

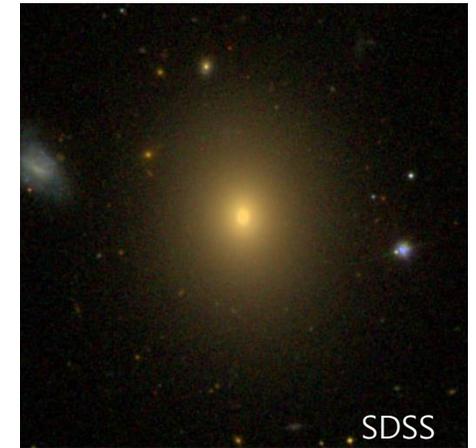
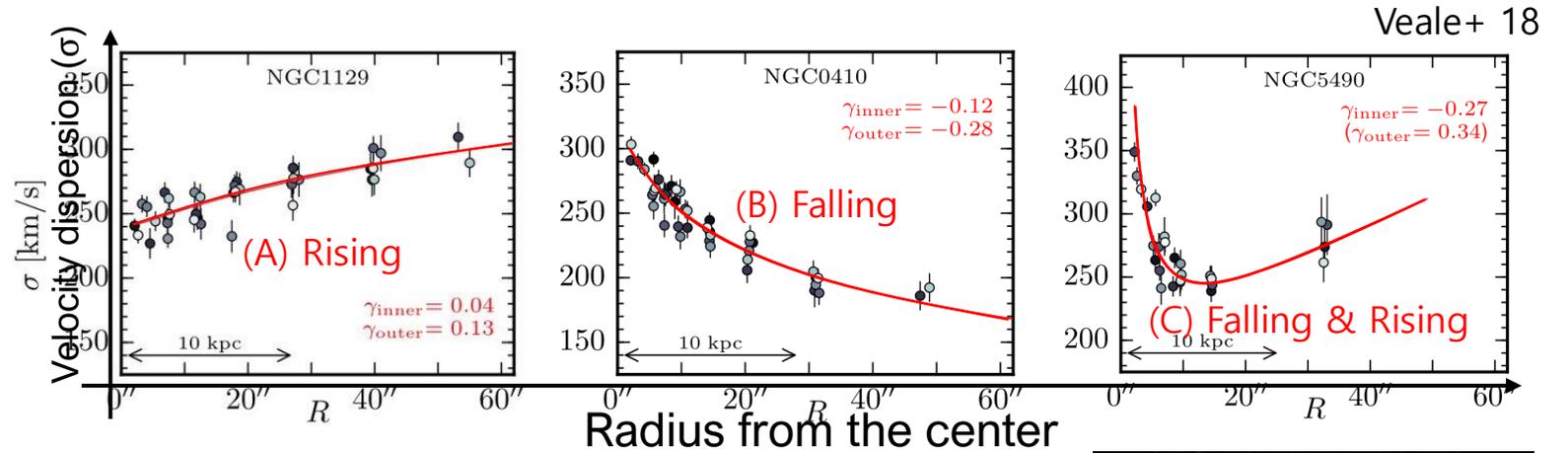
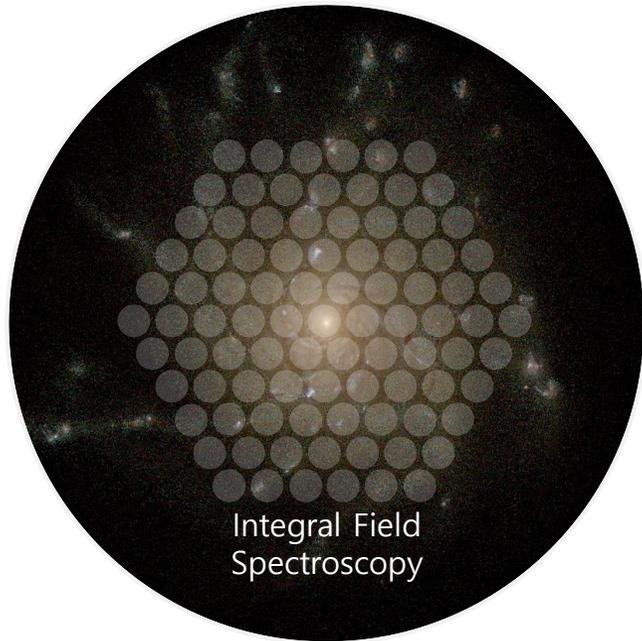
# Velocity dispersion profiles of simulated galaxies in NewHorizon

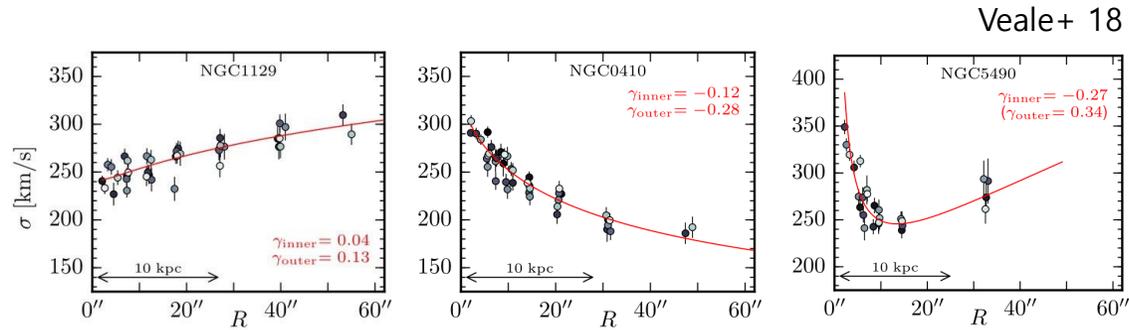
San Han<sup>1</sup>

Sree Oh<sup>2</sup>, Sukyoung Yi<sup>1</sup>

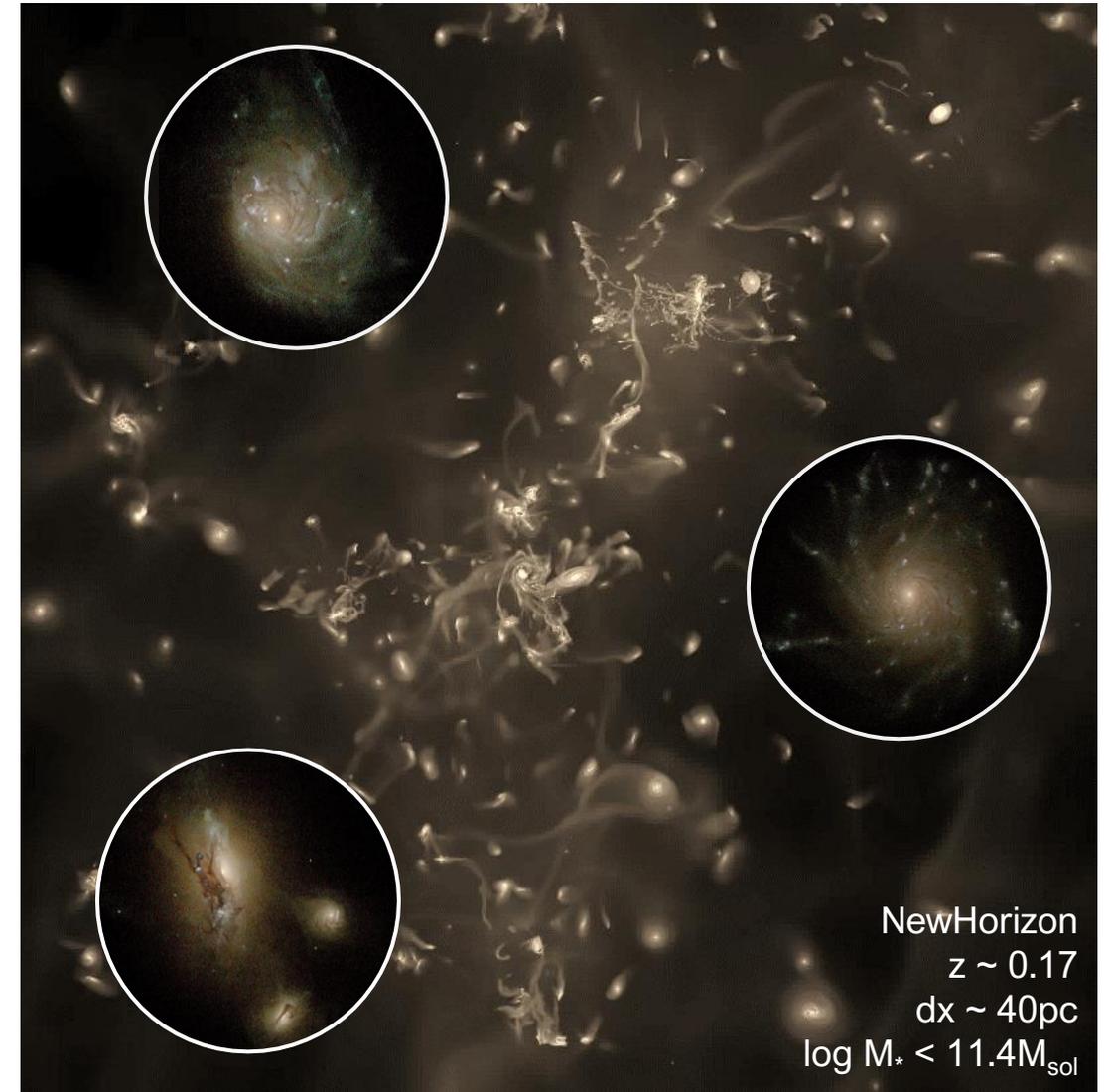
<sup>1</sup>Yonsei University, <sup>2</sup>Australian National University

# Velocity dispersion profiles of galaxies





- IFU studies report **various shapes** of velocity dispersion profile ( $\sigma(r)$ )
- The **shape of sigma profiles** could be linked to the **assembly history of galaxies**. (e.g., accretion, mergers and star formation.)
- We will use galaxies from the **NewHorizon** cosmological simulation.



## Sample selection

Galaxies with  $M_* > 10^9 M_{\text{sol}}$  are selected from 18 uniformly timed snapshots in the range of  $z = 0.17 - 2.15$ .

## Galaxy boundary

Defined as the radius where r-band surface brightness drops fainter than  $>26.5 \text{ mag/arcsec}^2$ .

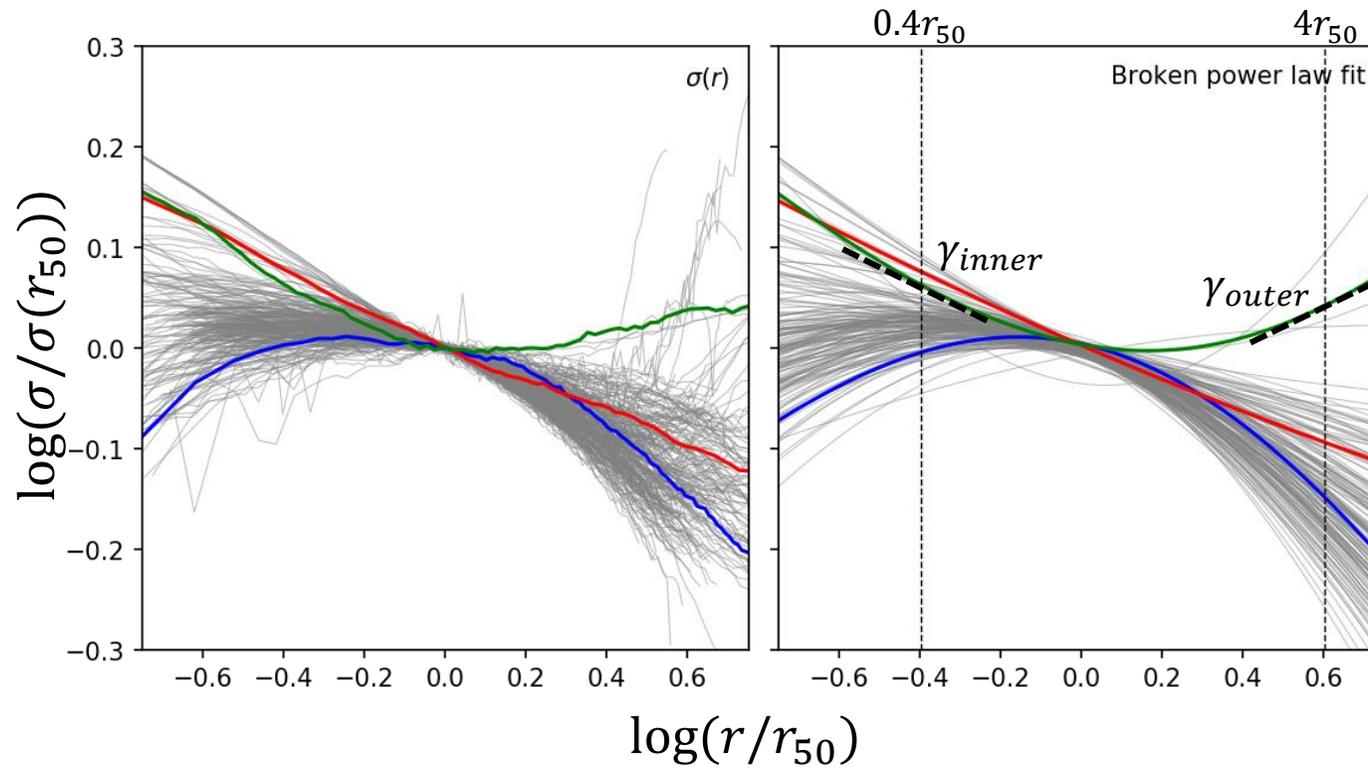
## Velocity dispersion (sigma) profile

Divide stars using  $\sim 100$  spherical shells centered on the galaxy.  $\sigma(r)$  is defined as root mean square of sigma in 3 directions.

$$\sigma(r) = \sqrt{(\sigma_r^2 + \sigma_\theta^2 + \sigma_\phi^2)/3}$$



# Sigma profiles of galaxies



Broken power law

$$\sigma(R) = \sigma_0 2^{\gamma_1 - \gamma_2} \left( \frac{R}{R_b} \right)^{\gamma_1} \left( 1 + \frac{R}{R_b} \right)^{\gamma_2 - \gamma_1}$$

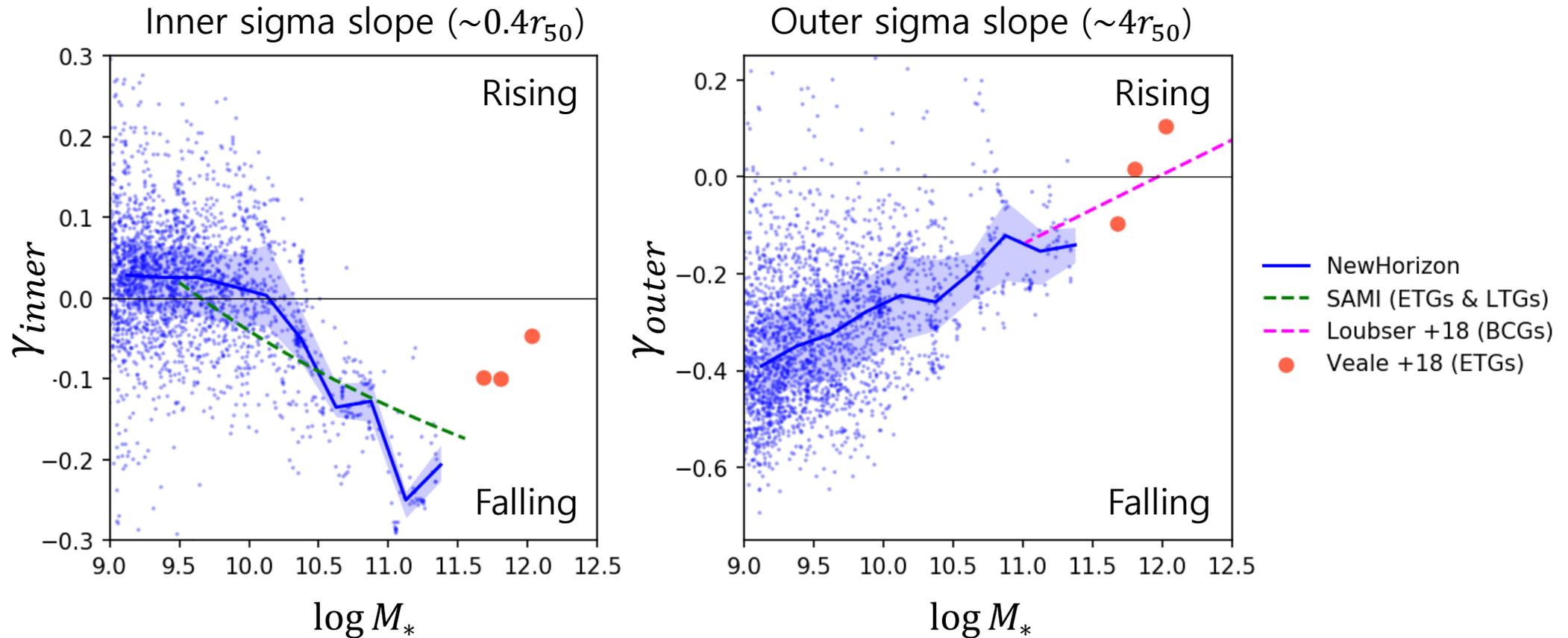


$\gamma_{inner}$

$\gamma_{outer}$

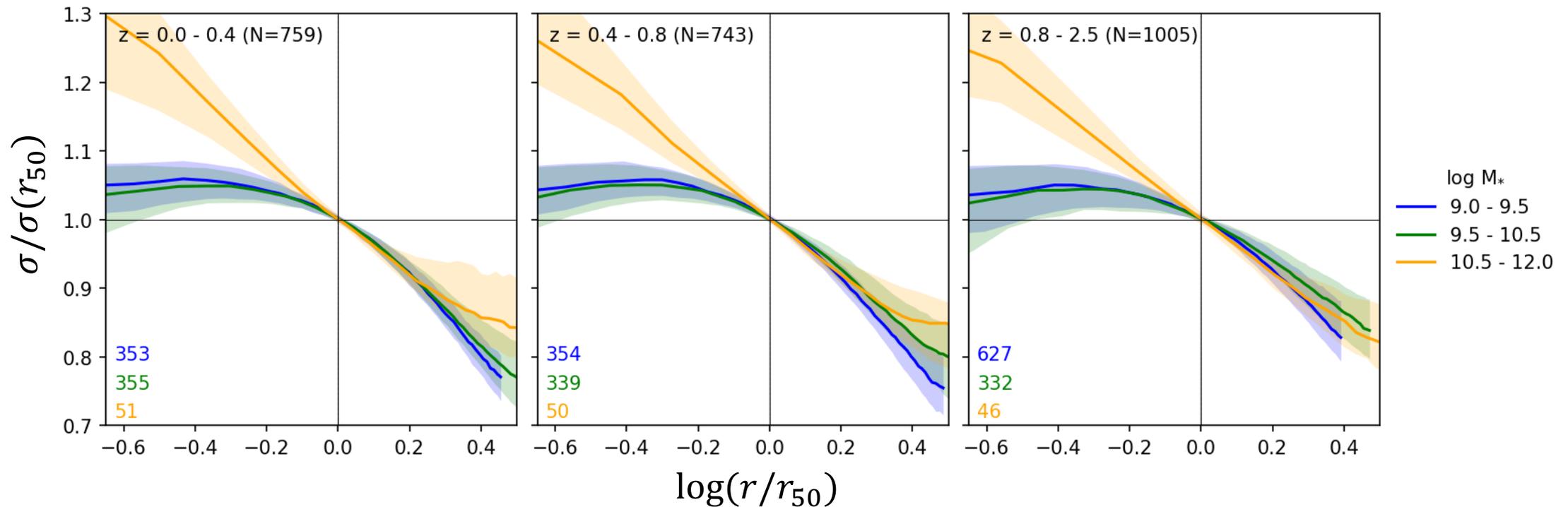
Veale+ 18

# Comparison with the IFU observations



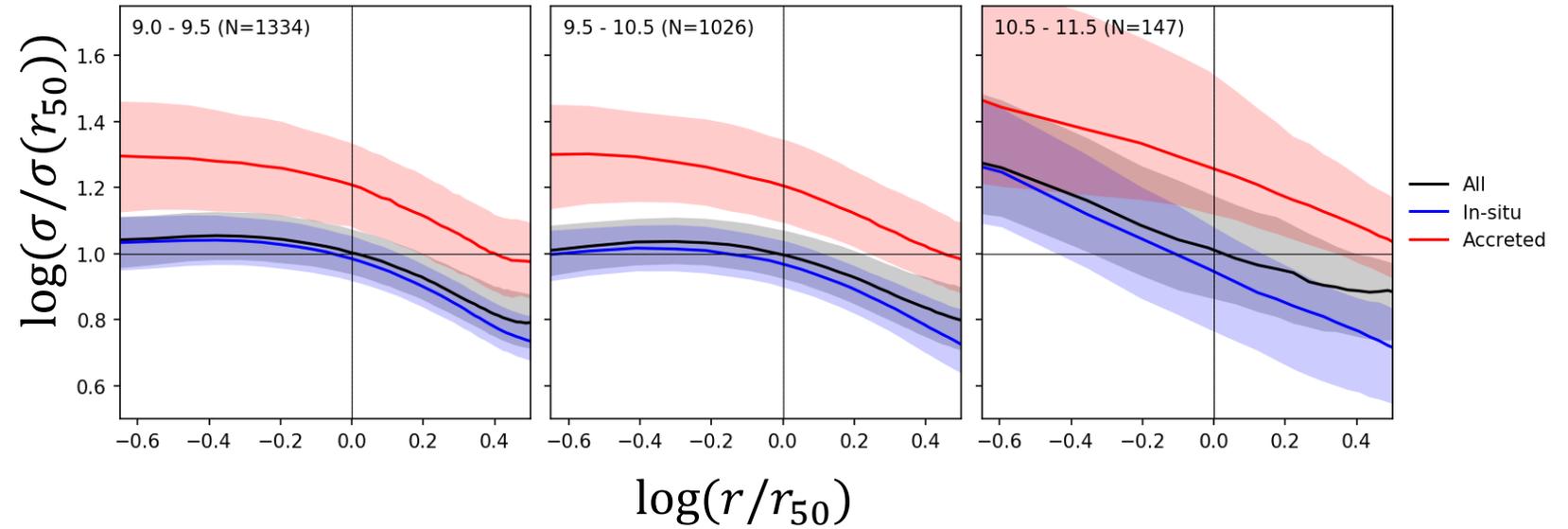
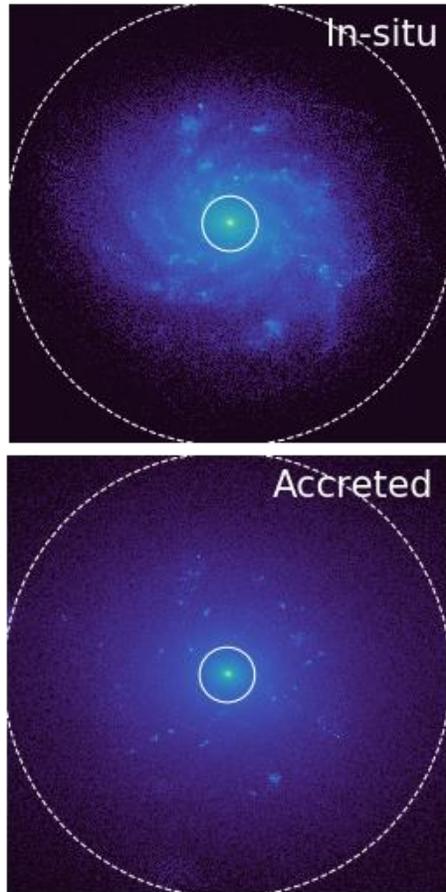
- Mass dependence of the velocity dispersion profiles largely agrees with IFU observations.

# Overview of the sigma profiles



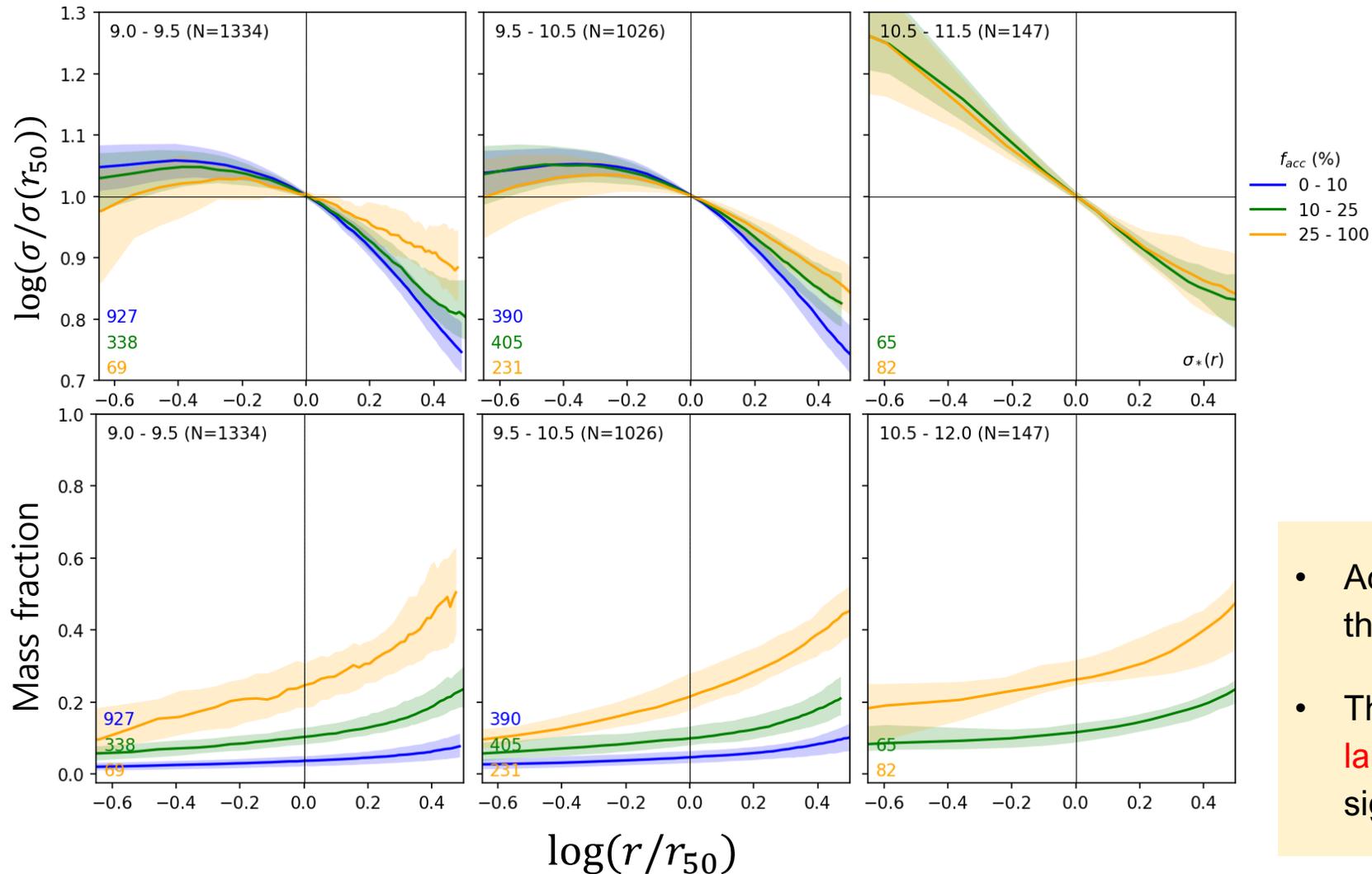
- Massive galaxies show steep inner sigma profile
- No strong redshift bias on the shape of the sigma profiles.

# In-situ formed and accreted stars



**Accreted stars** generally have higher velocity dispersion.

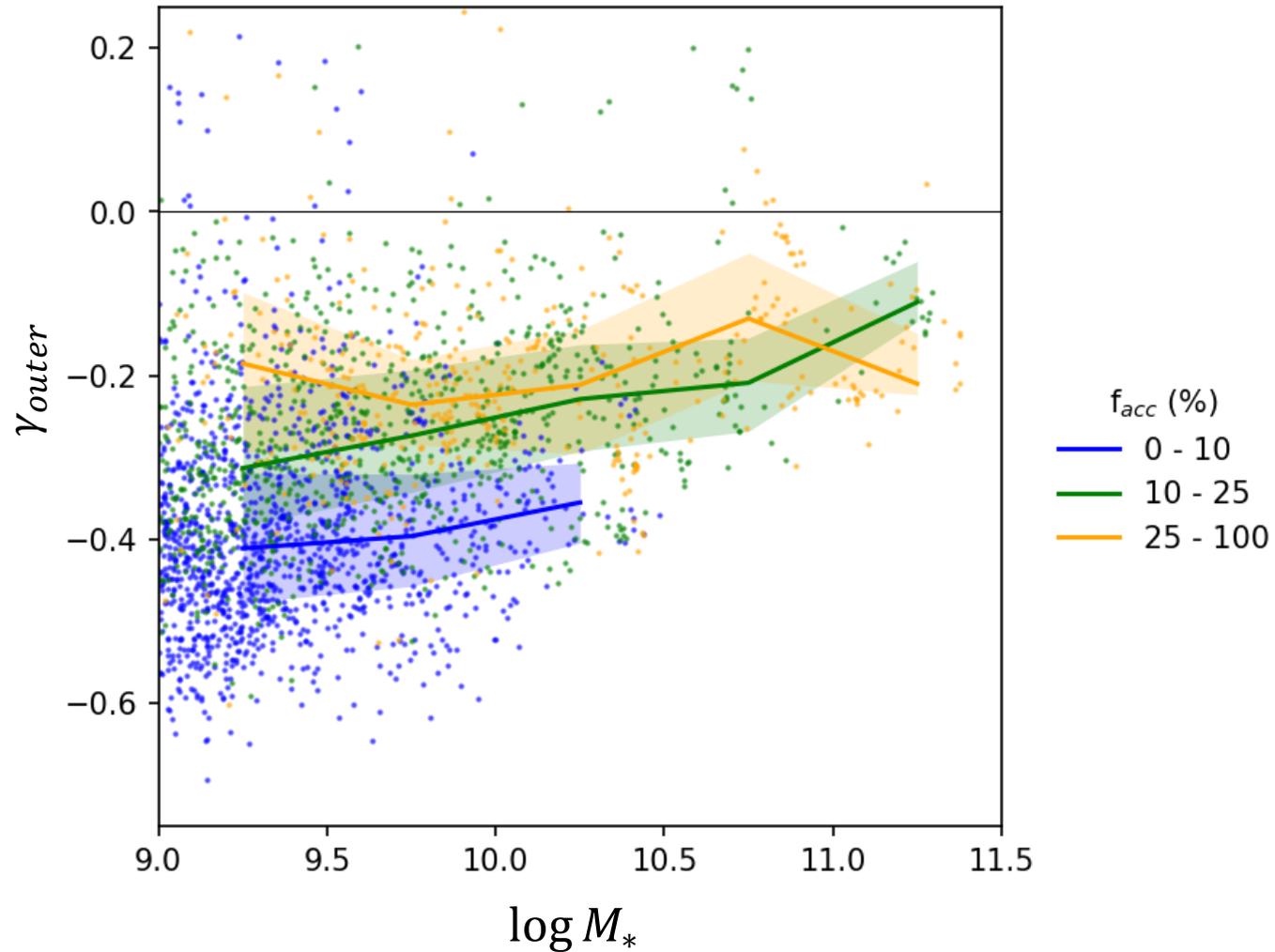
# Effect of accretion on the sigma profiles



- Addition of **accreted stars** enhances the velocity dispersion in the region.
- The effect of accretion **becomes larger at the outskirts**, making the sigma slope shallower and flatter.

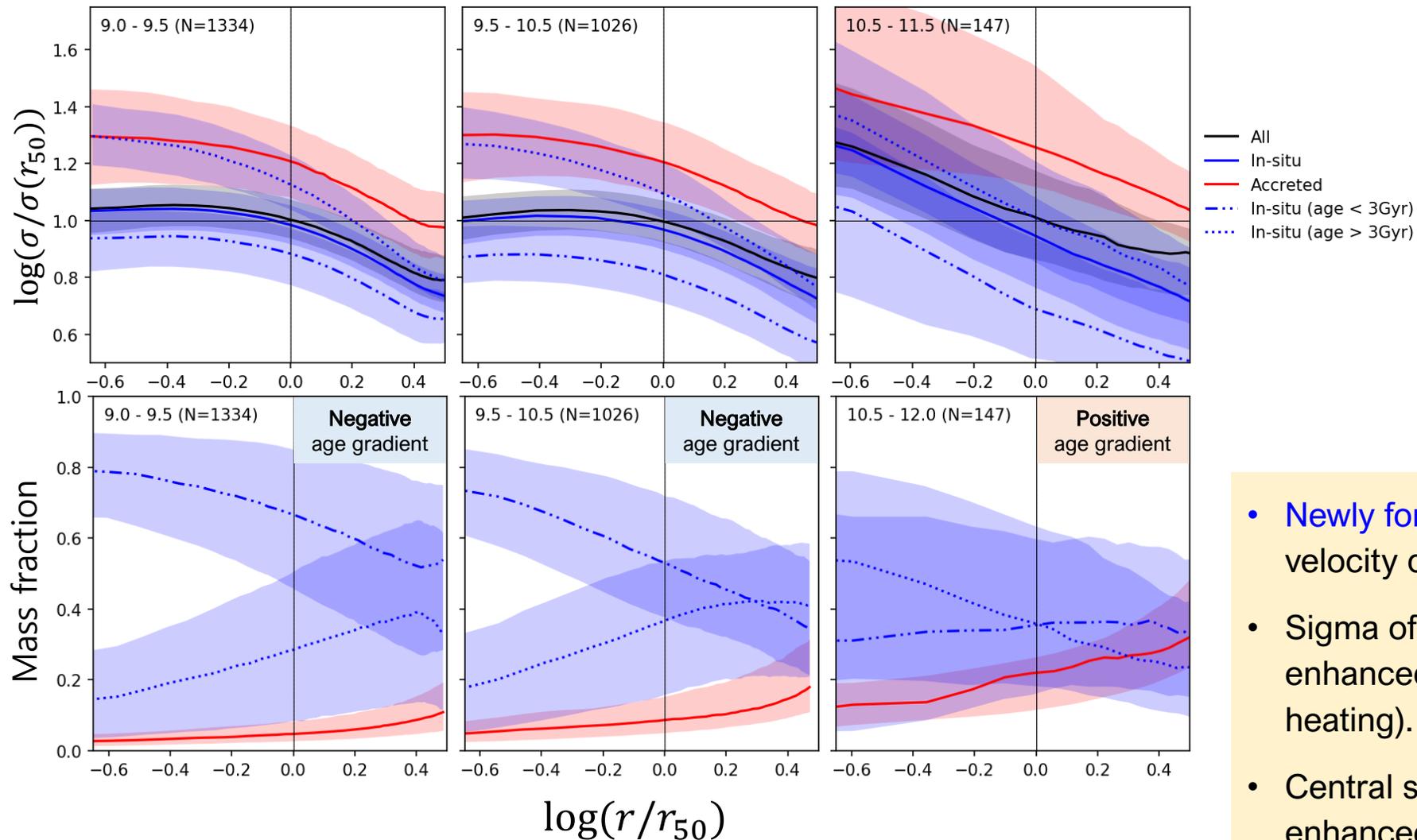
# Effect of accretion on the outer sigma slope

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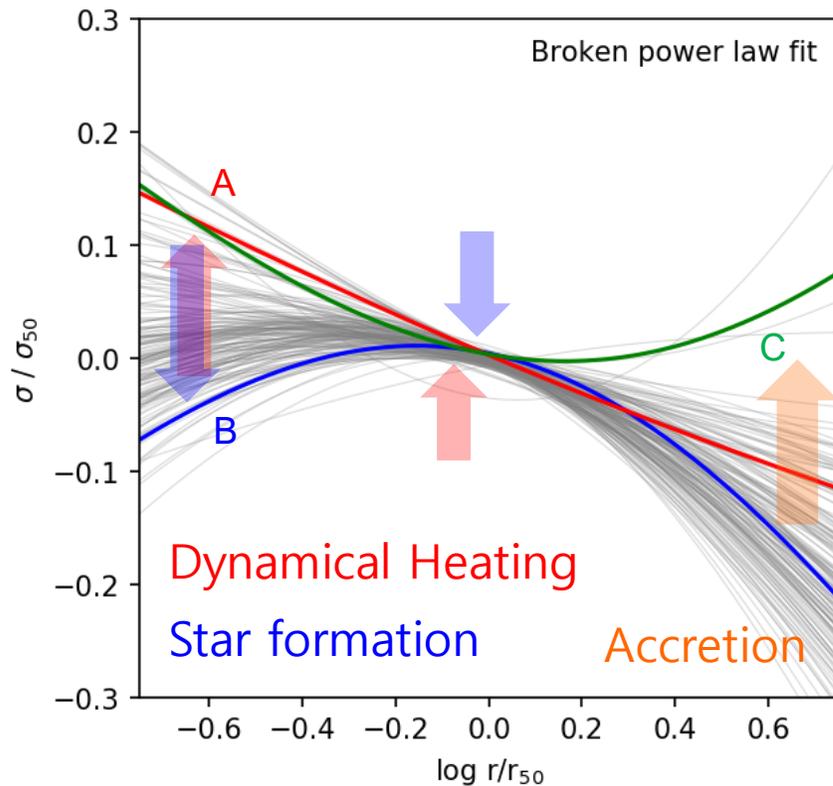
- **Accretion fraction** is the key parameter that determines the outer sigma slope.
- Massive galaxies are more likely to have **higher accretion fraction**
- **Shallower** outer sigma slopes on the massive end.

# Star formation and dynamical heating



- Newly formed stars have smaller velocity dispersion.
- Sigma of in-situ formed stars are enhanced over time (dynamical heating).
- Central sigma of massive galaxies are enhanced by old in-situ stars.

# Summary

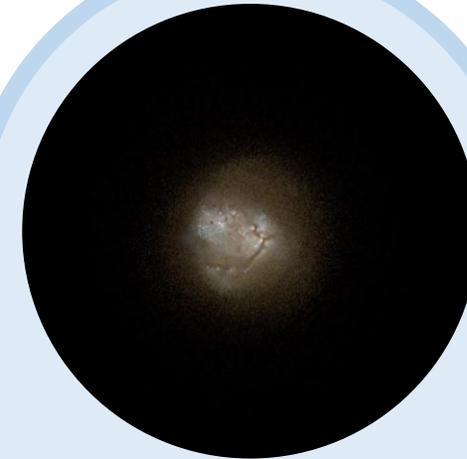


2021-09-29



## Massive galaxies (A / C) ( $\log M_* \gtrsim 10.5$ )

- Steeply falling inner sigma profile by **negative stellar age gradients** with the radius.
- Outer sigma profile enhanced by **accreted stars**.



## Small galaxies (B) ( $\log M_* \lesssim 10.5$ )

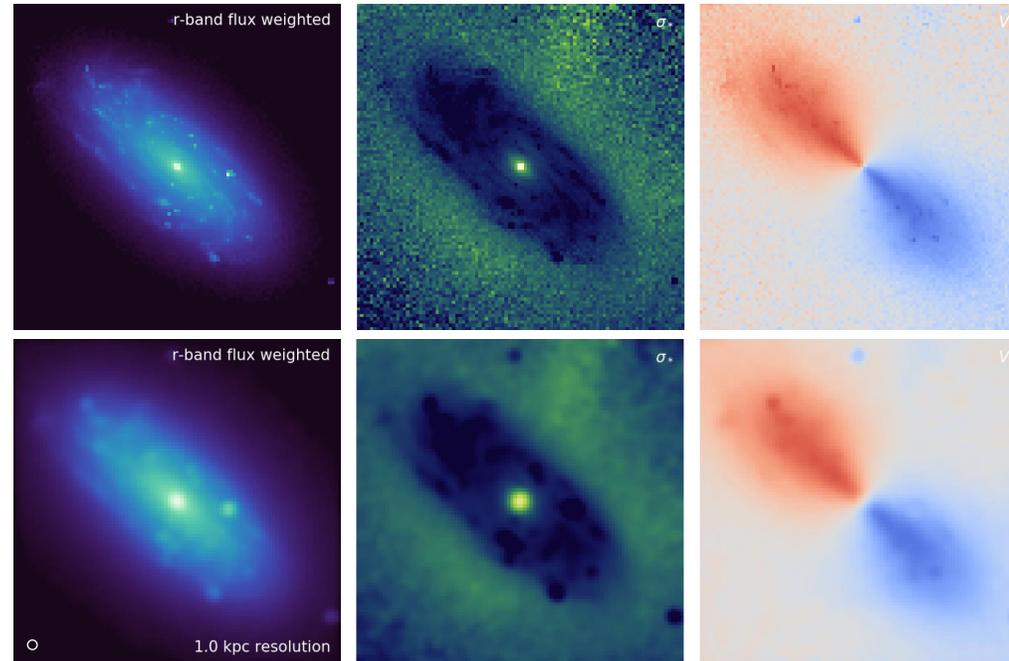
- Flat / rising inner sigma profile by **positive stellar age gradients** with the radius.
- Outer sigma profile enhanced by **old in-situ formed stars** and *sometimes by accreted stars*.

NH mock images

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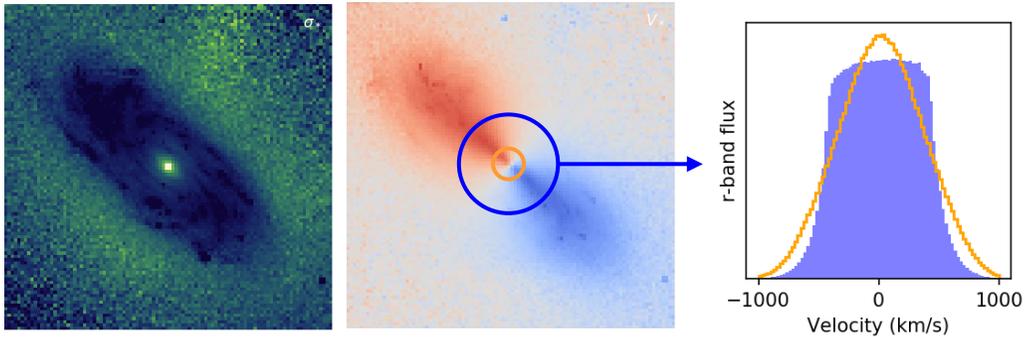
# 2D IFU mock image (Preliminary)

RUM 2021



- Generate mock IFU images with observational biases considered (projection, beam smearing effect, etc.) to measure sigma profiles.

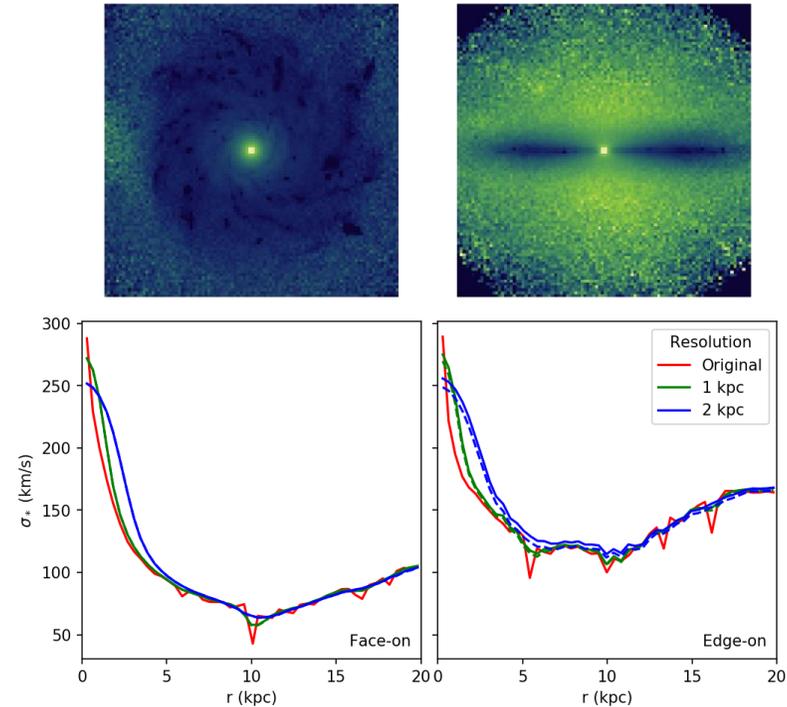
# Effect of the resolution (Preliminary)



$$\widetilde{\sigma}_0^2 = \underbrace{G(\sigma_i^2)}_{\text{Sigma smoothing term}} + \underbrace{\sigma_b^2}_{\text{Velocity gradient term}}$$

$$\widetilde{V}_0 = G_b(V_i) = \frac{\sum_i K_b(\vec{r}_0 - \vec{r}_i) V_i F_i}{\sum_i K_b(\vec{r}_0 - \vec{r}_i) F_i}$$

$$\sigma_b^2 = \frac{\sum_i K_b(\vec{r}_0 - \vec{r}_i) (\widetilde{V}_0 - V_i)^2 F_i}{\sum_i K_b(\vec{r}_0 - \vec{r}_i) F_i}$$



- **Sigma smoothing** has a strong impact on the inner slope.
- The **velocity gradient** term is not as effective as the **smoothing term**. (even if the galaxy is edge-on, and rotation-dominated)

The background of the slide is a cosmic web visualization, showing a complex network of filaments and nodes of galaxies in shades of purple and blue. A dark blue horizontal band is centered across the image, containing the text.

# Thank you!