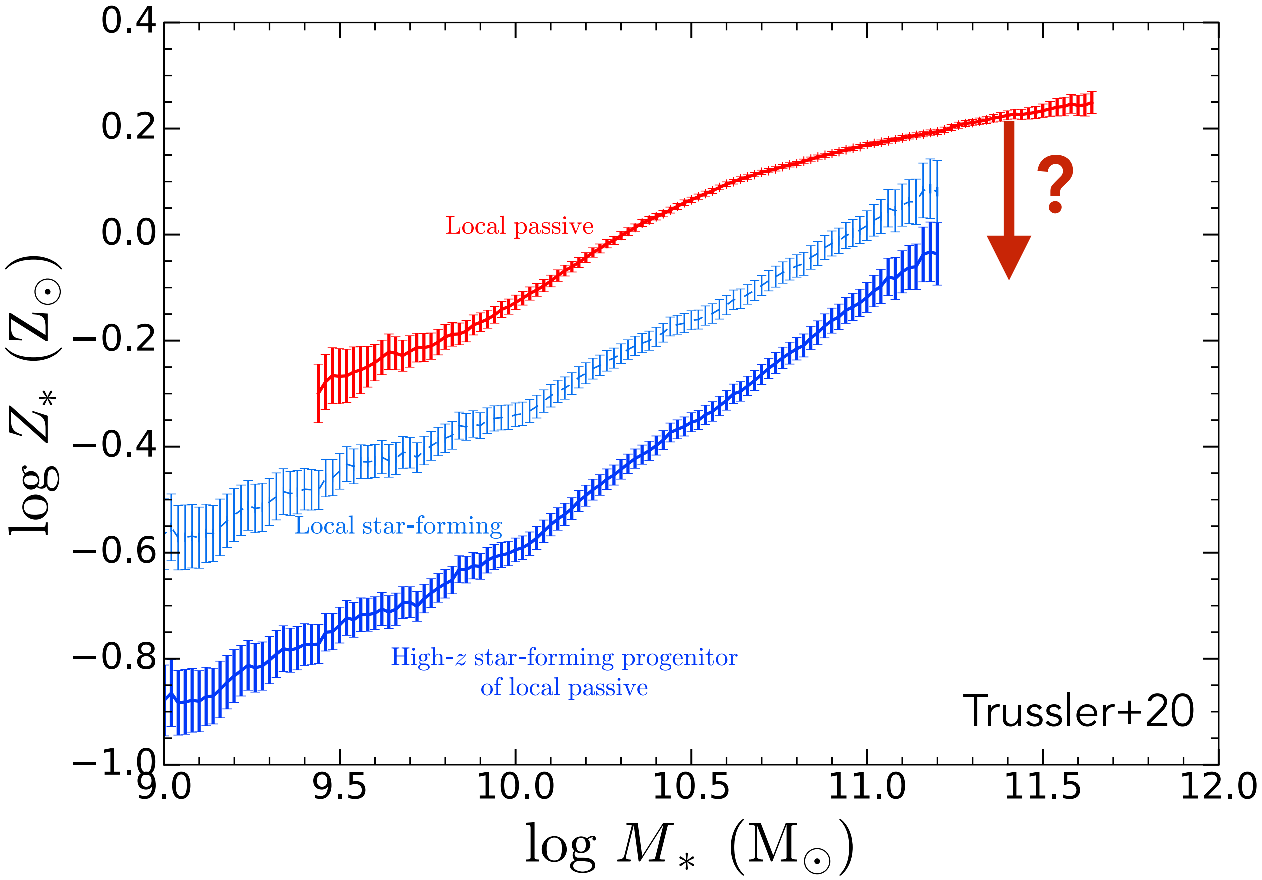




Do **dry mergers** contribute to the evolution of the **passive MZR?**

Are **rejuvenation** events too **rare** and/or **insignificant** to be important?

Summary

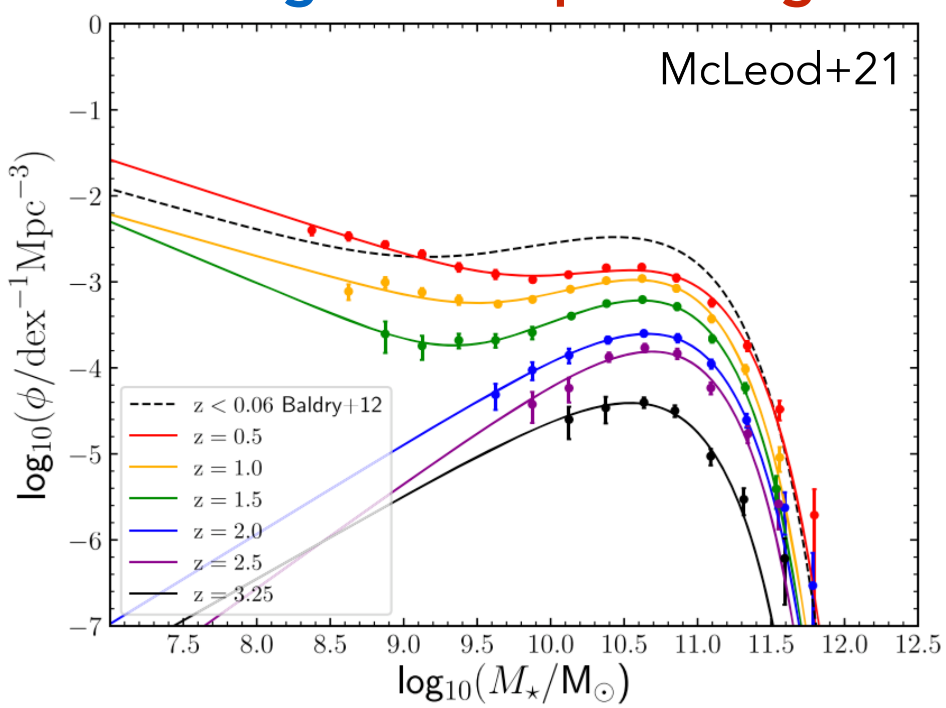


How does this **chemistry** of **passive galaxies evolve** with cosmic time?

MOONZ–z will provide us with the **definitive answer!**

What **drives** the (lack of) evolution in the **passive MZR**?

Progenitors/quenching?



Mergers?