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## Galaxy morphology and the stellar-halo mass relation

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# Galaxy Morphology & the Stellar-to-Halo Mass Relation

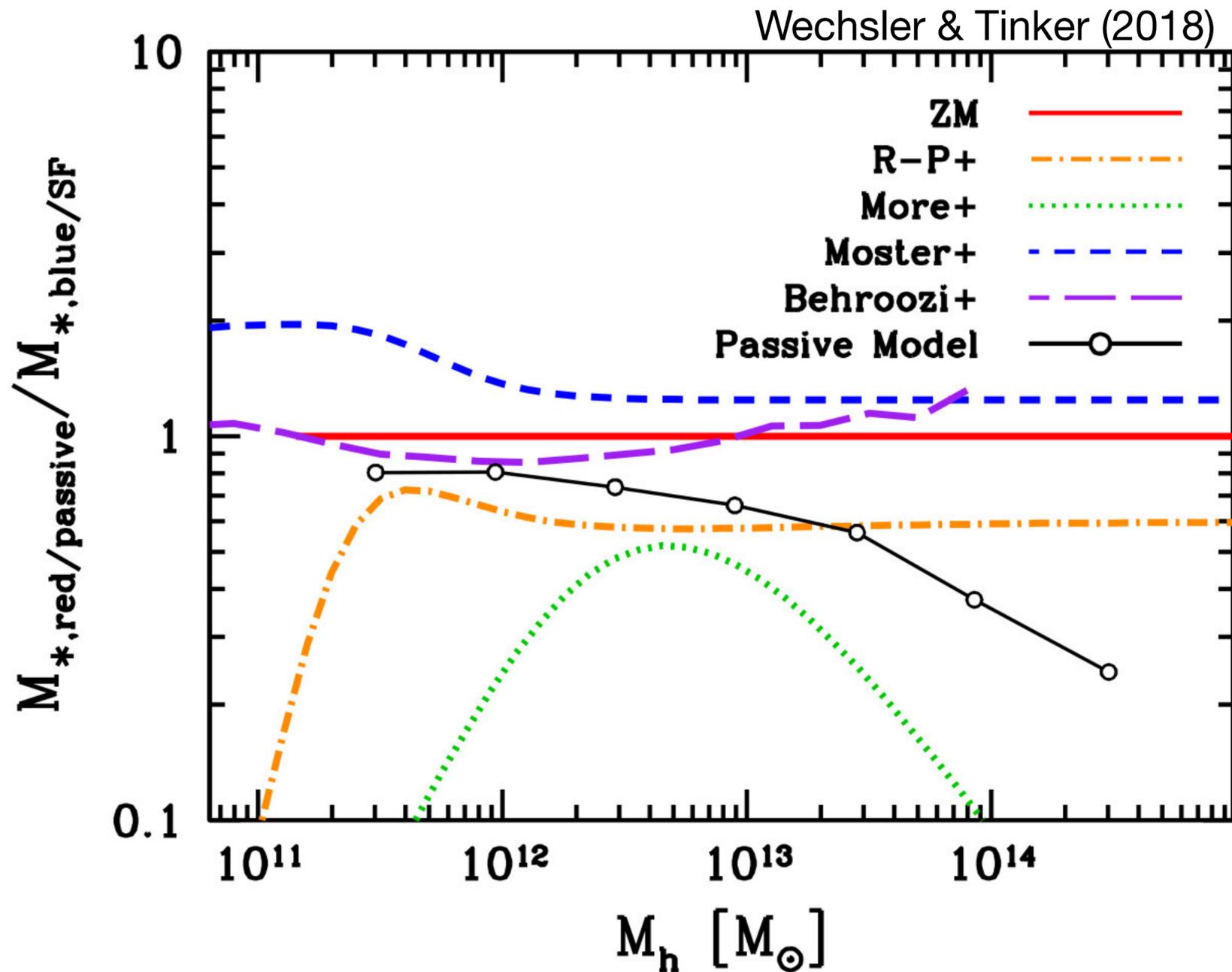
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<sup>2</sup>Leiden University (Netherlands)

# The dependency of the SHMR on galaxies' morphology or color is not yet fully understood



At fixed halo mass, passive central galaxies can be either more massive, equal or less massive than star-forming galaxies (e.g. Dutton et al. 2010; More et al. 2011; Hearin et al. 2014; Rodriguez-Puebla et al. 2015; Mandelbaum et al. 2016; Moster et al. 2018; Behroozi et al. 2018).

## SDSS DR7 sample: NYU-VAGC+MPA/JHU+Galaxy Zoo+Halo Catalogue

SDSS DR7 sample cross-match of

- \* NYU Value-Added Galaxy Catalog ([Blanton et al. 2005](#))

with:

### > Stellar Masses

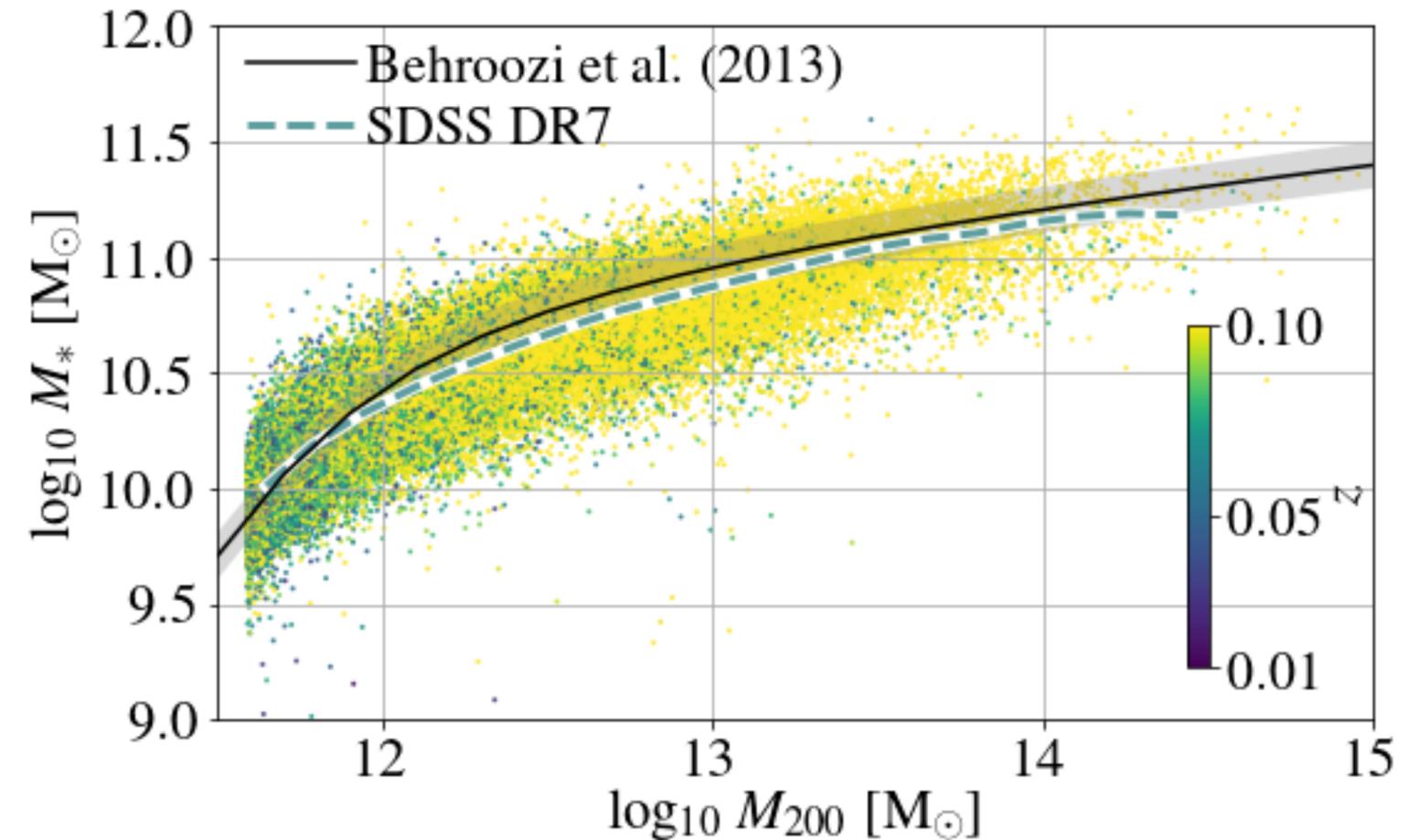
- \* MPA/JHU stellar mass & star formation rates catalogue ([Kauffmann et al. 2003](#); [Brinchmann et al. 2004](#))
- \* Stellar mass catalogue from [Chang et al. \(2015\)](#)

### > Halo Masses

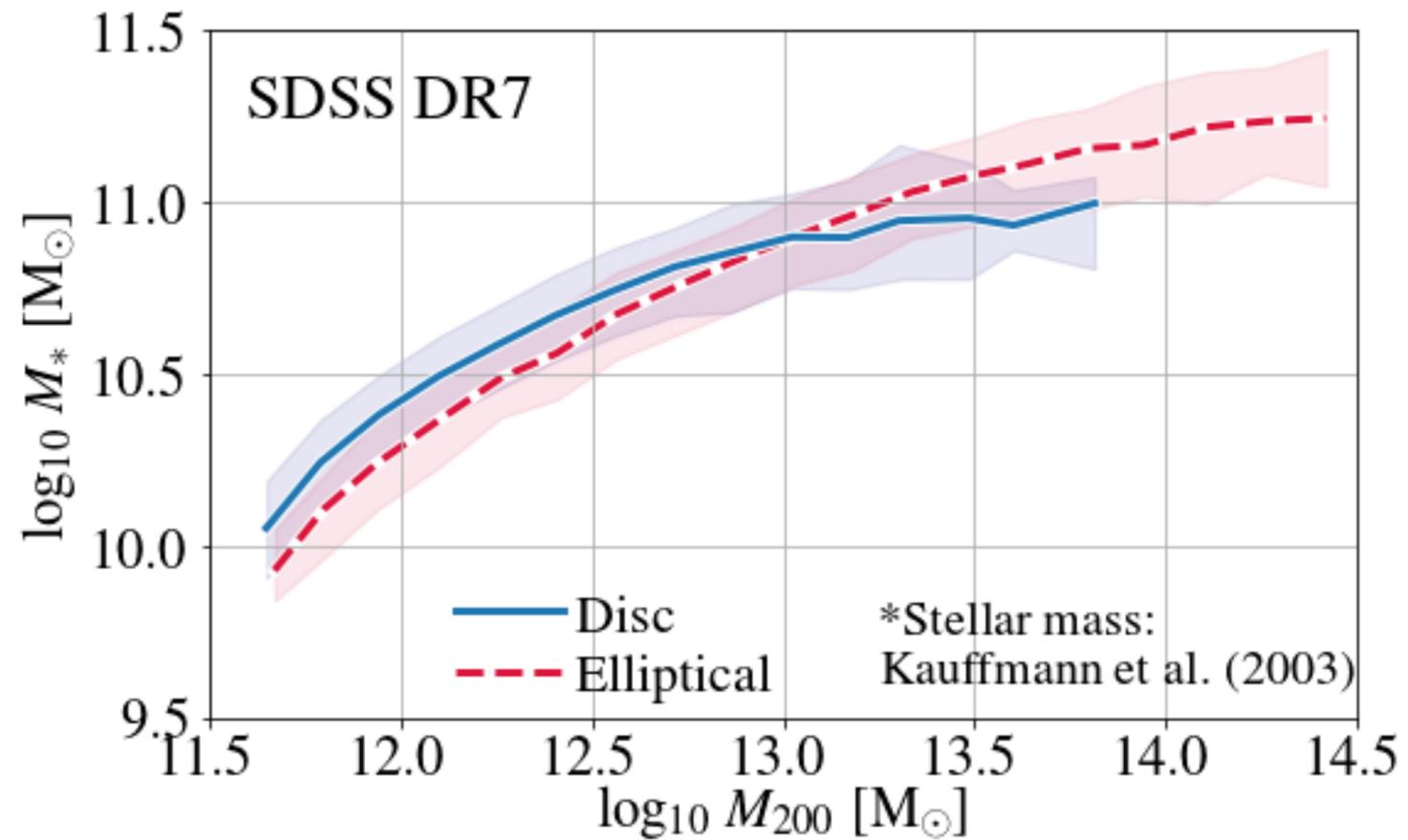
- \* Galaxy group catalogue from [Yang et al. \(2007\)](#)

### > Galaxy Morphology

- \* GalaxyZoo (morphology) catalogue from [Lintott et al. \(2011\)](#)

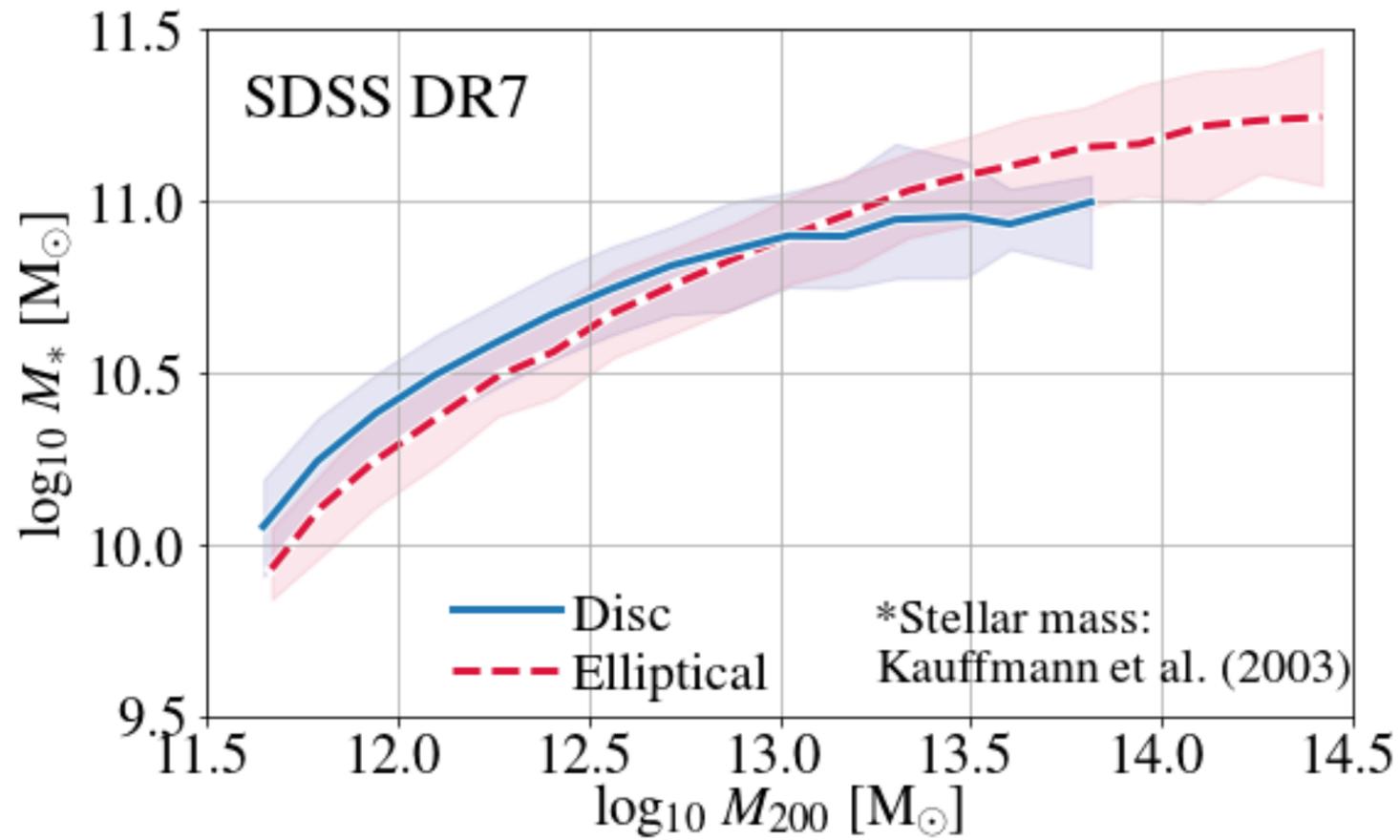


## SDSS DR7: Stellar-To-Halo Mass Relation

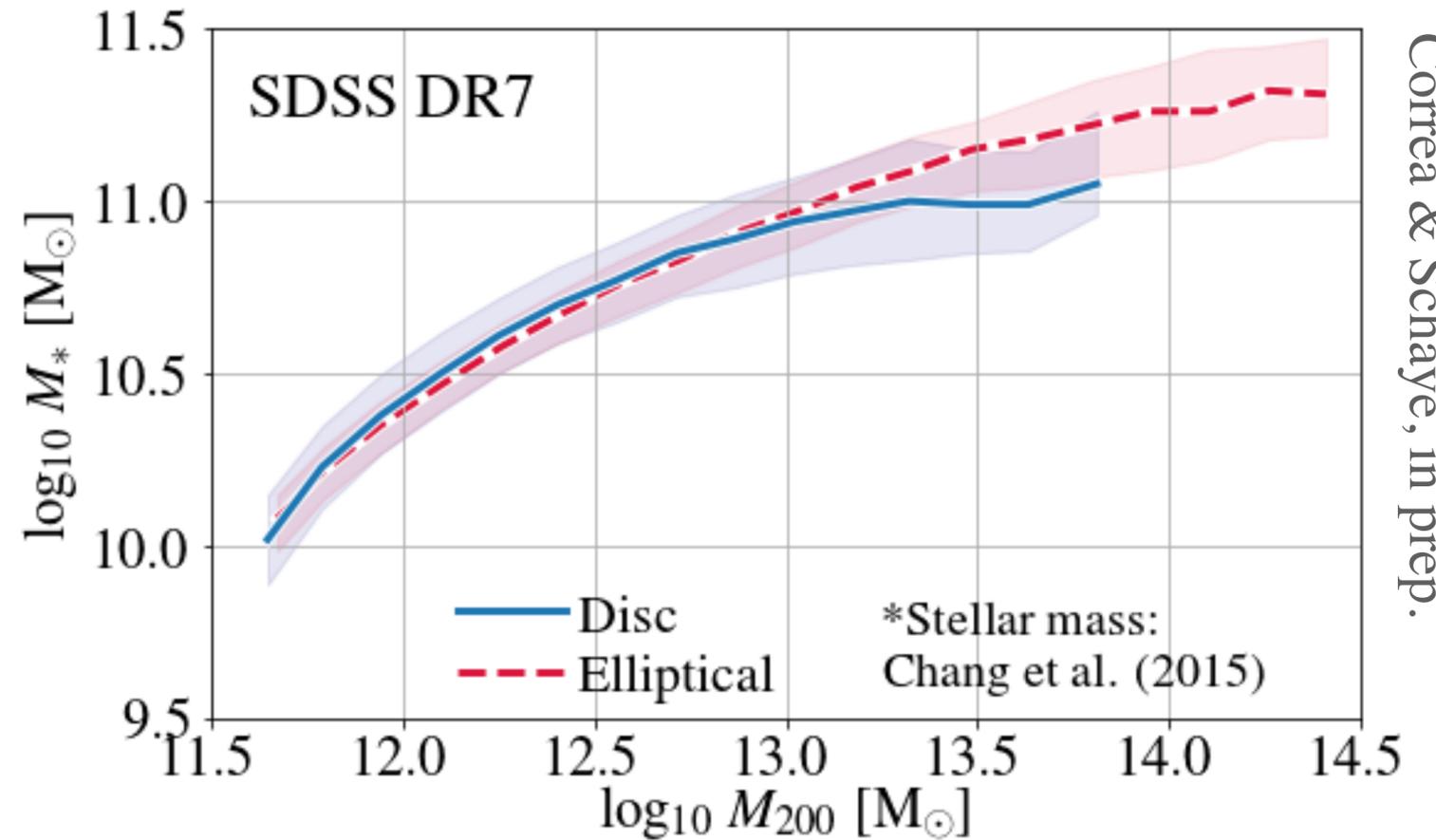


Stellar-to-halo mass relation  
using the stellar masses from  
[Kauffmann et al. \(2003\)](#)

# SDSS DR7: Stellar-To-Halo Mass Relation

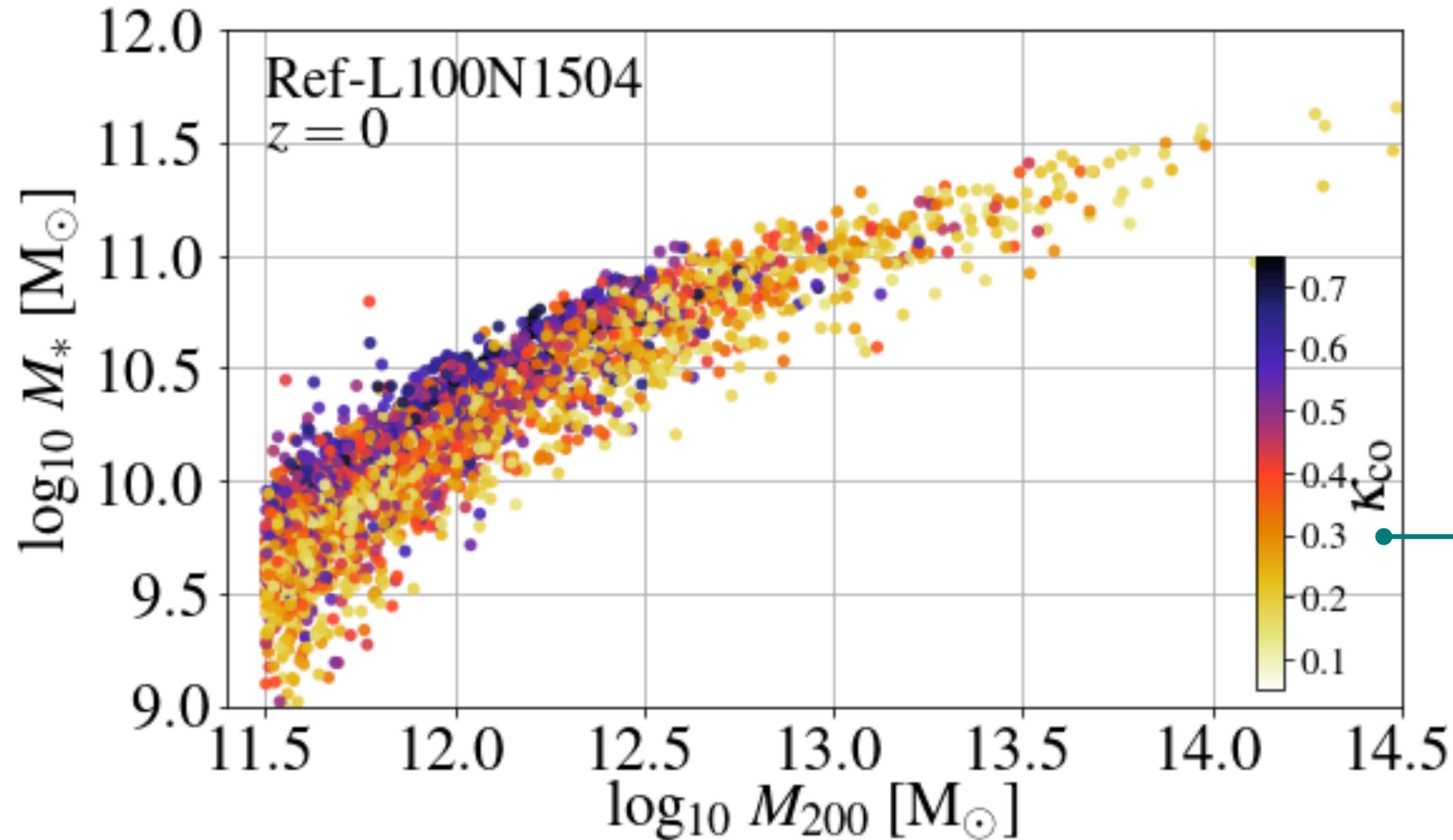


Stellar-to-halo mass relation using the stellar masses from [Kauffmann et al. \(2003\)](#)



Stellar-to-halo mass relation using the stellar masses from [Chang et al. \(2015\)](#), [Brinchmann et al. \(2004\)](#)

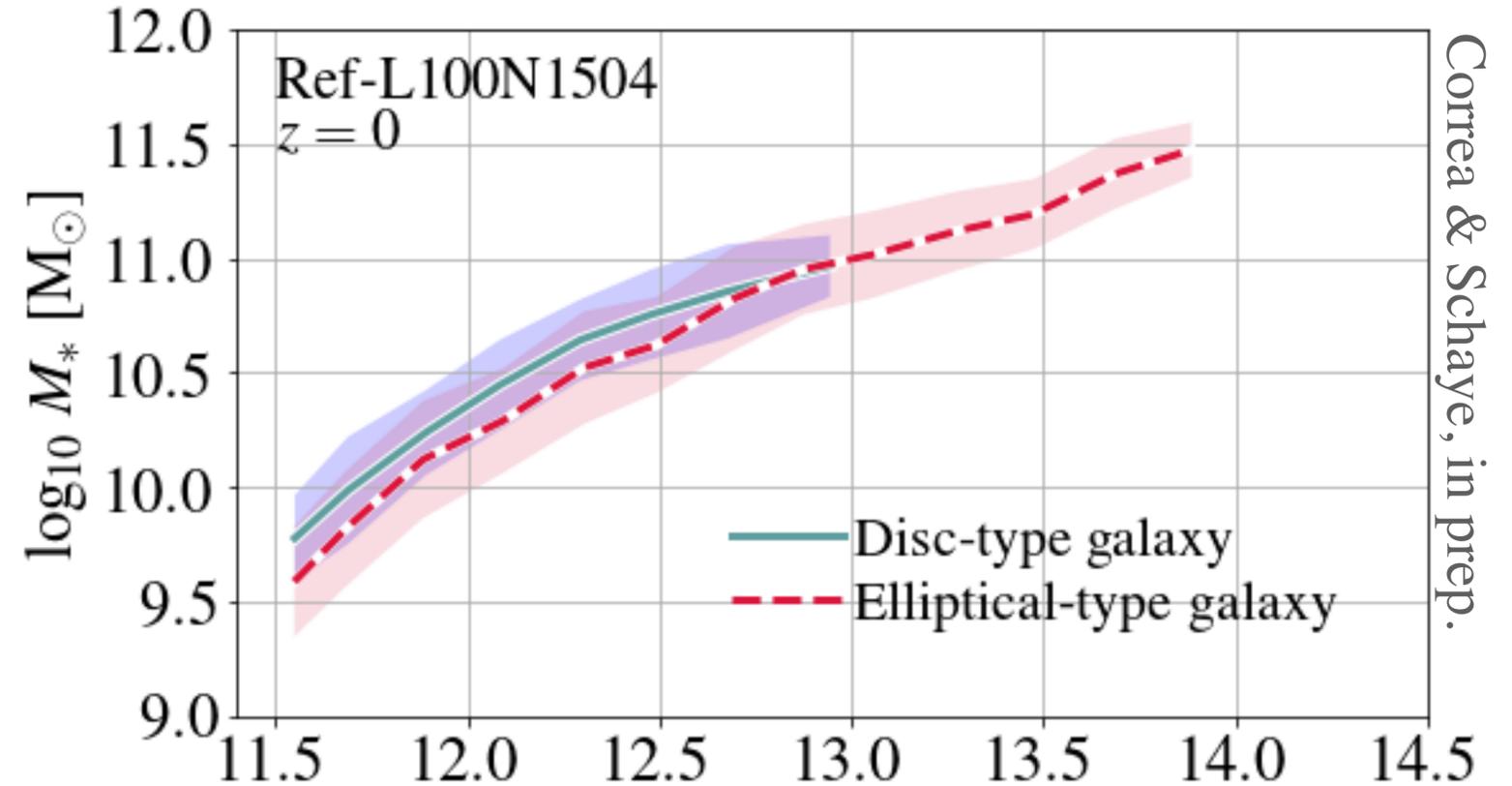
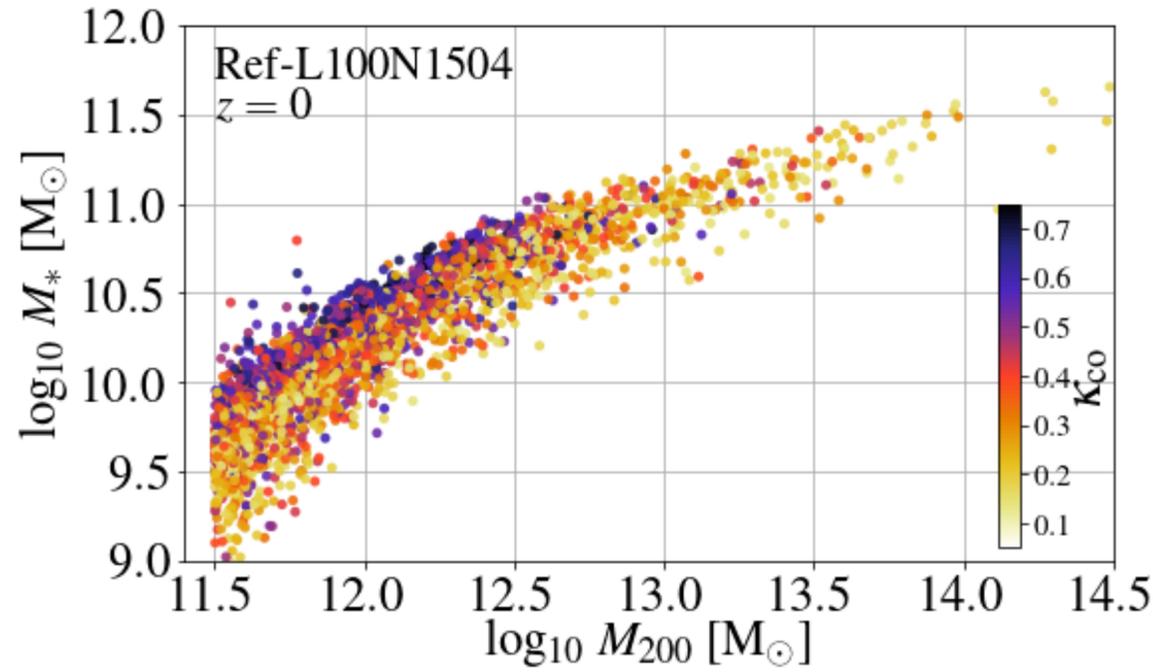
## EAGLE Simulation: Stellar-To-Halo Mass Relation



$\kappa_{CO}$  is a stellar kinematic-based indicator of morphology

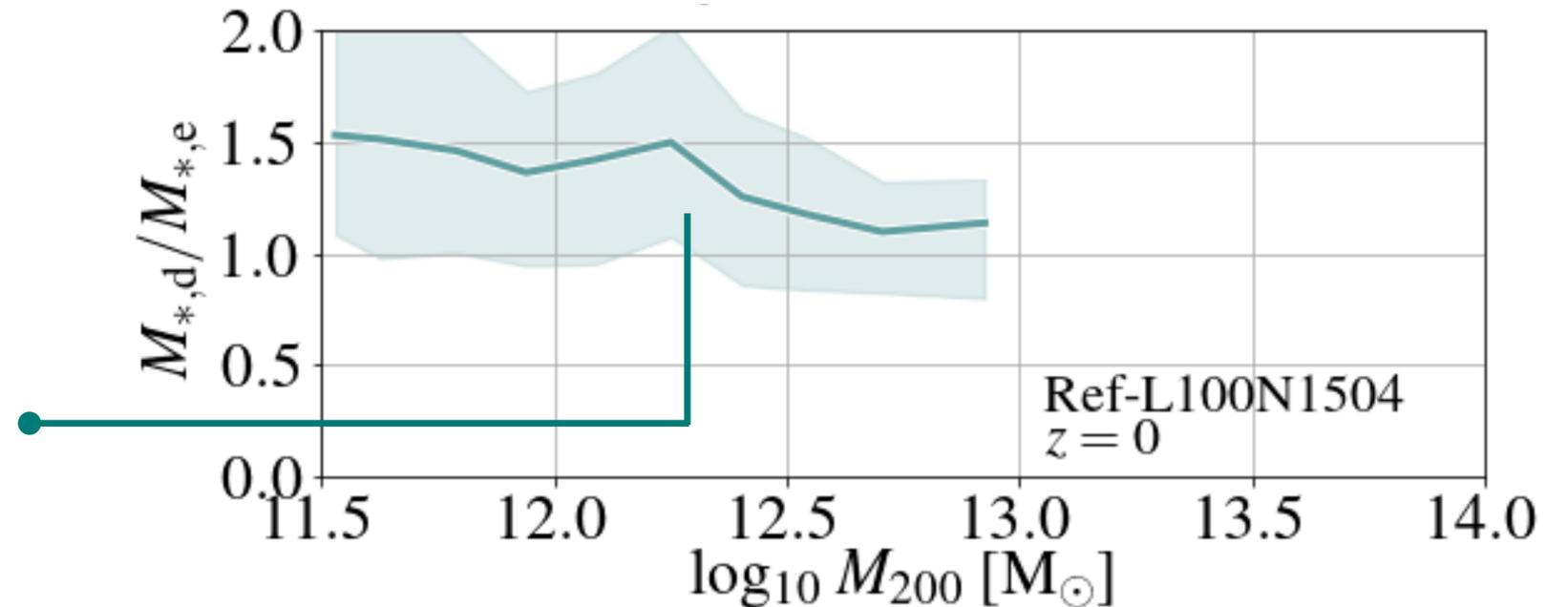
Large values of  $\kappa_{CO} > 0.5$  correspond to disc-like galaxies,  
low values of  $\kappa_{CO} < 0.3$  correspond to spheroidal galaxies

# EAGLE Simulation: Stellar-To-Halo Mass Relation



Correa & Schaye, in prep.

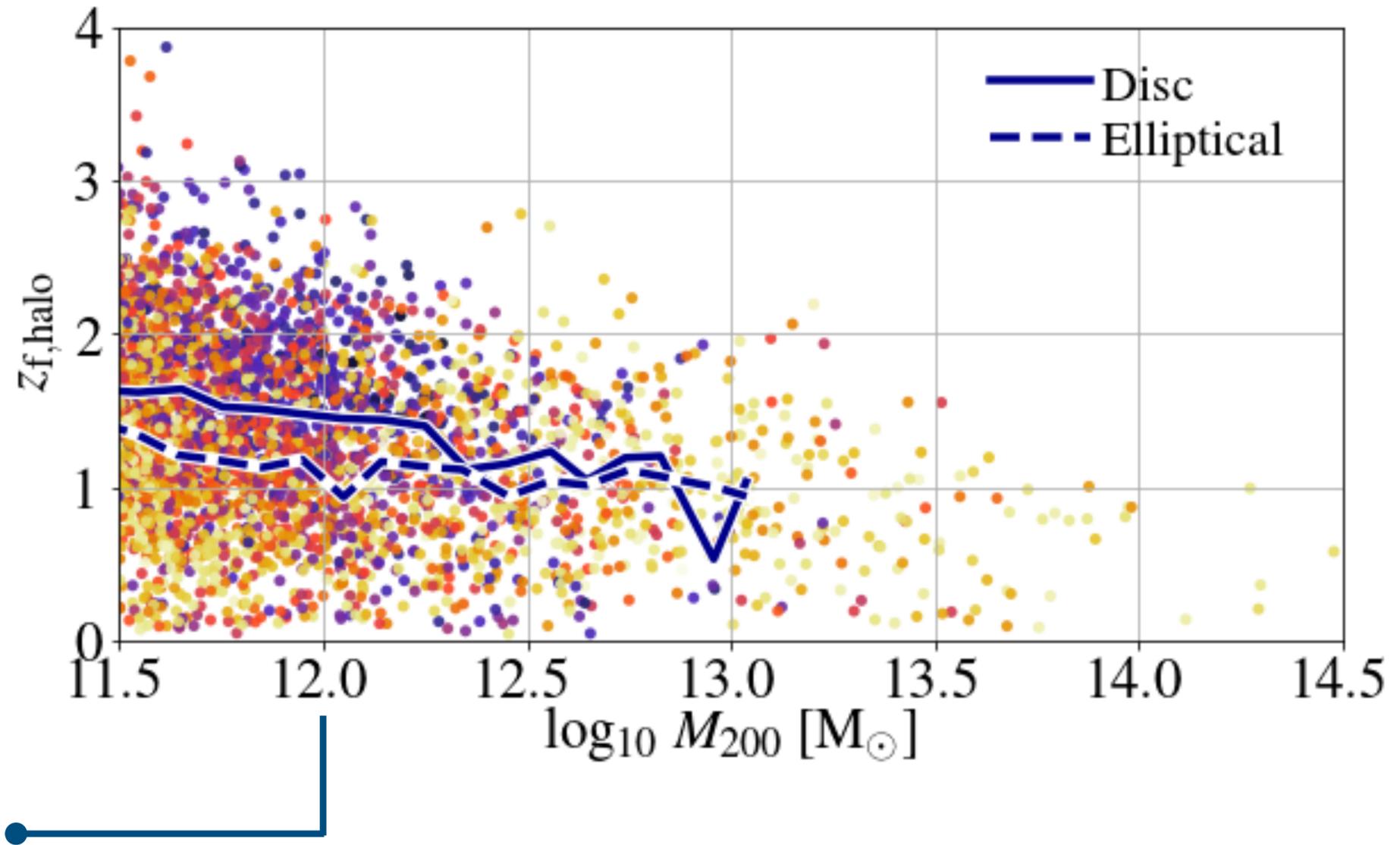
At fixed halo mass EAGLE disc galaxies are up to a factor 1.5 more massive than ellipticals



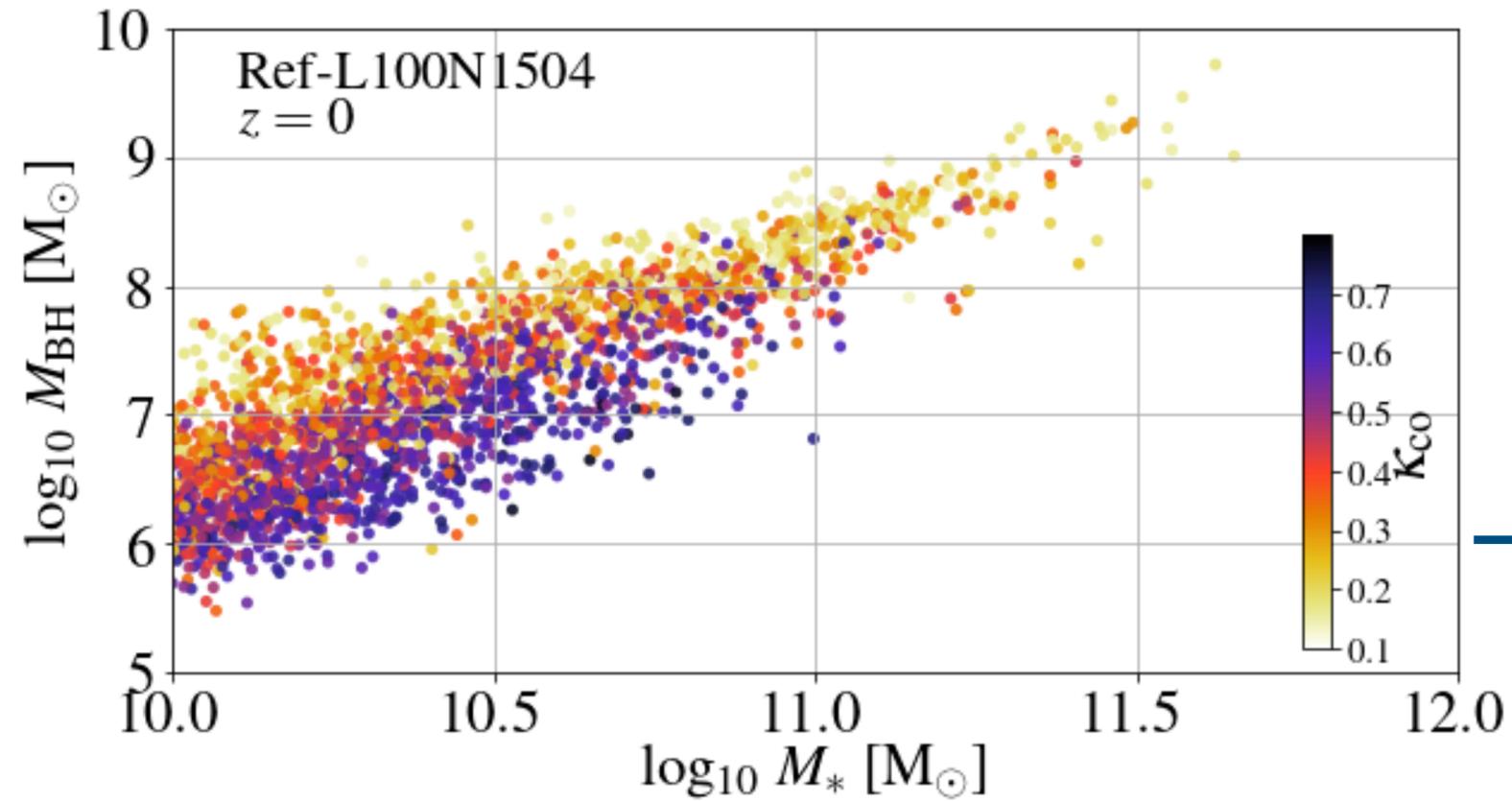
## Morphology & SHMR: Halo Formation

$10^{12} M_{\odot}$  haloes hosting disc galaxies formed (on averaged) at  $z \approx 1.5$

$10^{12} M_{\odot}$  haloes hosting elliptical galaxies formed at  $z \approx 1$ , roughly 2 Gyr later than haloes hosting disc-type galaxies

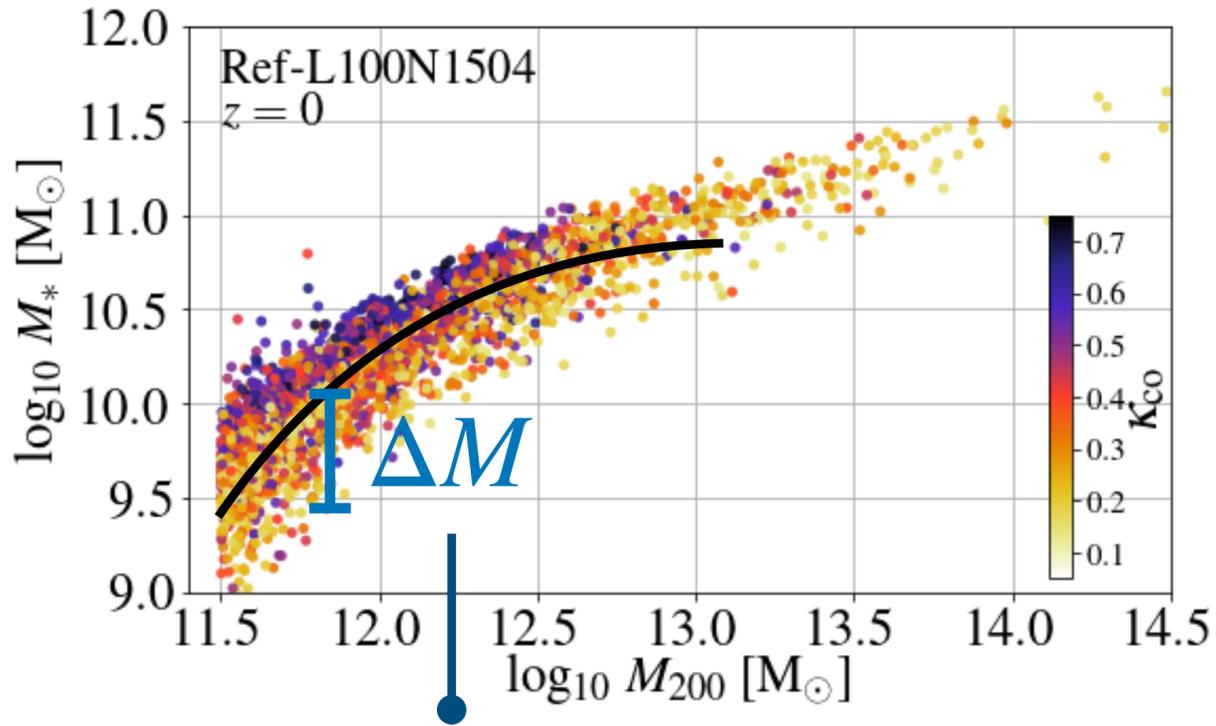


# Morphology & SHMR: AGN Feedback



At fixed stellar mass disc galaxies tend to host less massive central black holes than elliptical galaxies

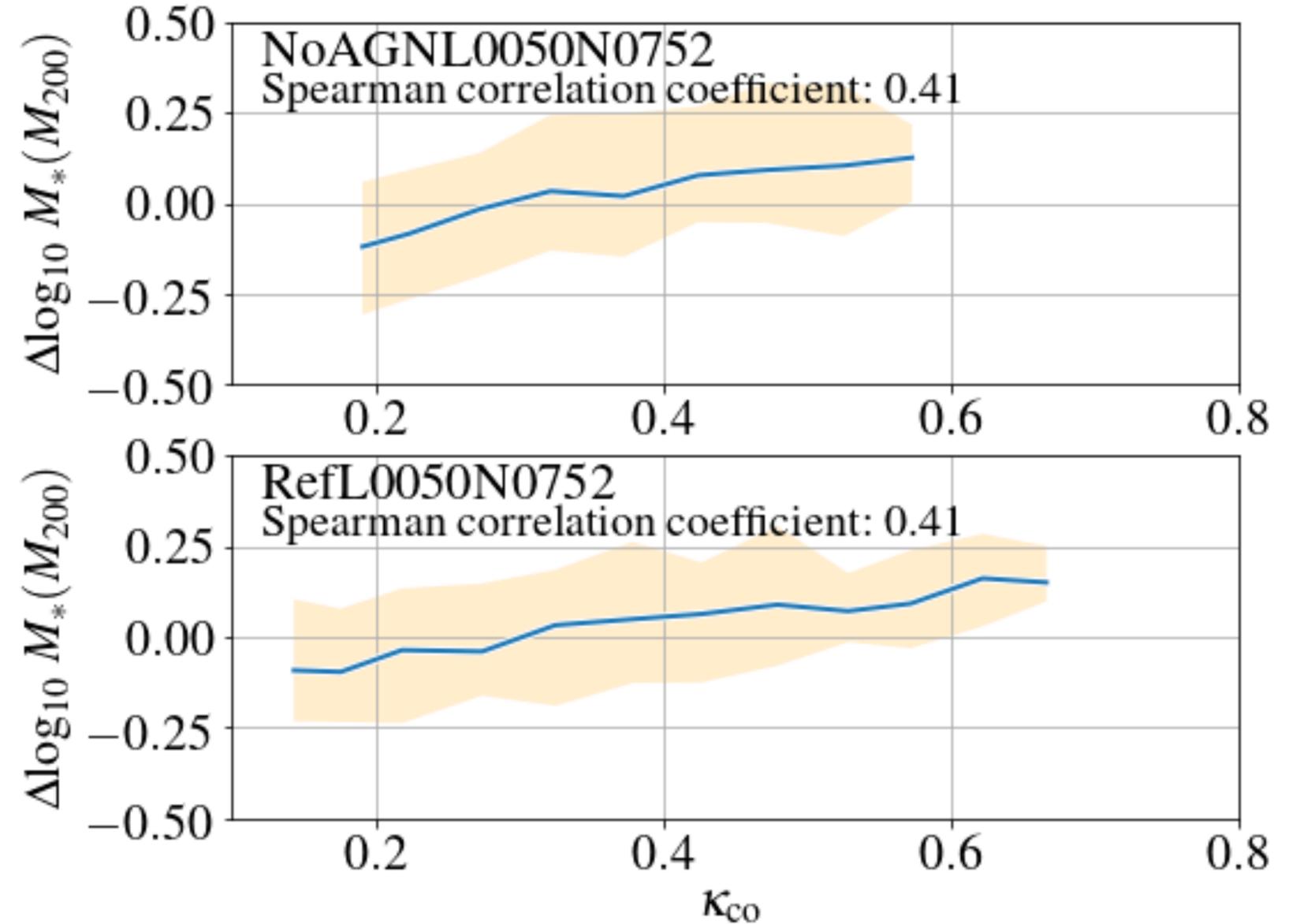
# Morphology & SHMR: AGN Feedback ON & OFF



$\Delta M$  : Deviation from the median stellar mass given the halo mass

$\Delta M$  is the same between simulations with & without AGN feedback

BH does not produce the morphology-SHMR

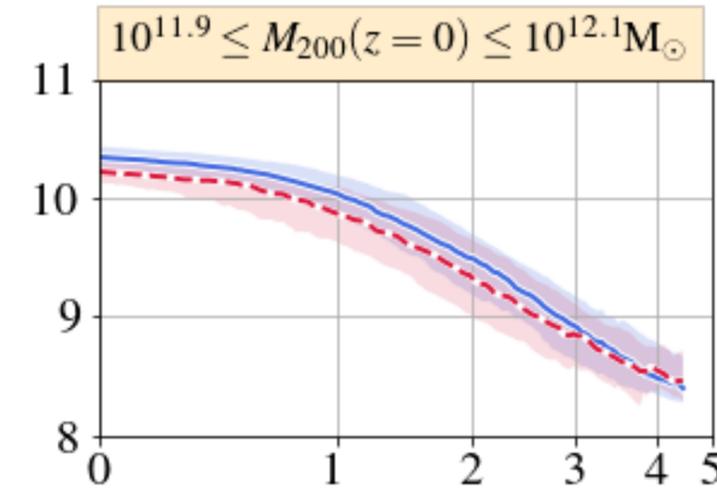
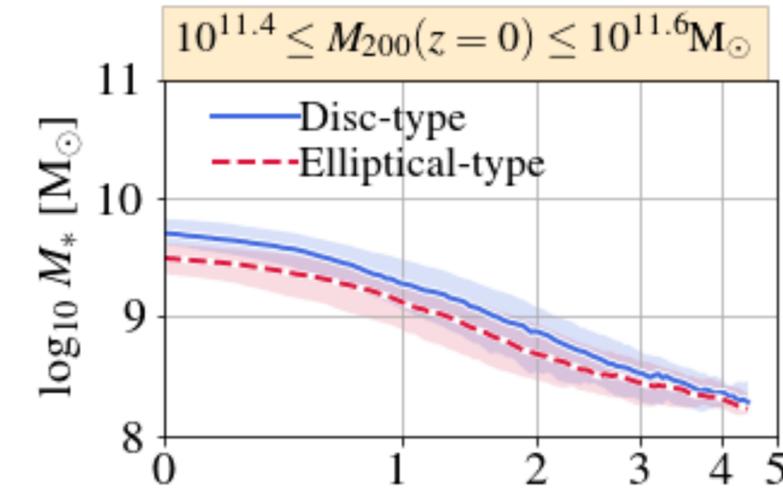


# Galaxy Evolution

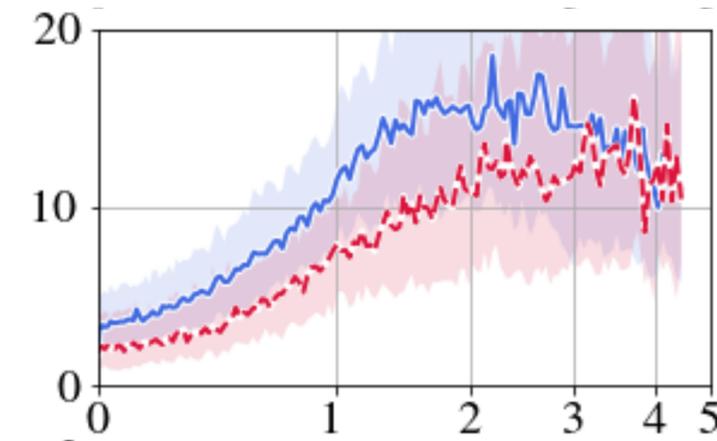
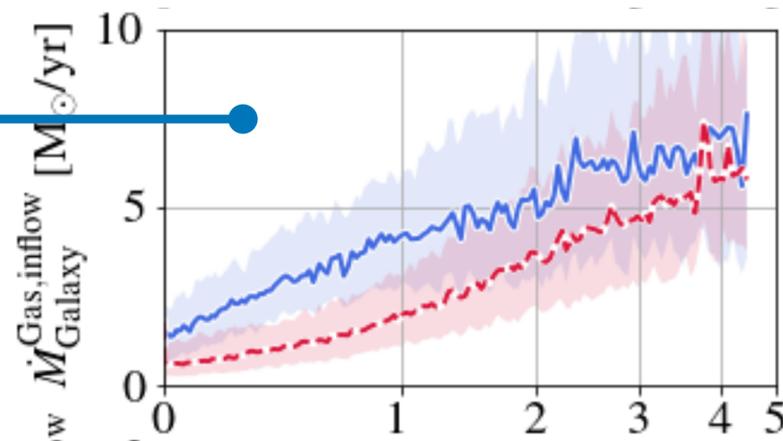
Central galaxies in haloes  $\leq 10^{12} M_{\odot}$

Disc galaxies have larger rates of gas accretion

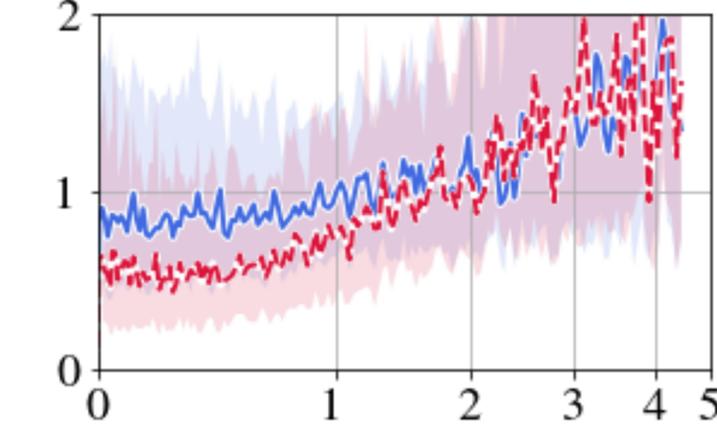
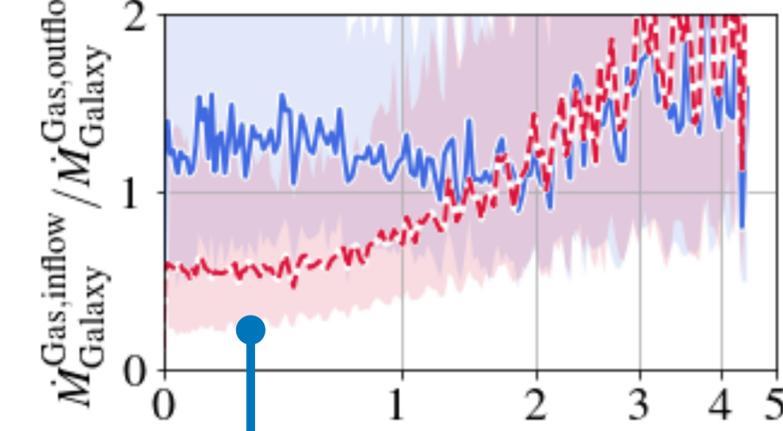
At  $z < 1$  elliptical galaxies have larger rates of gas outflow than inflow



Stellar Mass



Galaxy gas inflow rate



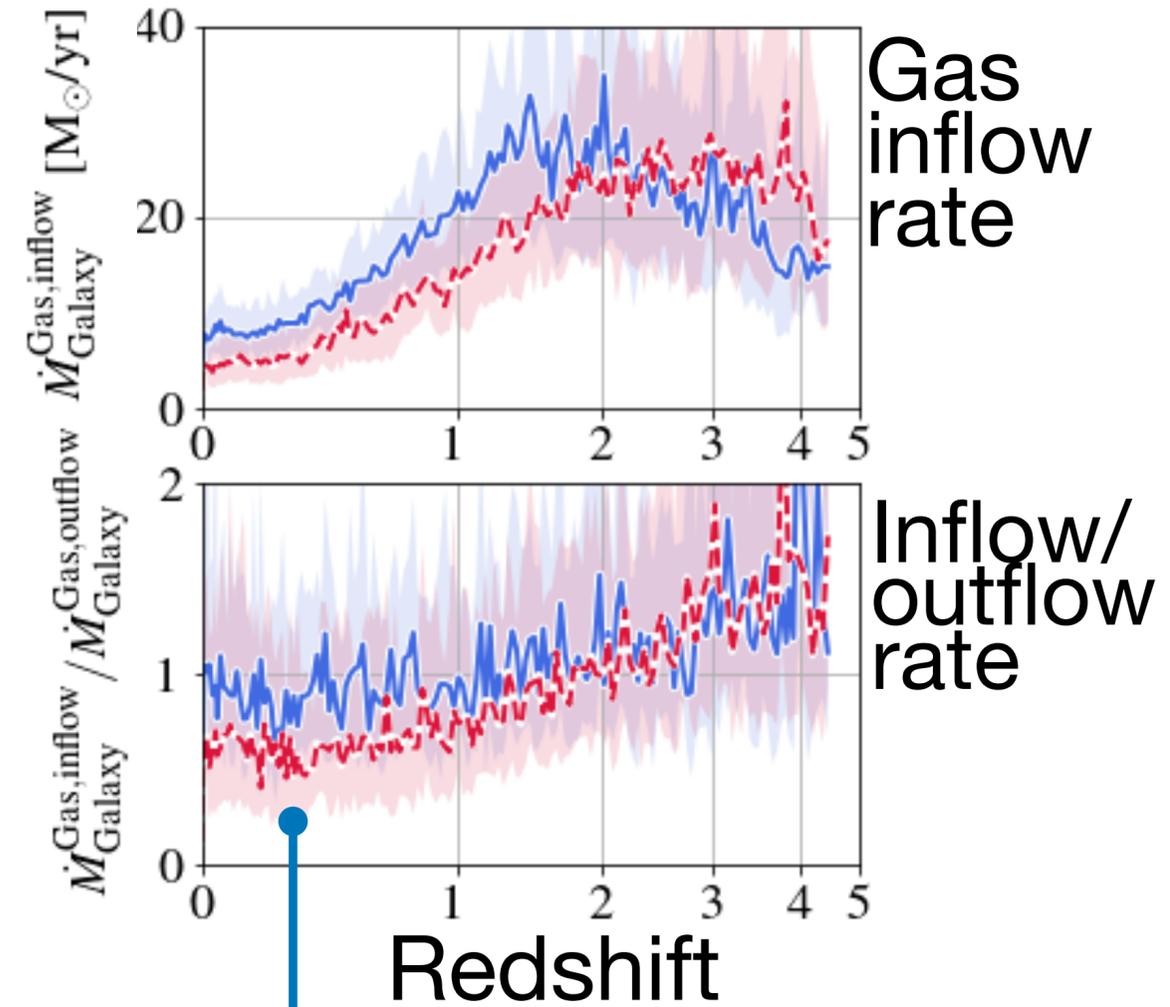
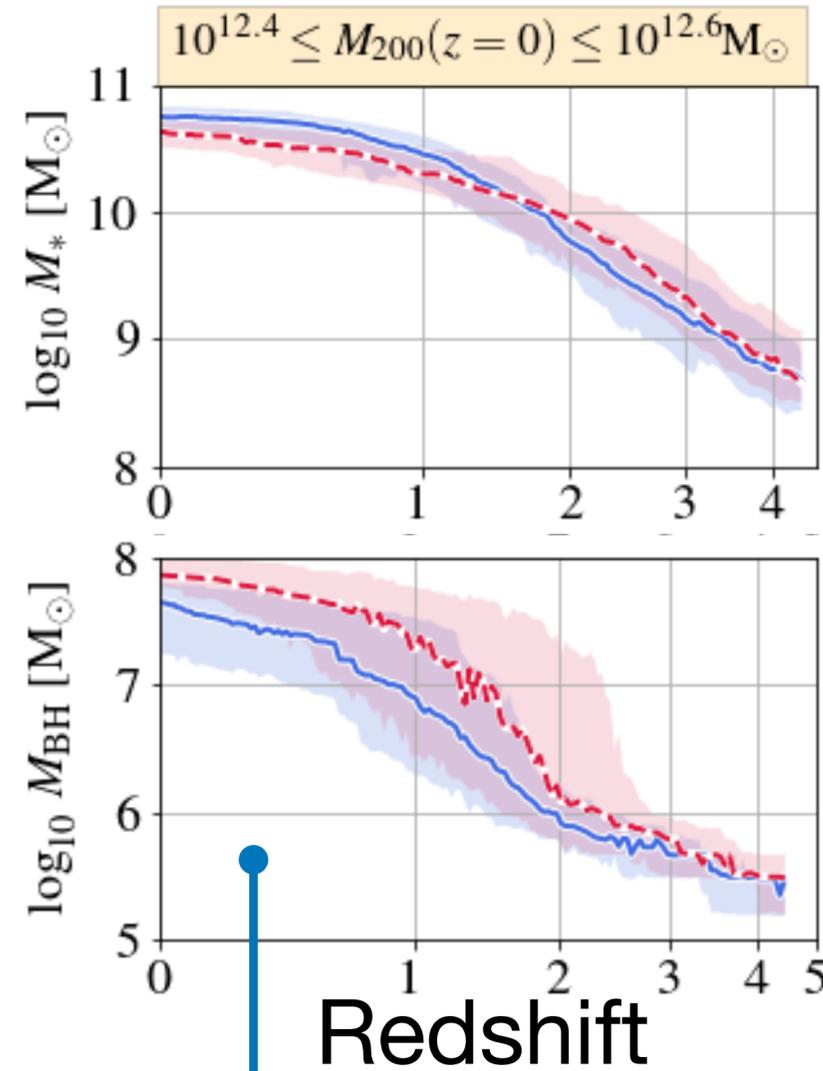
Inflow/outflow rate

Redshift

Redshift

# Galaxy Evolution

Central galaxies in haloes  $> 10^{12} M_{\odot}$



BH in elliptical galaxies rapidly grows and ejects gas out of halo

In disc galaxies, the rate of gas inflow remains large for longer

# Summary

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## SDSS sample

- At fixed halo mass, median masses of disc central galaxies are larger than ellipticals (but only for Kauffmann et al. 2003 stellar masses!)
- Is this indication of biased mass-to-light ratios?

## EAGLE simulation

- EAGLE disc-type central galaxies have median masses larger than ellipticals at fixed halo mass
- Disc central galaxies in haloes  $\leq 10^{12} M_{\odot}$  reside in earlier forming haloes and have larger rates of gas inflow relative to outflows than ellipticals
- Elliptical central galaxies in haloes  $> 10^{12} M_{\odot}$  host faster growing black holes than discs. BHs rapidly eject gas out of halo, decreasing galaxies gas inflow

Thank you!

# Back-up slides

## Galaxy Morphology & the Stellar-To-Halo Mass Relation

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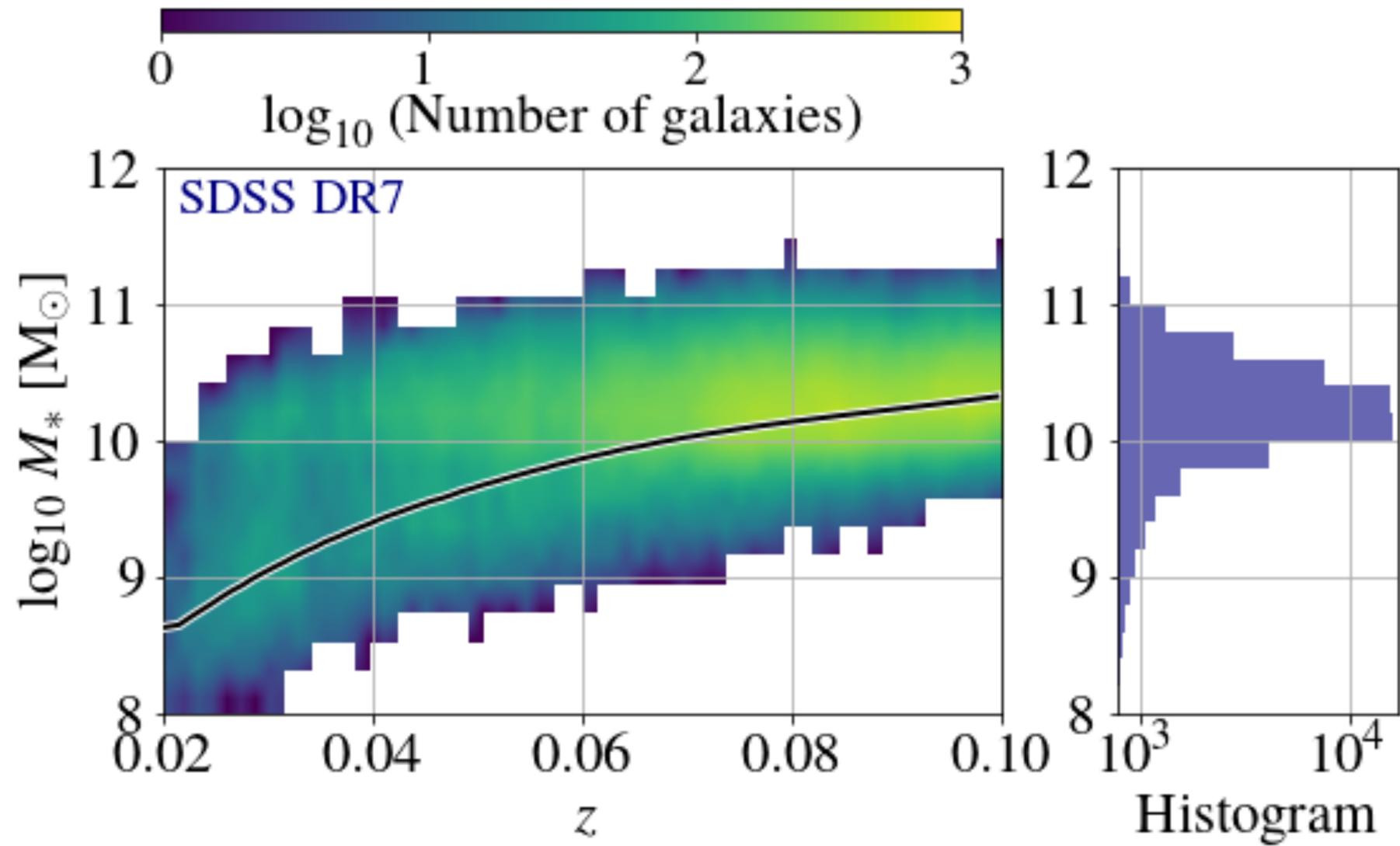
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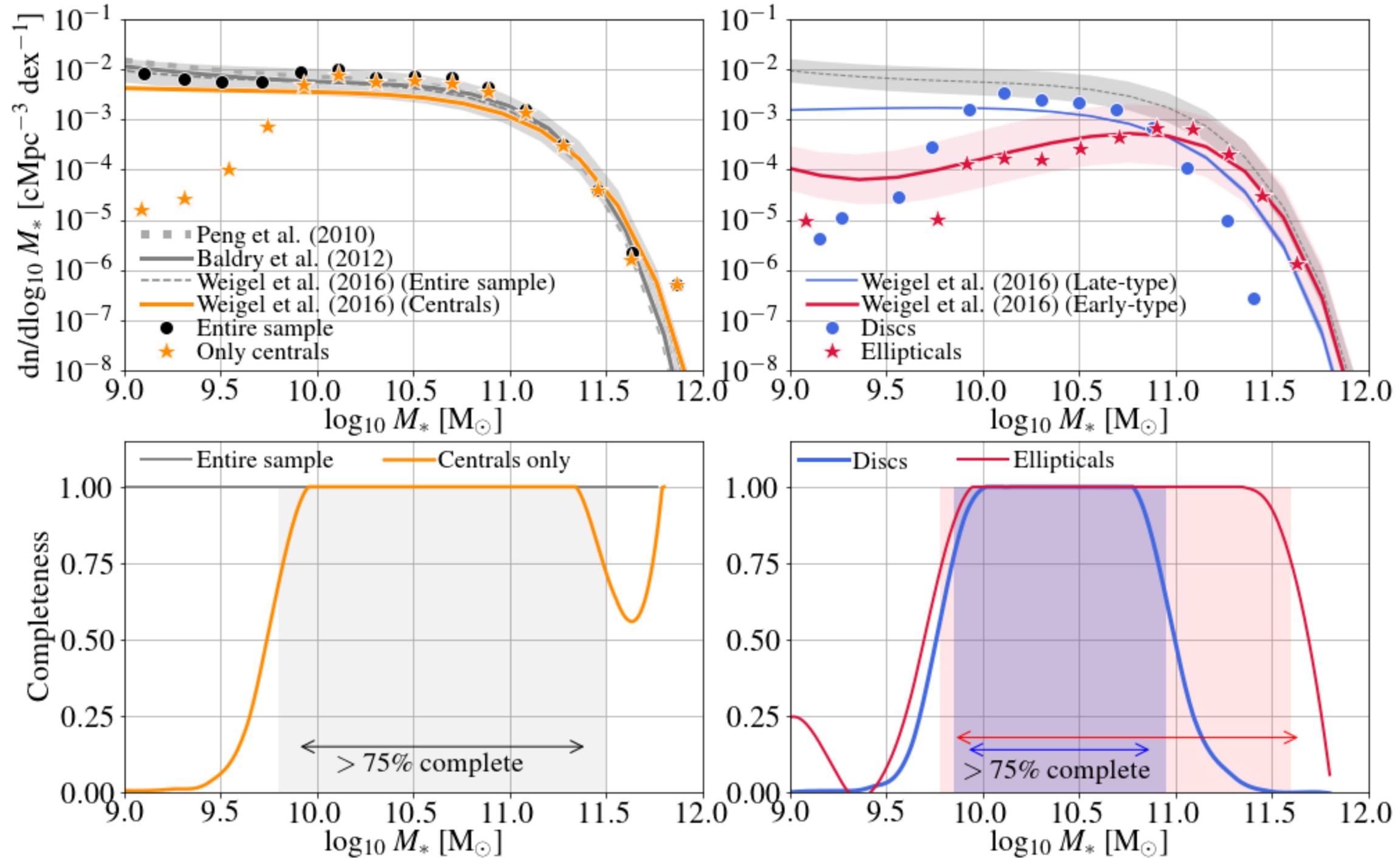
<sup>2</sup>Leiden University (Netherlands)

# SDSS DR7 sample: Completeness analysis

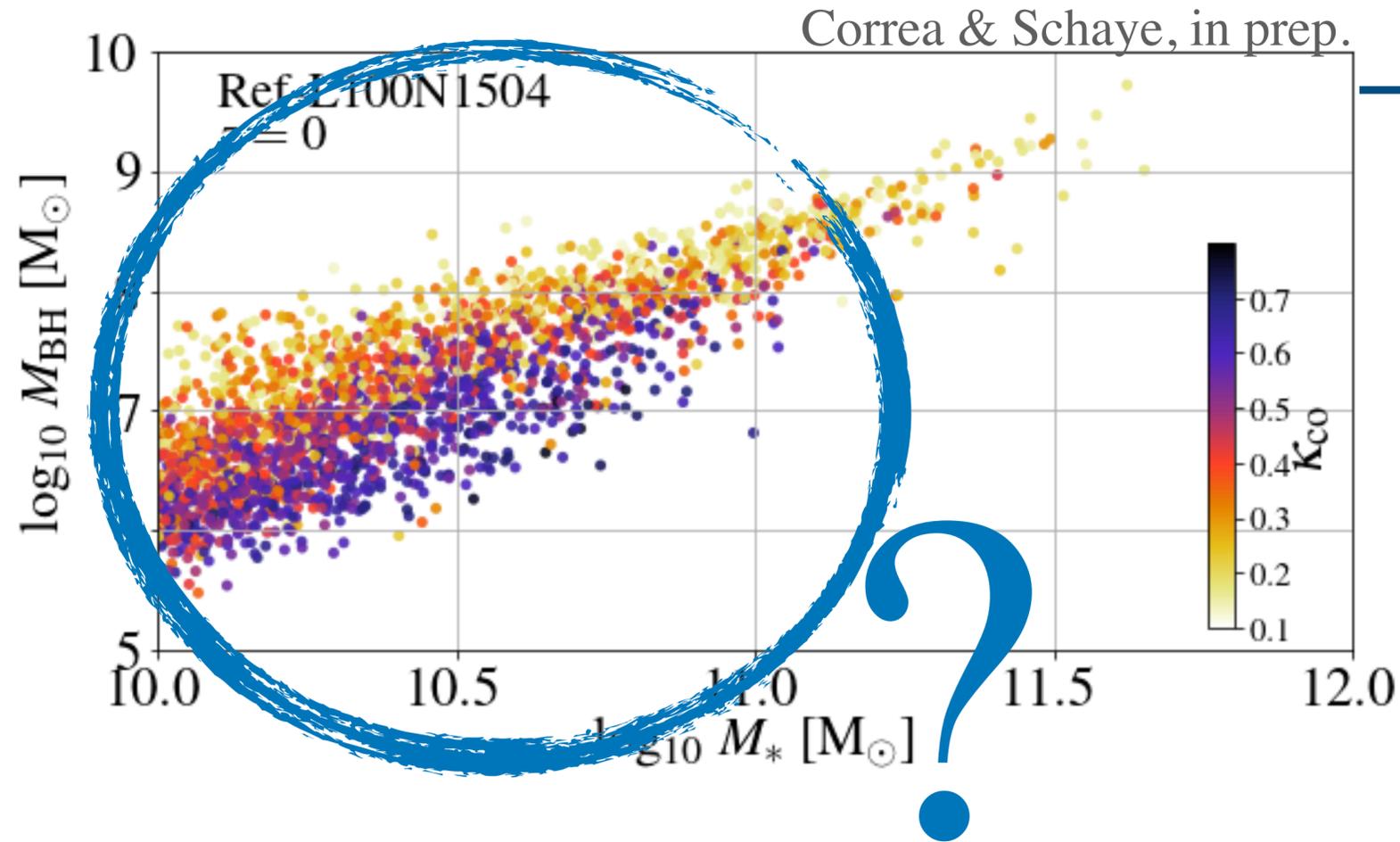
95% completeness limit at each redshift observable by the survey



## SDSS DR7 sample: Completeness analysis



# Morphology & SHMR: AGN Feedback

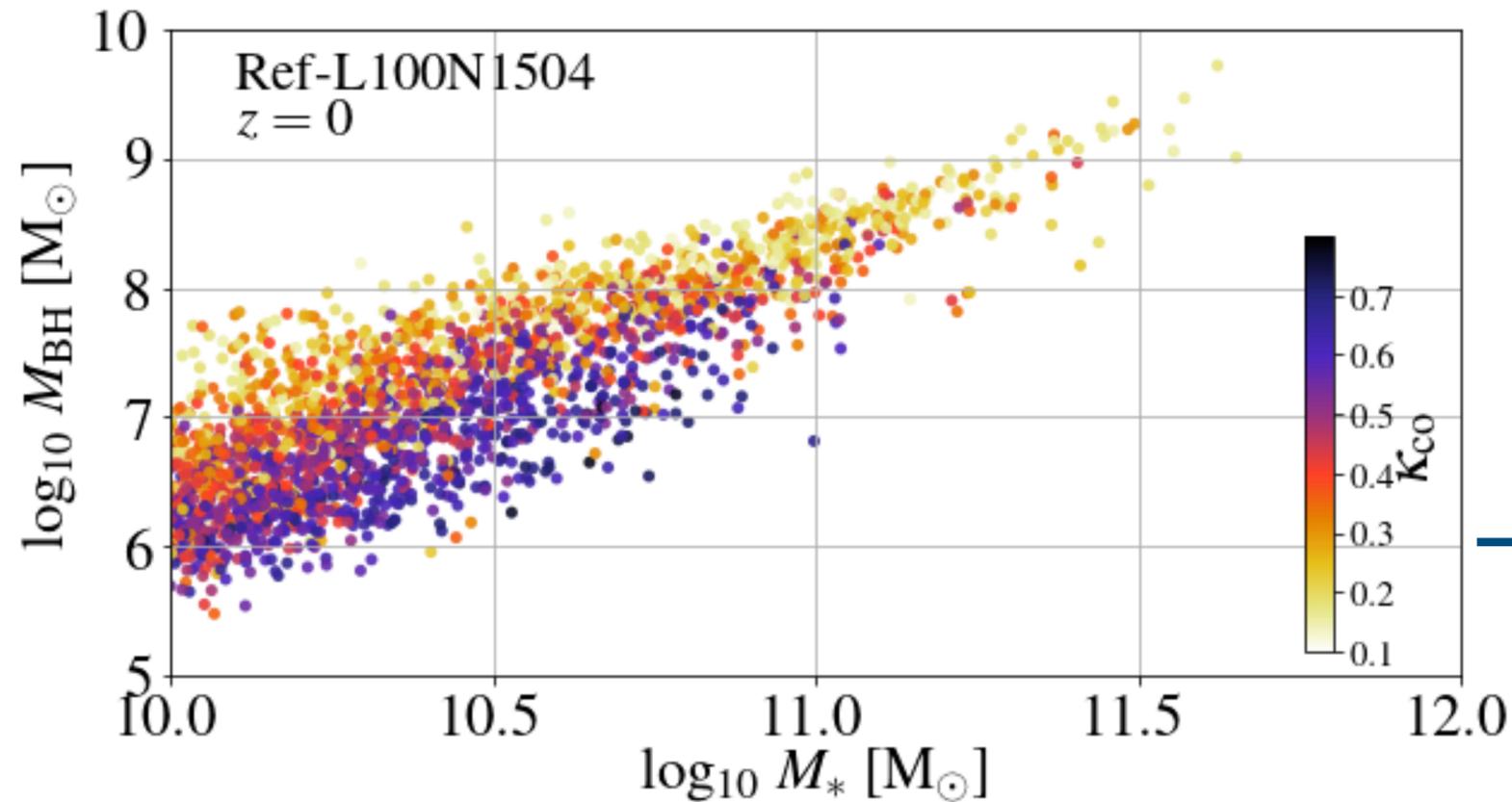


Elliptical galaxies are embedded in later-forming haloes

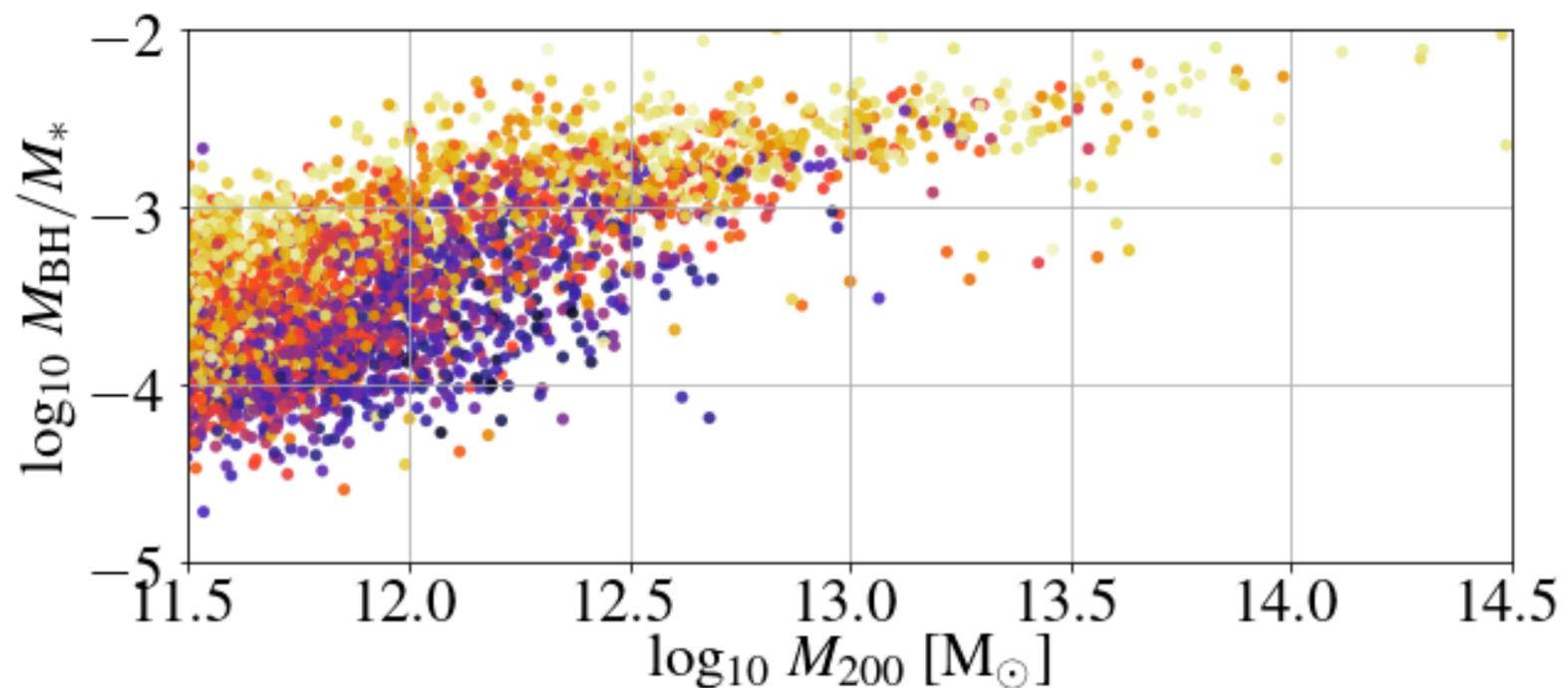
undergo a faster growth rate

that triggers a rapid growth phase of central black holes

# Morphology & SHMR: AGN Feedback



At fixed stellar mass disc galaxies tend to host less massive central black holes than elliptical galaxies



At fixed halo mass, the relative ratio of BH mass and stellar mass is lower for disc-type galaxies than for ellipticals.