

# The Star Formation Properties of Merging Galaxies at $0.3 < z < 2.5$

**Andrea Silva (NAOJ)**

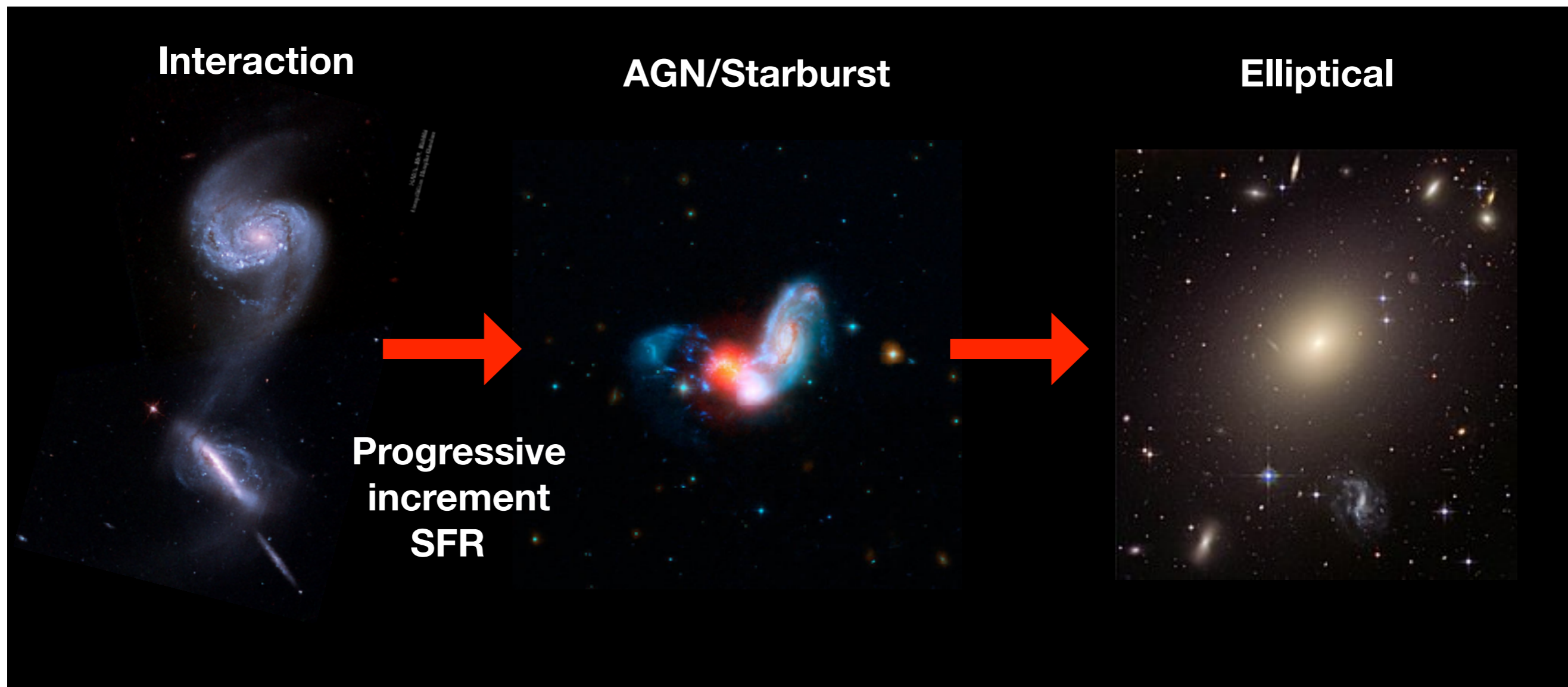
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**Silva et al. 2018, ApJ 868 46S**

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Ros Skelton (SAAO), Daisuke Iono (NAOJ), Nick Martis (Tufts Univ.), Cemile Marsan  
(York Univ.), Ken-Ichi Tadaki (NAOJ), Gabriel Brammer (Cosmic Dawn Center),  
Jeyhan Kartaltepe (Rochester IT)*

# Why study high-z galaxy mergers?

- ❖ The merging of two galaxies with similar mass (major mergers) can make profound changes in the morphology and the properties of galaxies



# Why study high- $z$ galaxy mergers?

- ❖ The merging of two galaxies with similar mass (major mergers) can make profound changes in the morphology and the properties of galaxies
- ❖ Their fraction seem to increase with redshift

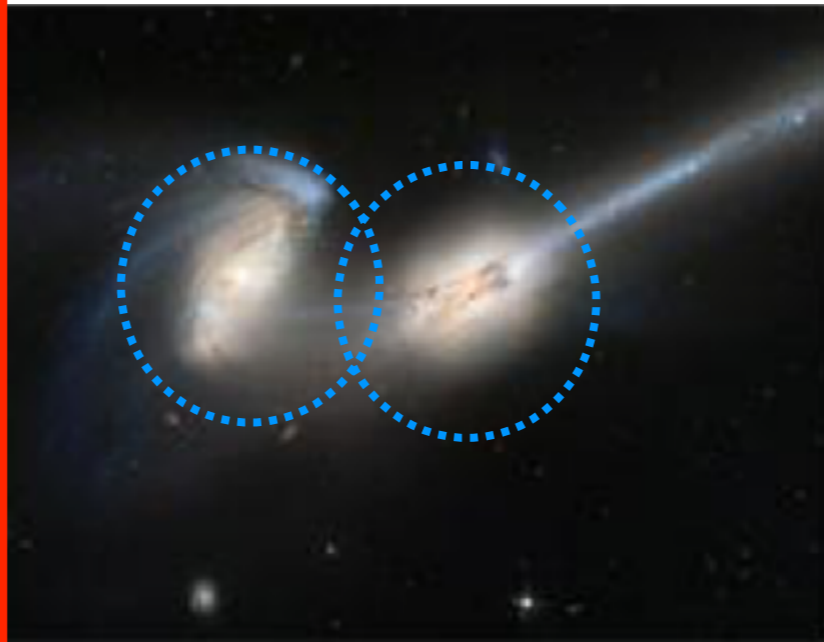
**Most of studies of major mergers at  $z > 1$  have focus on global statistics (e.g. merger rate) and not impact on properties**

**In this work, we focus on the SF properties of high- $z$  merging galaxies**

# Method to Select Mergers

*Lackner et al. 2014*

## B. Pre-coalescence



*We select galaxies with  
**two intact nuclei**  
**separated by few kpc**  
(just before  
coalescence).*

# Method to Select Mergers

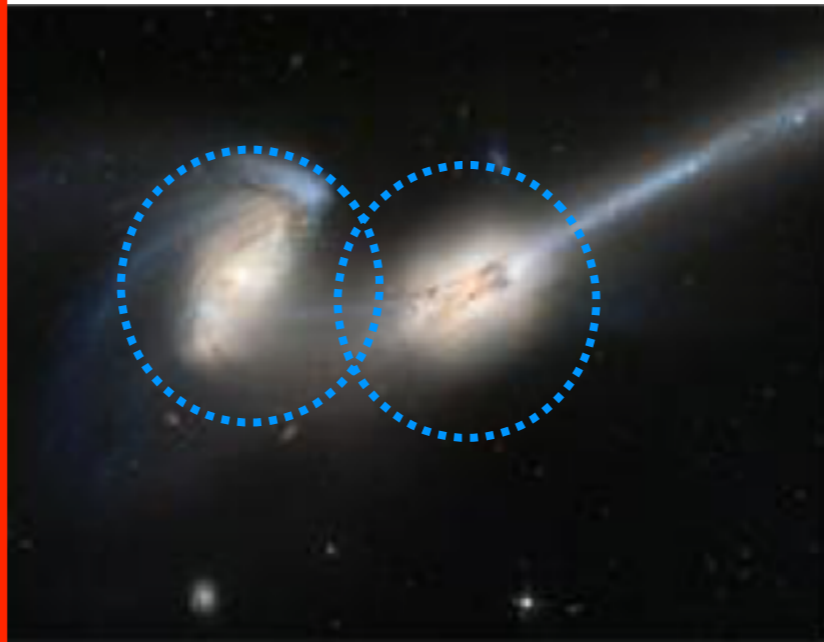
*Lackner et al. 2014*

## A. Early-Stage



*Selection of galaxy  
pairs with  
separations  $< 100$   
kpc*

## B. Pre-coalescence

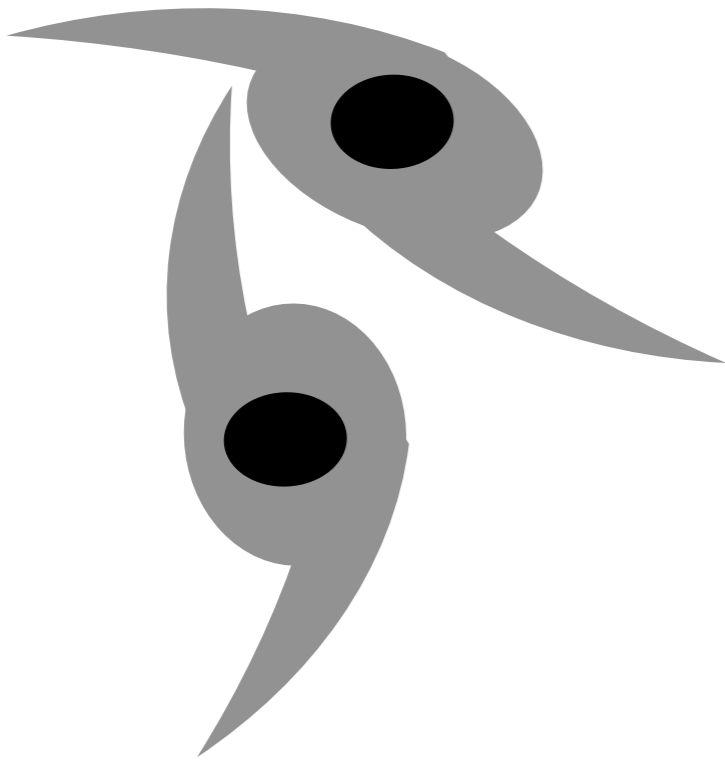


*We select galaxies with  
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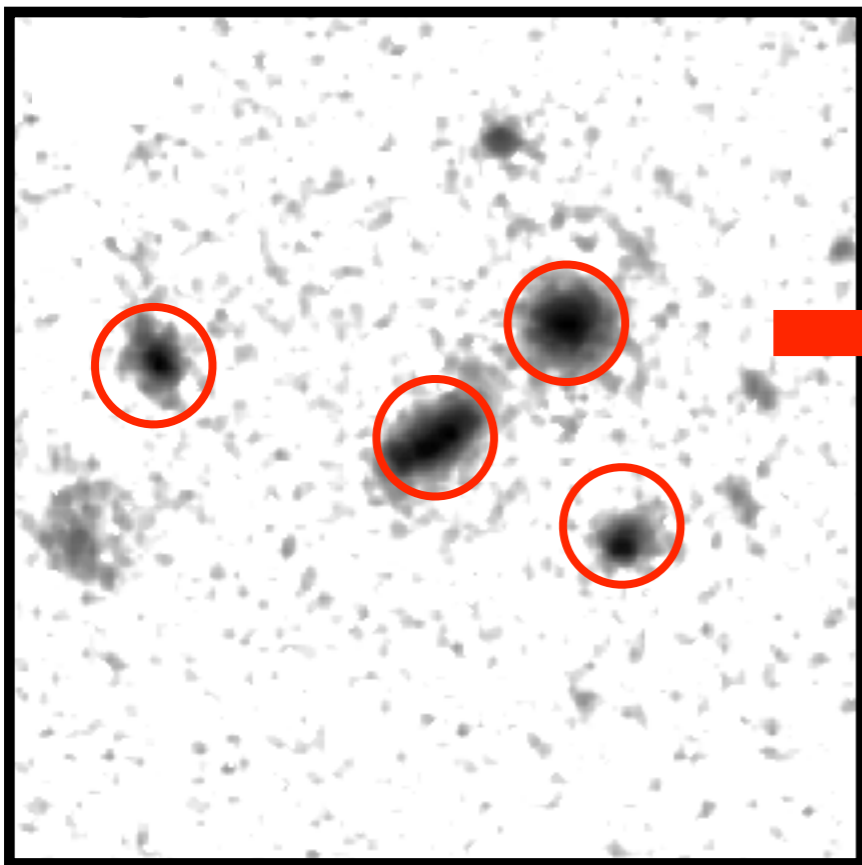
## C. Post-Merger



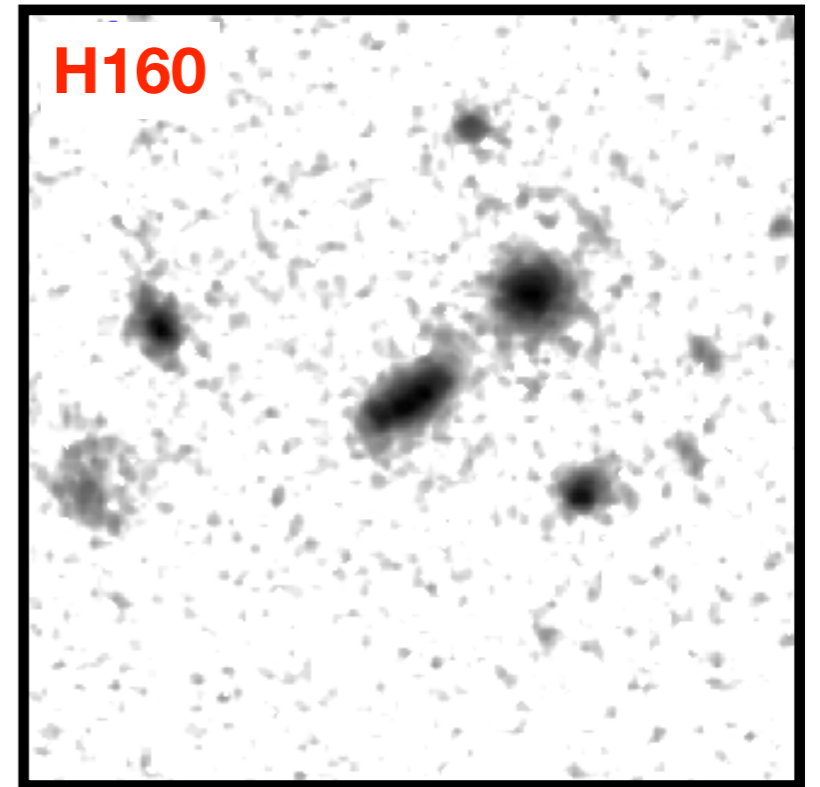
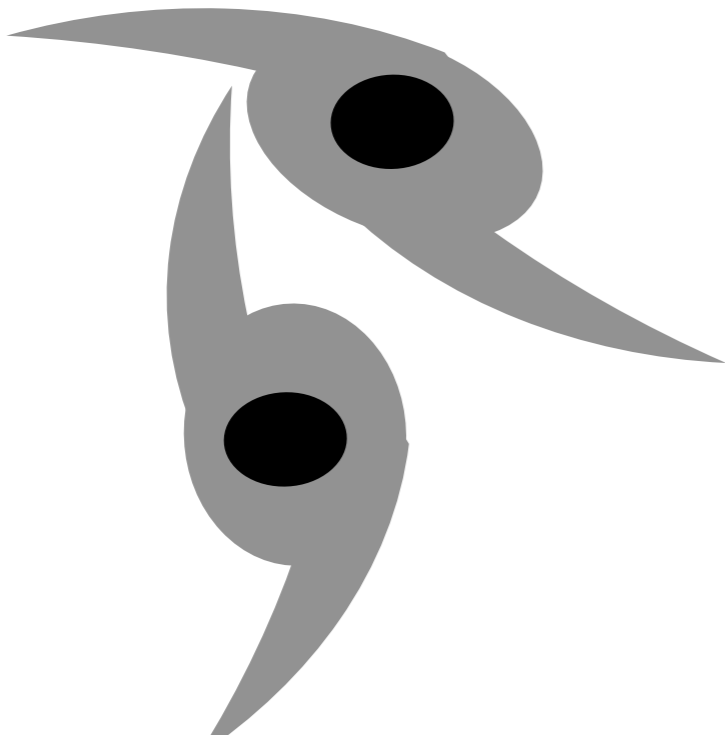
*Selection of galaxies  
with disturbed  
morphologies*



## Lackner et al 2014's method



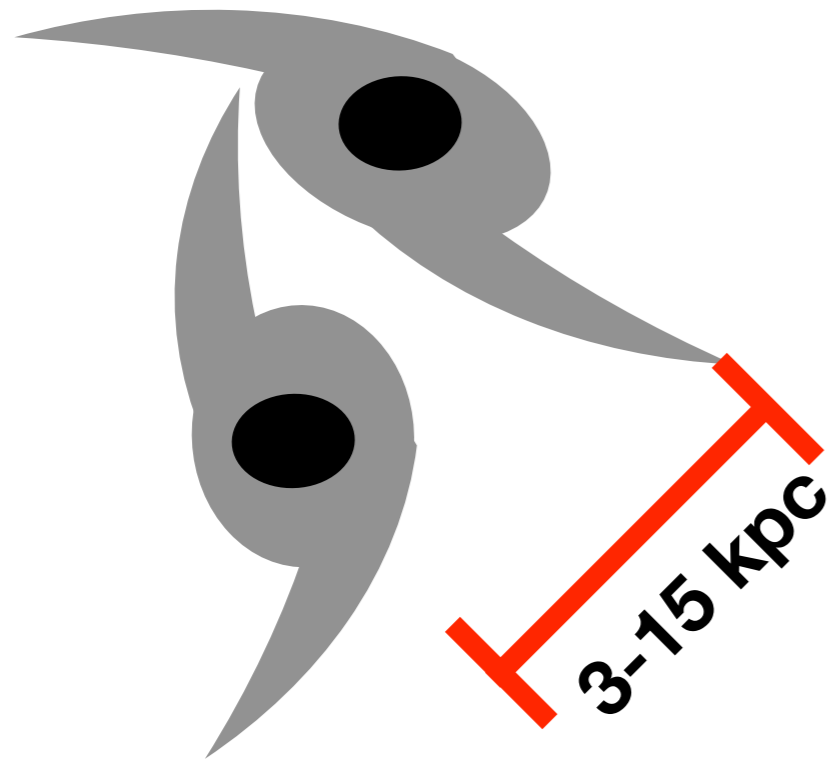
- ❖ Select bright regions in an image
- ❖ Restrictions on the properties of these regions to select galaxy pairs at close separation



## Apply method to near-IR HST/F160W images

- ❖ Selection of mergers in **rest-frame optical/NIR** out to  $z=2.5$
- ❖ Centered on  $\sim 5700$  galaxies with  $M_{\text{star}} > 10^{10} M_{\text{sun}}$  and  $0.3 < z_{\text{best}} < 2.5$  in CANDELS (COSMOS, AEGIS, GOODS-N, GOODS-S, UDS) fields
- ❖ Match selected regions with 3D-HST catalogs (Skelton+14, Momcheva+16) to find properties
- ❖ Use redshifts to separate potential mergers from line of sight contaminants

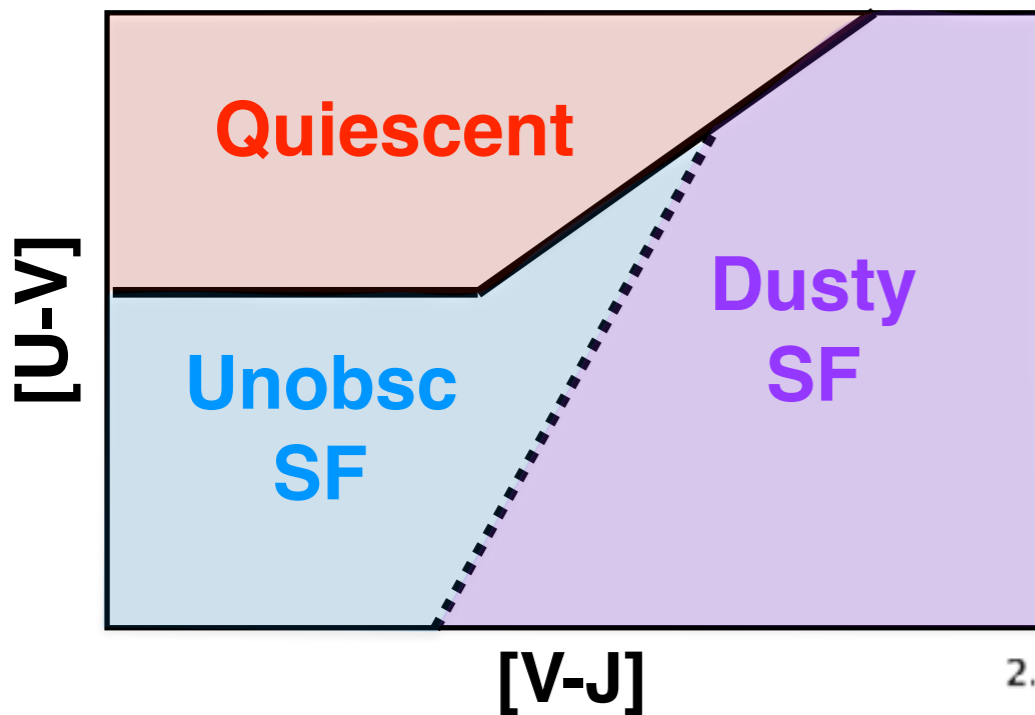
# Final Sample of Mergers



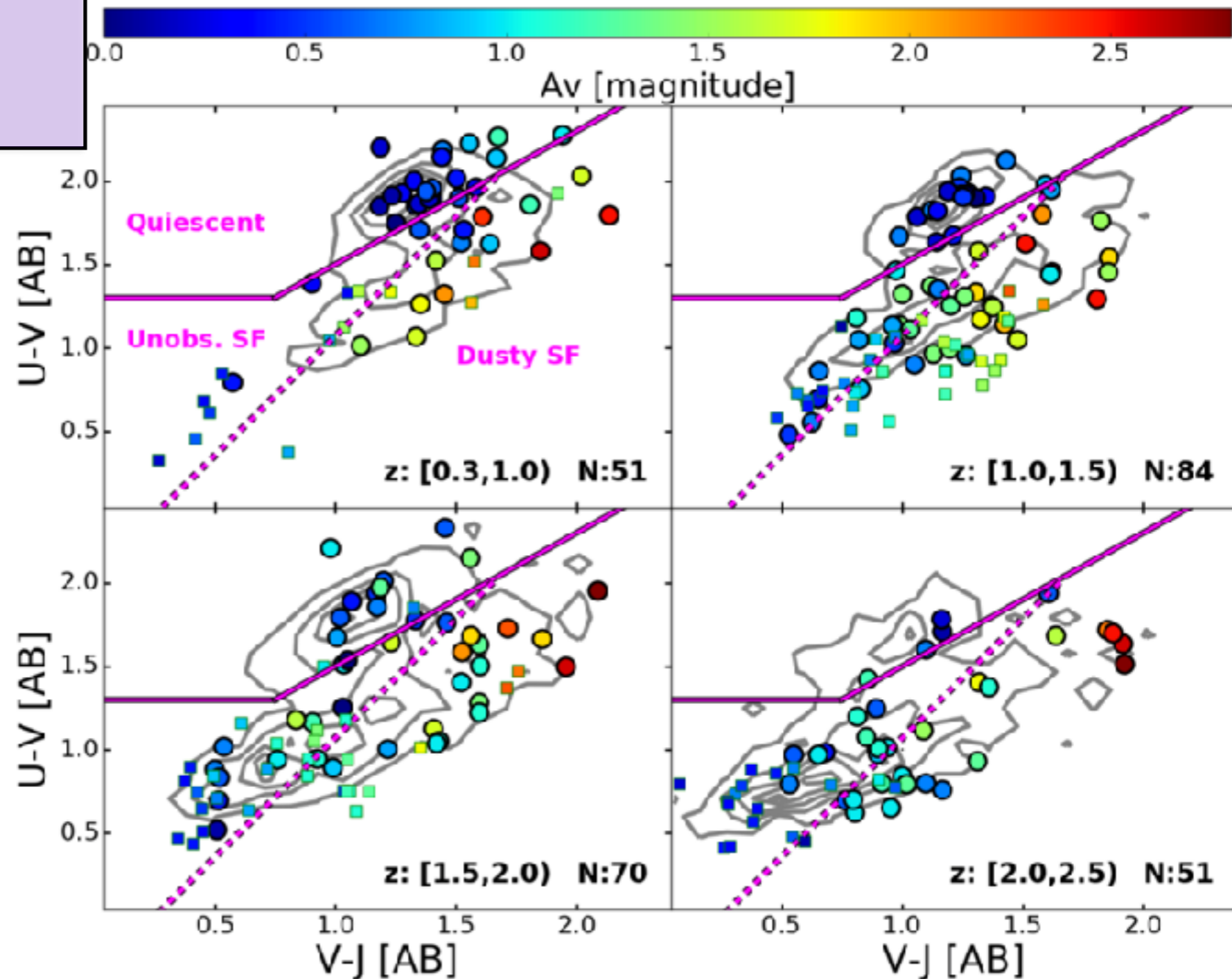
- ❖ **Primary Sample:** 130 merging systems ( $8.3 < \log M_{\text{star}} < 11.5$ )
- ❖ Projected distance 3-15 kpc
- ❖ Major Mergers constructed using a cut in stellar mass ratio
- ❖  $0.3 < z < 2.5$
- ❖ **High-mass sample:** 64 systems (both galaxies with  $M_{\text{star}} > 10^{10} M_{\text{sun}}$ , Guo+12)

We will focus mostly on this sample

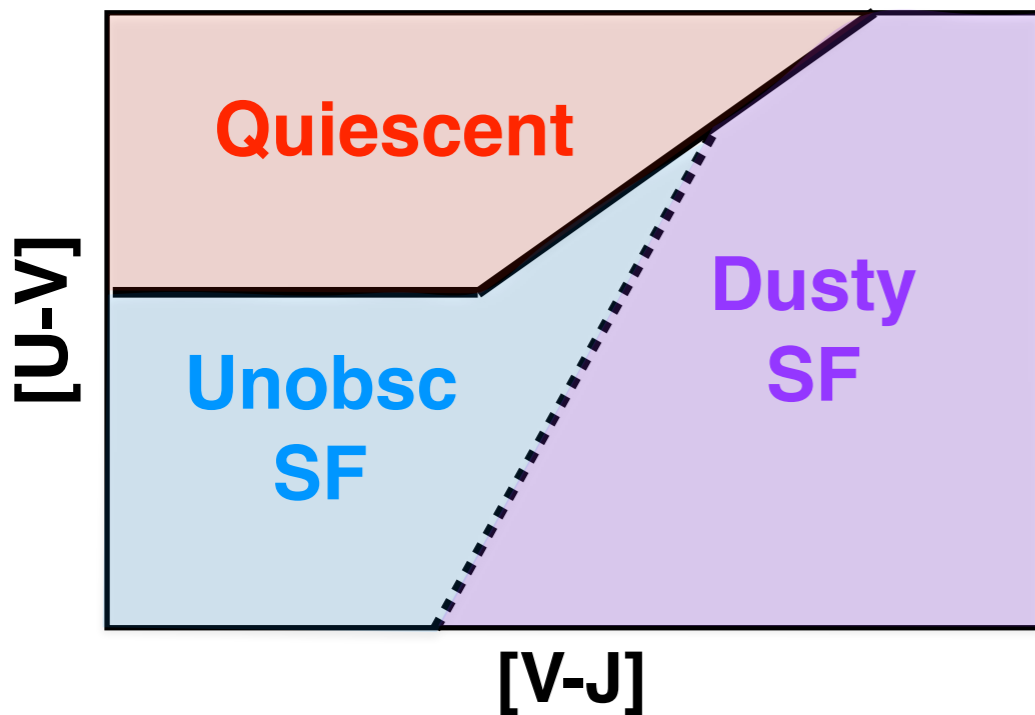
# Use UVJ colors to separate galaxies by type



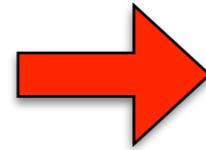
*Whitaker et al. 2015*  
*Martis et al. 2016*



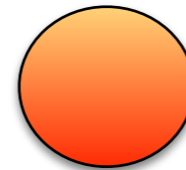
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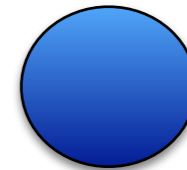
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## *Separate Galaxies*

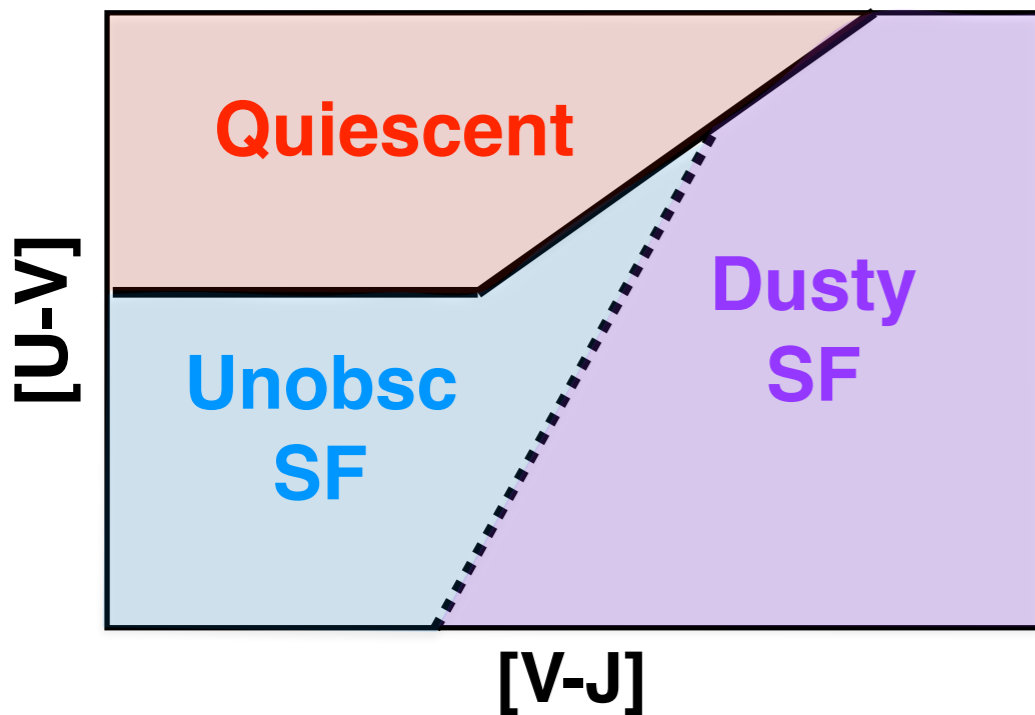


Quiescent  
(36%)

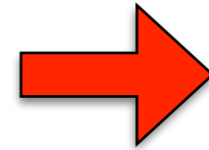


Star-forming  
dusty (42%)  
unobscured (22%)

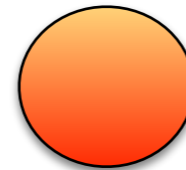
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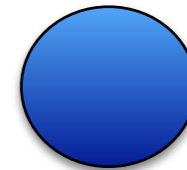
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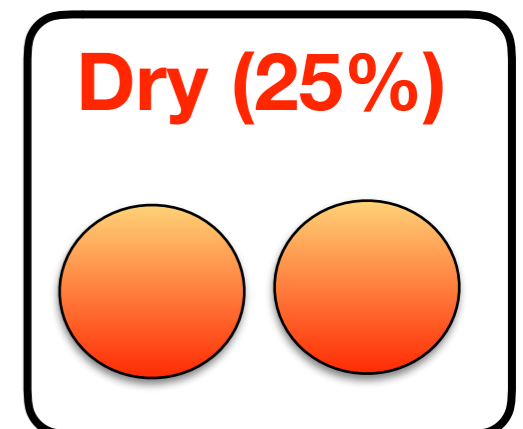
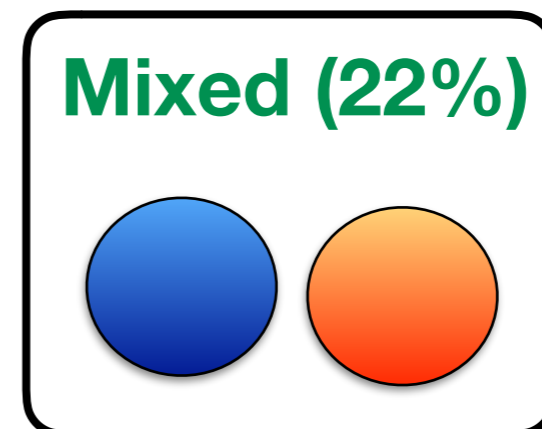
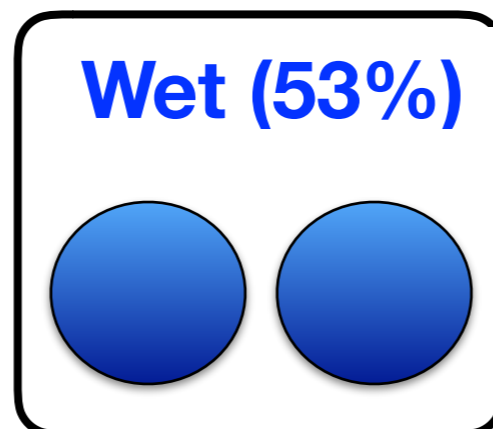
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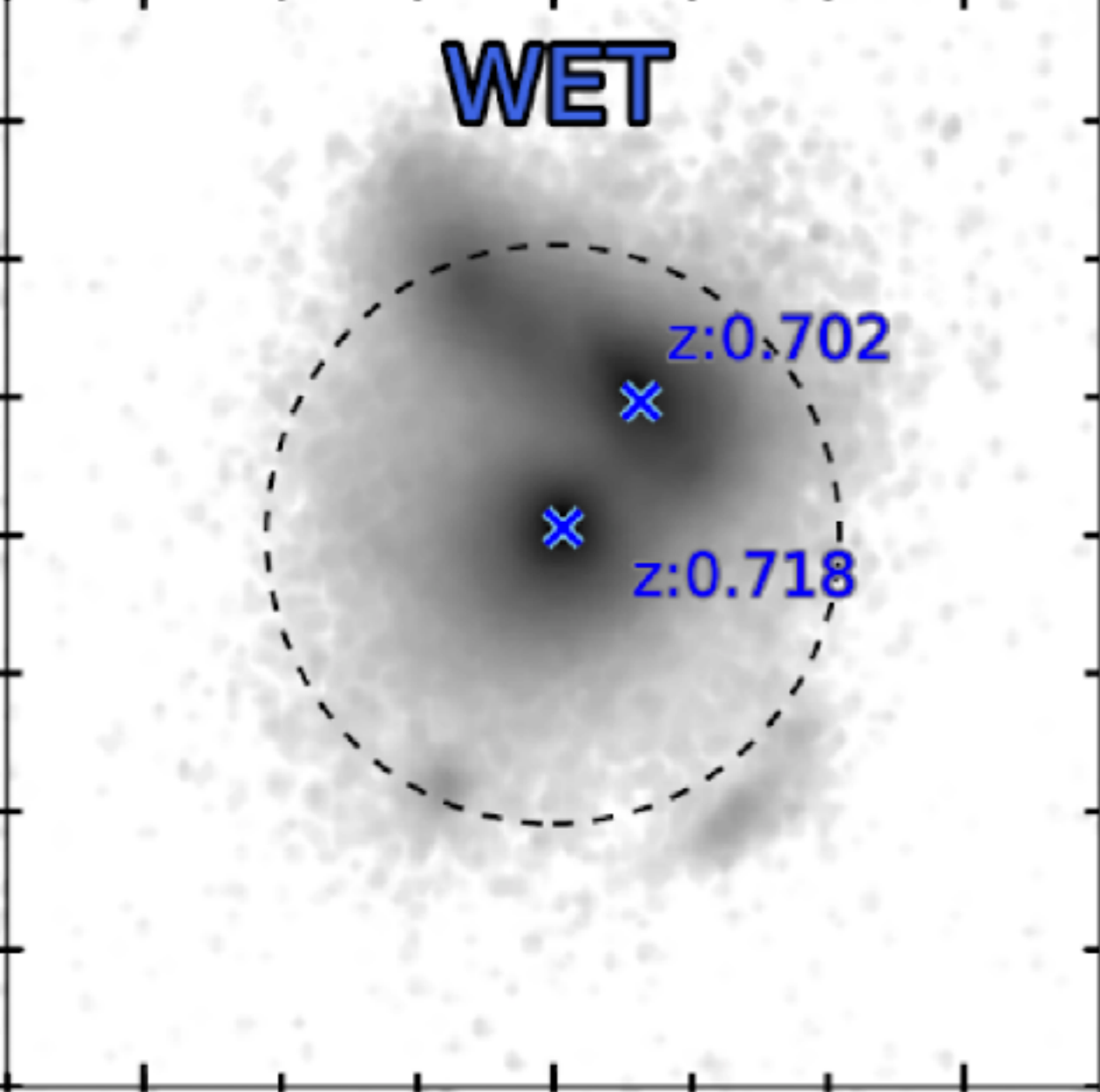
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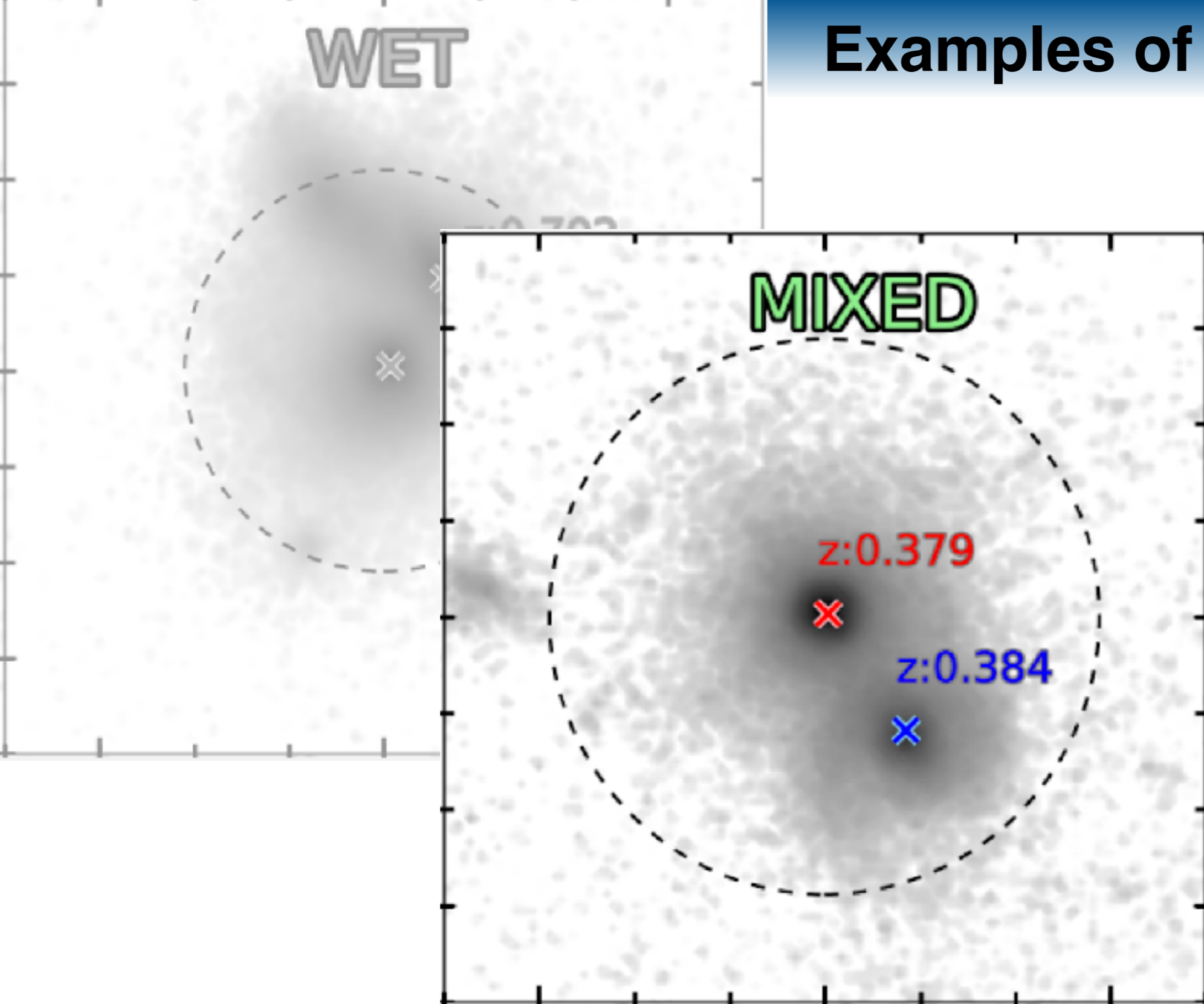
## *Separate Mergers*



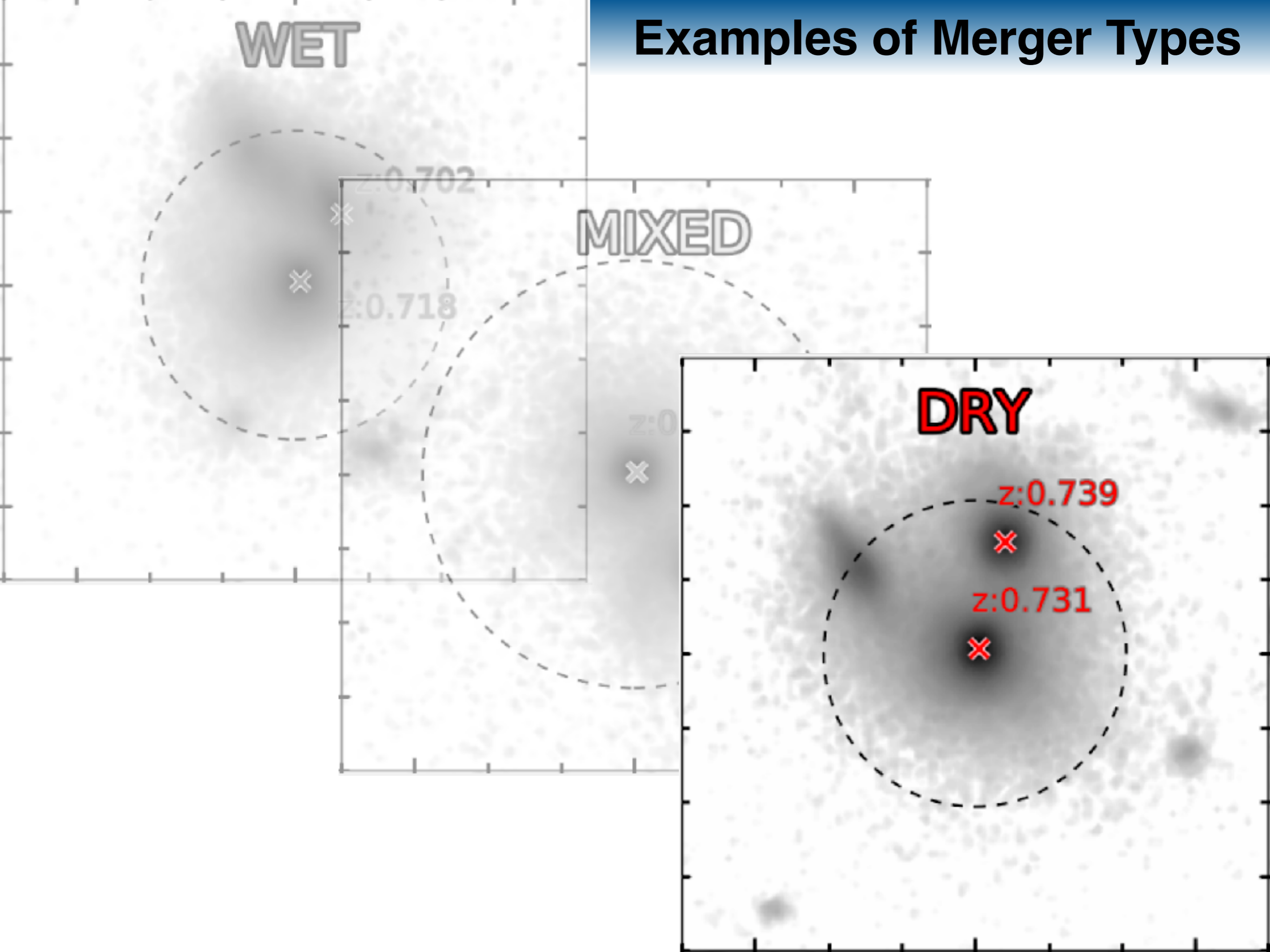
# Examples of Merger Types



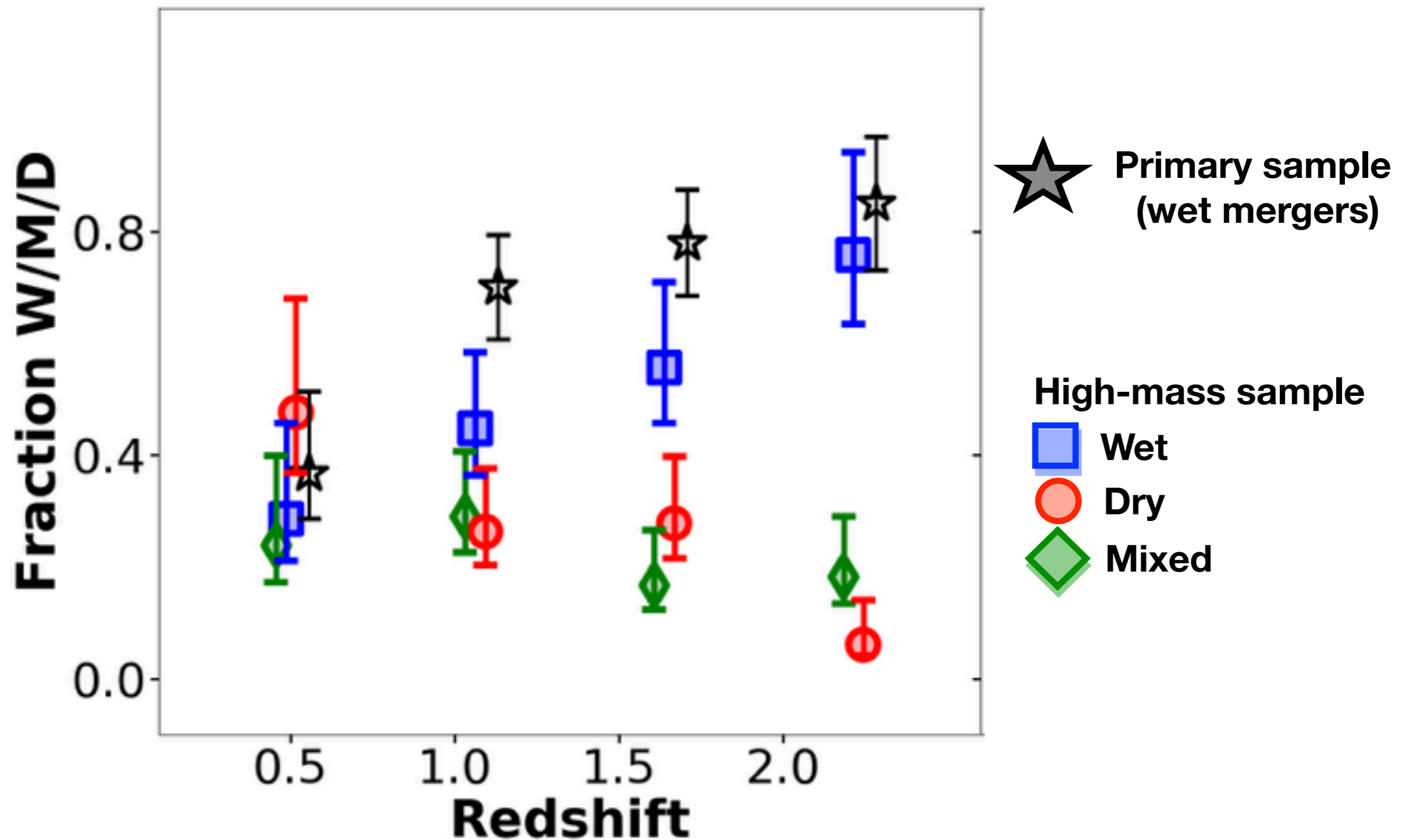
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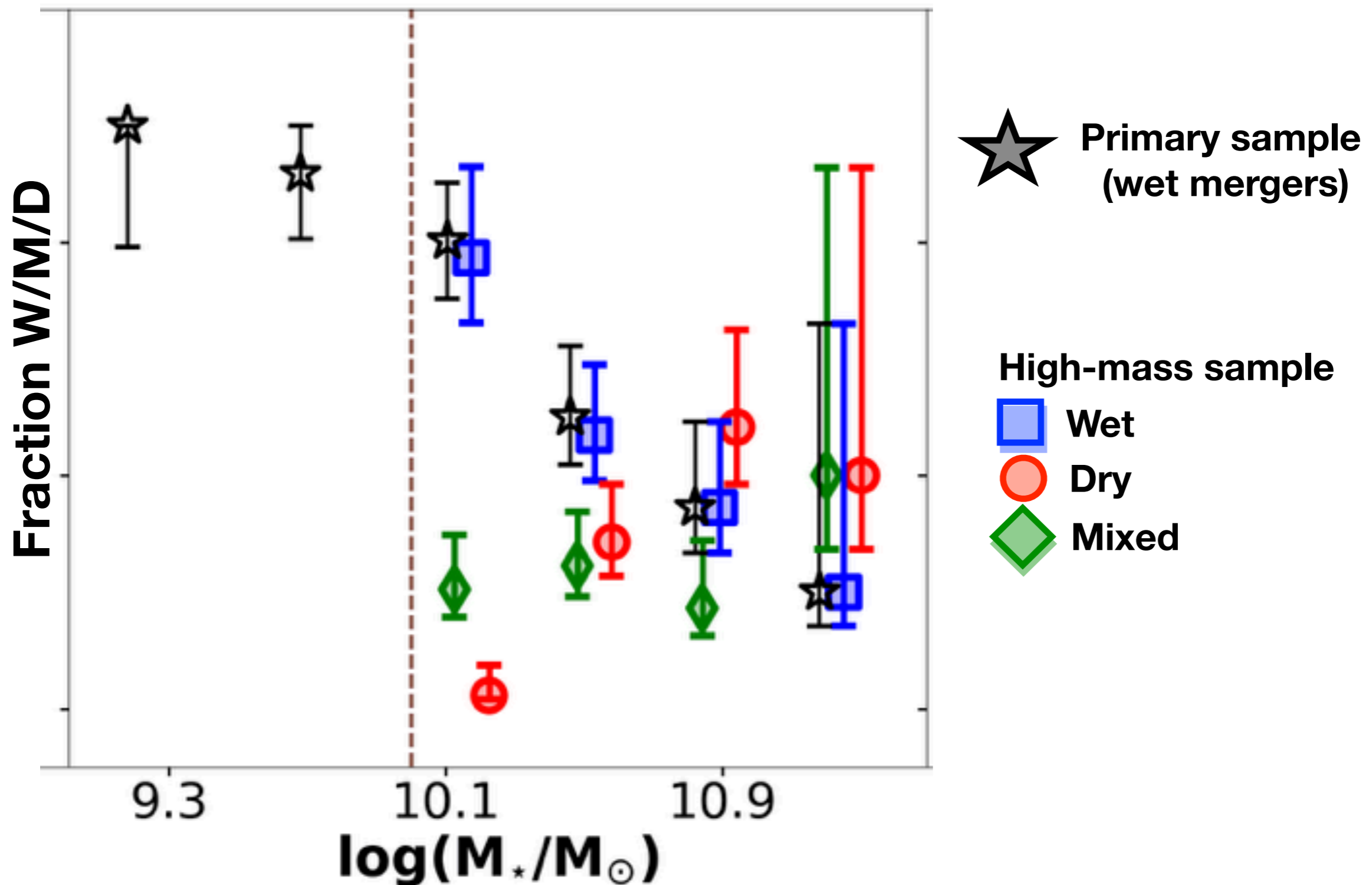


# Fraction dry/mixed/wet mergers



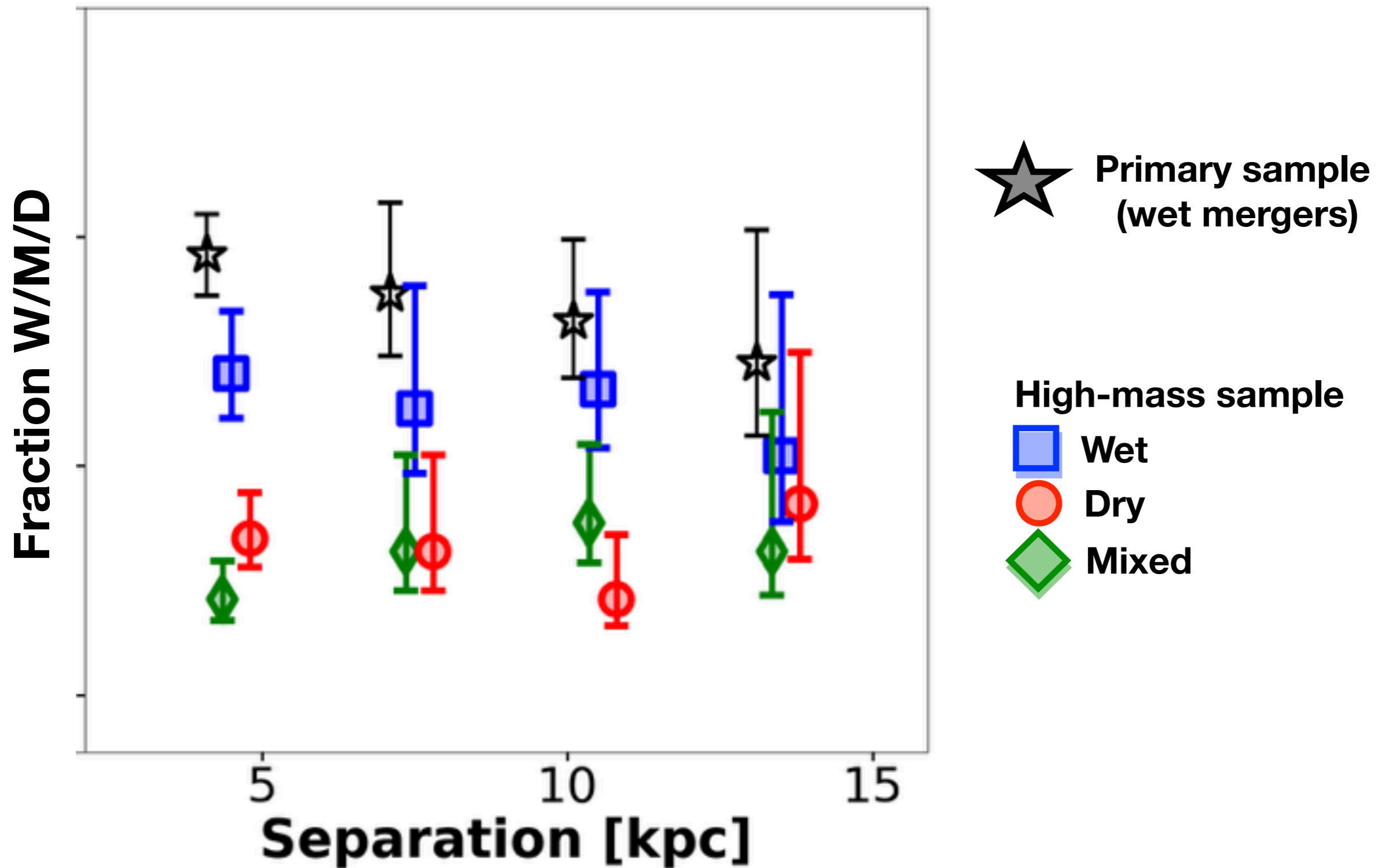
- ❖ Wet mergers are dominant at higher  $z$
- ❖ Fraction dry mergers increases with cosmic time

# Fraction dry/mixed/wet mergers



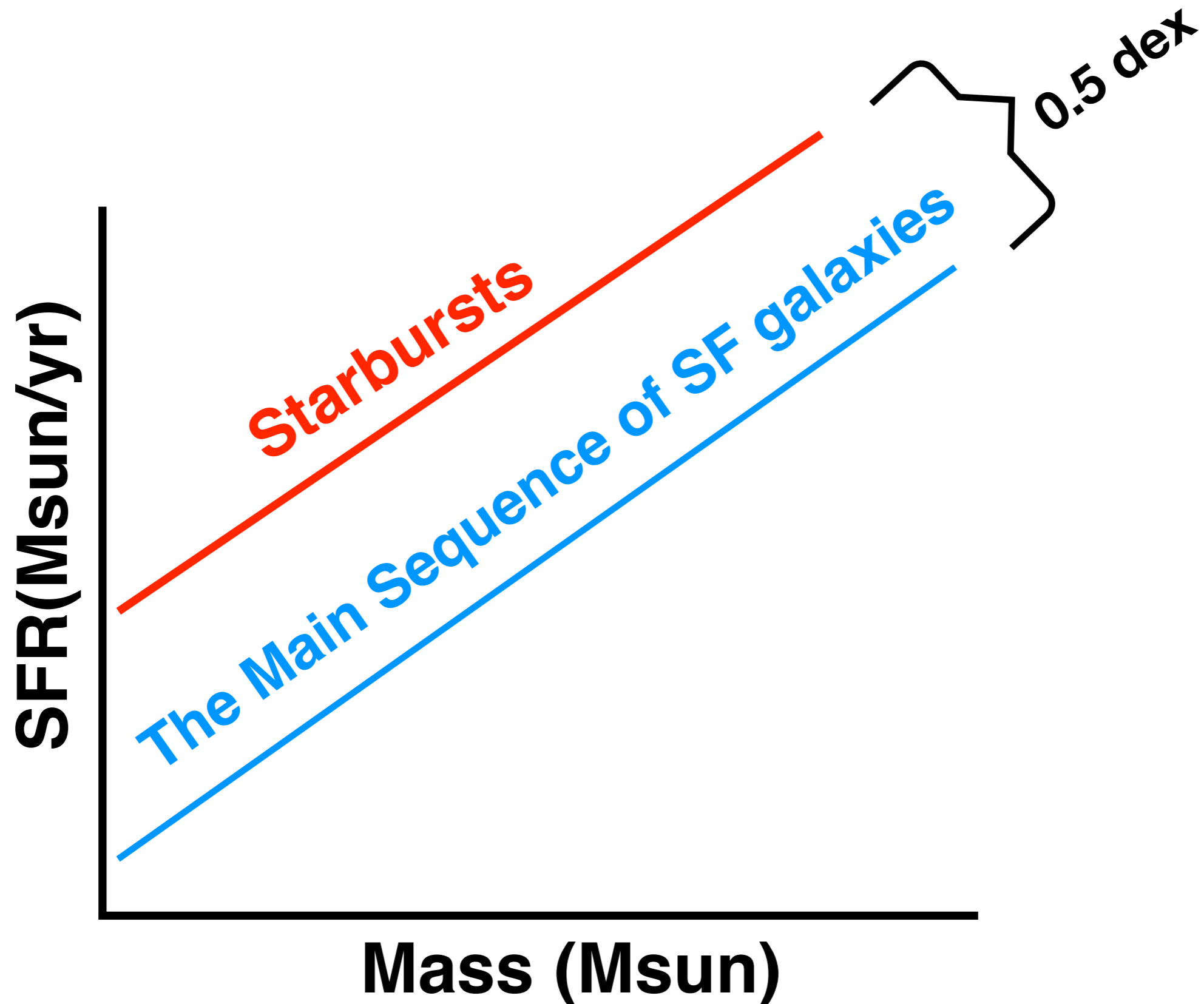
- ❖ Wet mergers are dominant at lower  $M_{\text{star}}$
- ❖ Fraction dry mergers increases with  $M_{\text{star}}$

# Fraction dry/mixed/wet mergers



❖ Fractions of w/m/d mergers roughly constant with separation

# Definition of Starburst

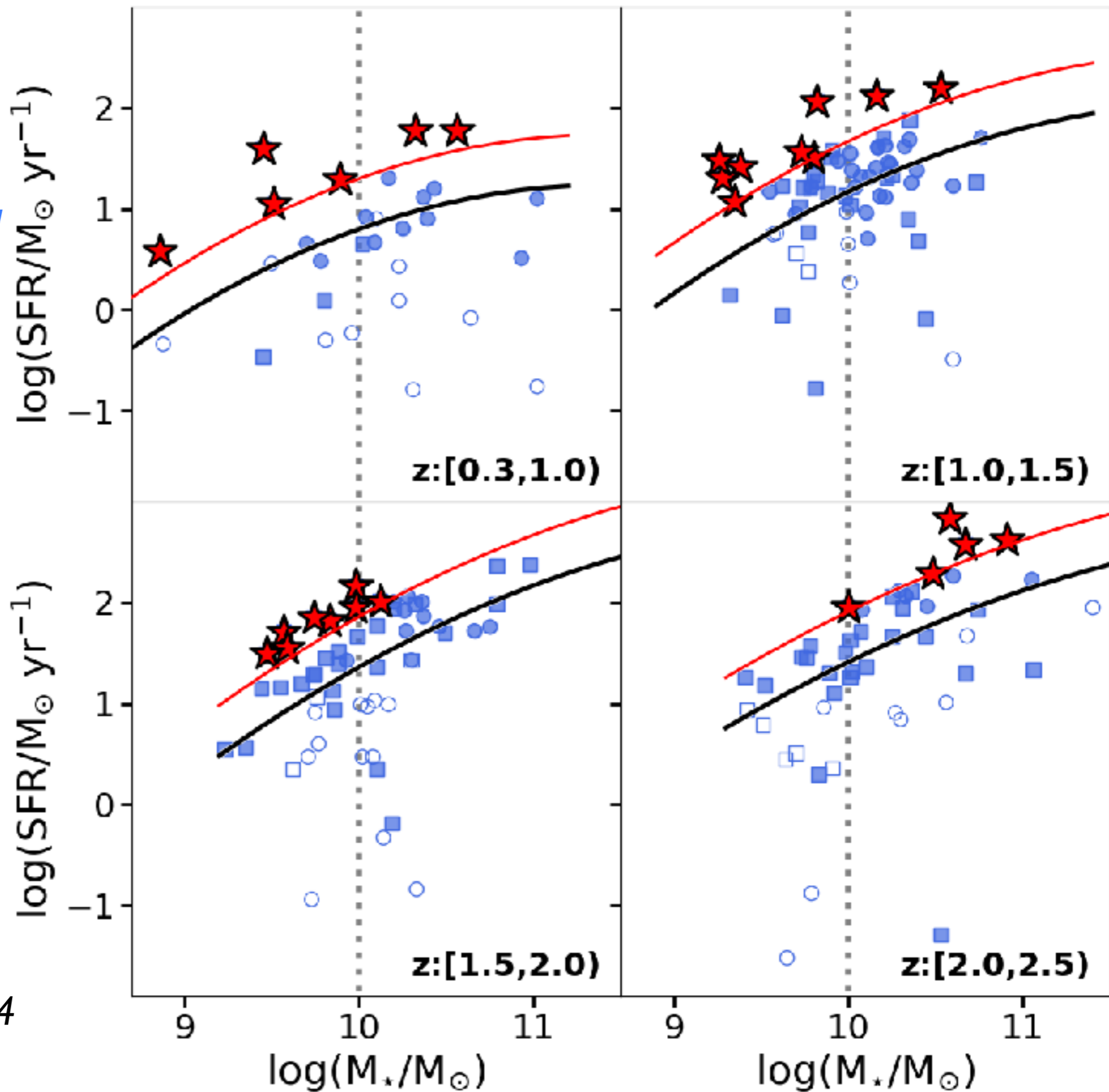


★ *Starbursts*

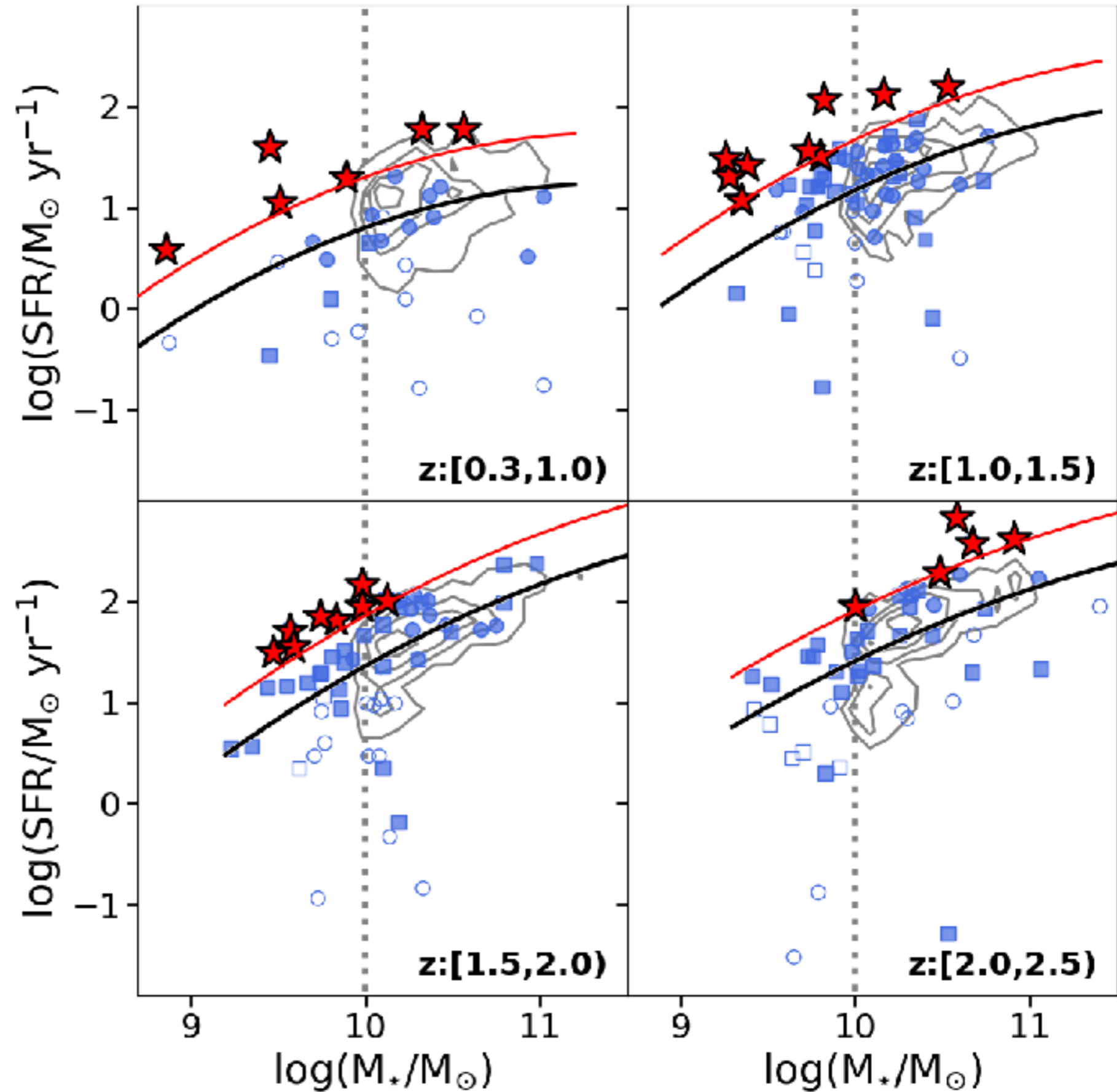
● *Star-forming  
merging  
galaxies*

Includes  
Primary sample

— *MS fit Whitaker+14*



# Comparison SF activity in Mergers & non mergers



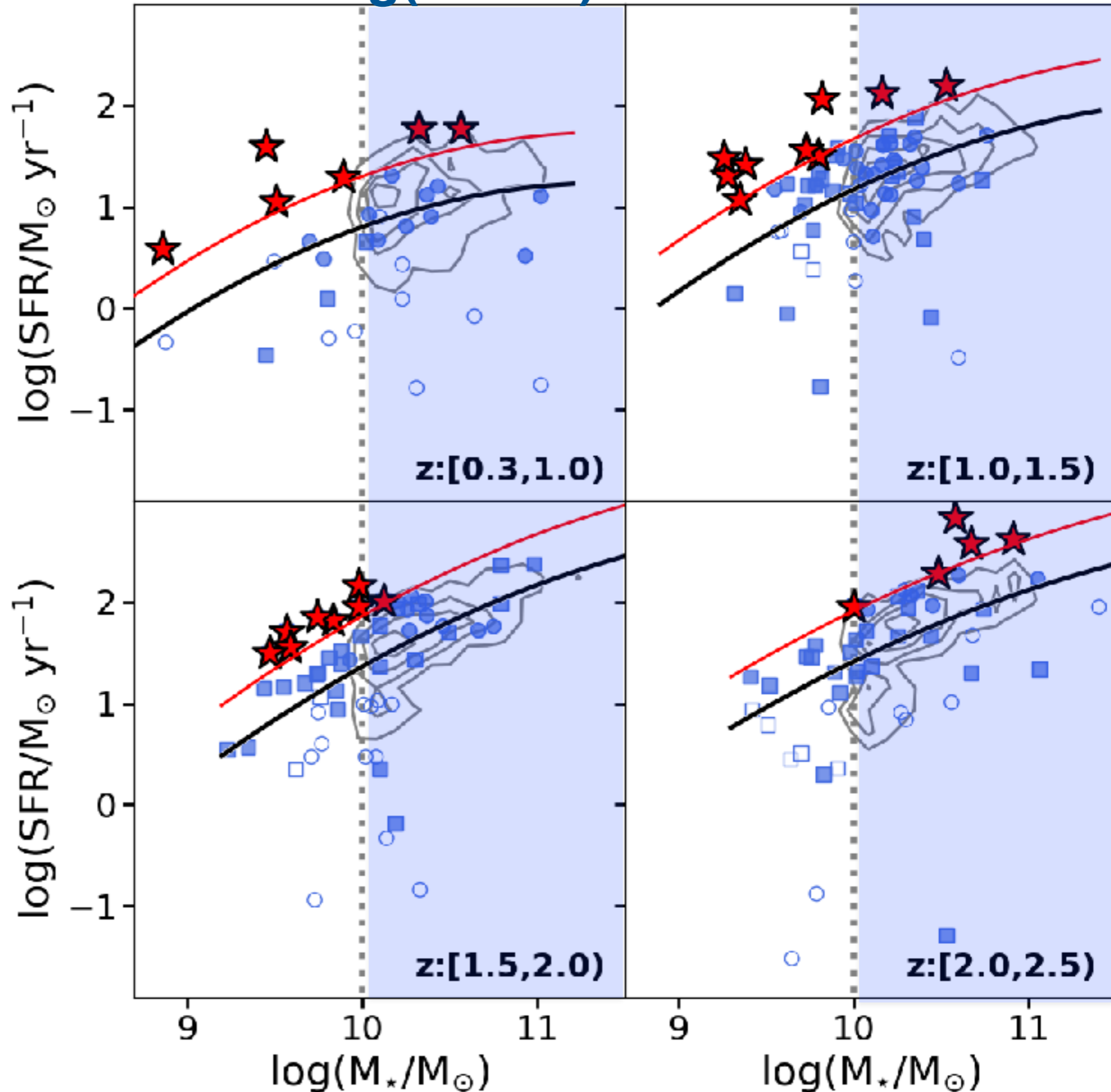
# At masses $\log(M_{\star}/M_{\odot}) > 10$

*KS test: No difference*

*12% of the merger sample are starbursts*

*All the starbursts are dusty SF galaxies and are in wet mergers*

↓  
*High  $f_{\text{gas}}$ ?*

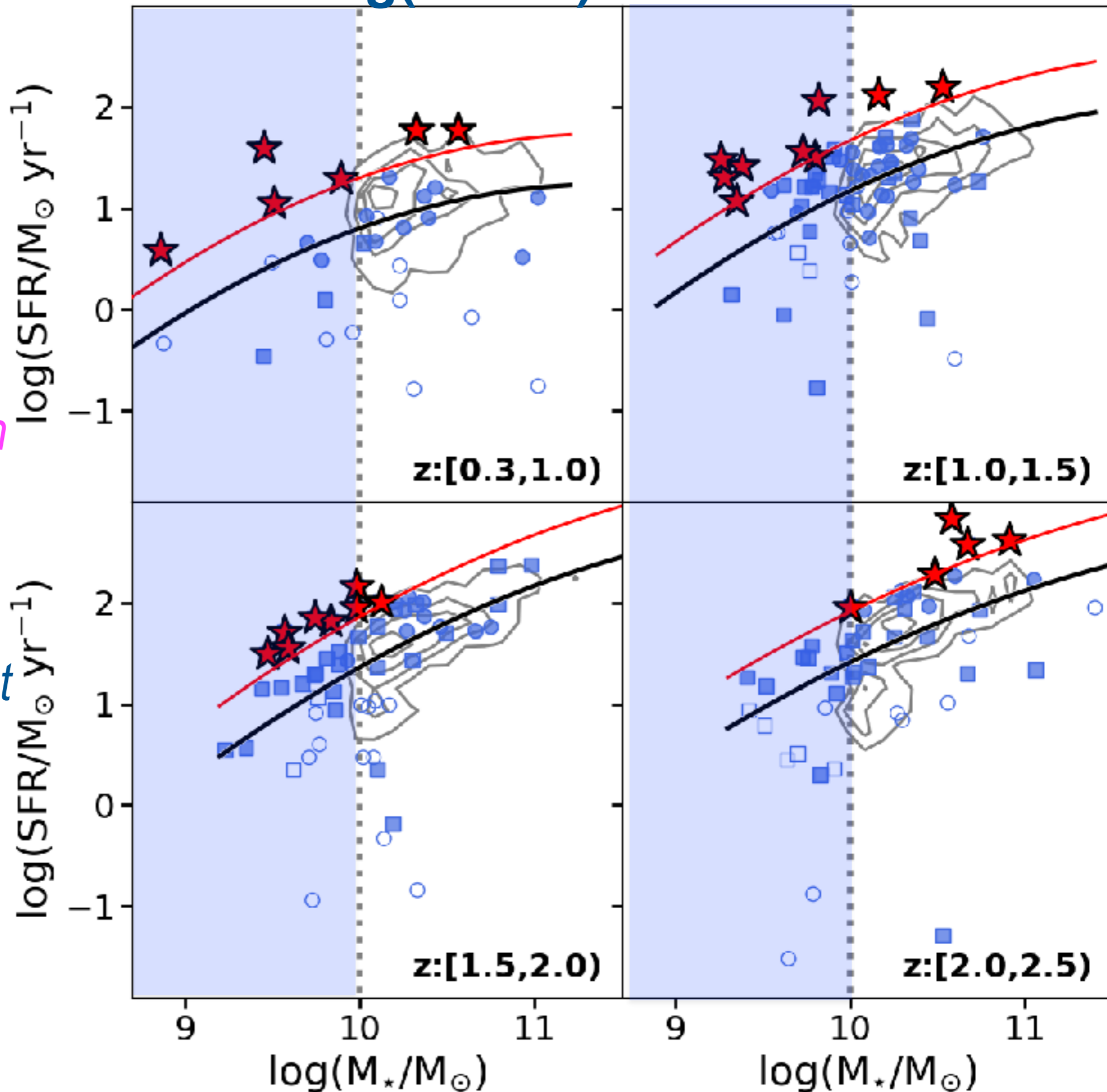


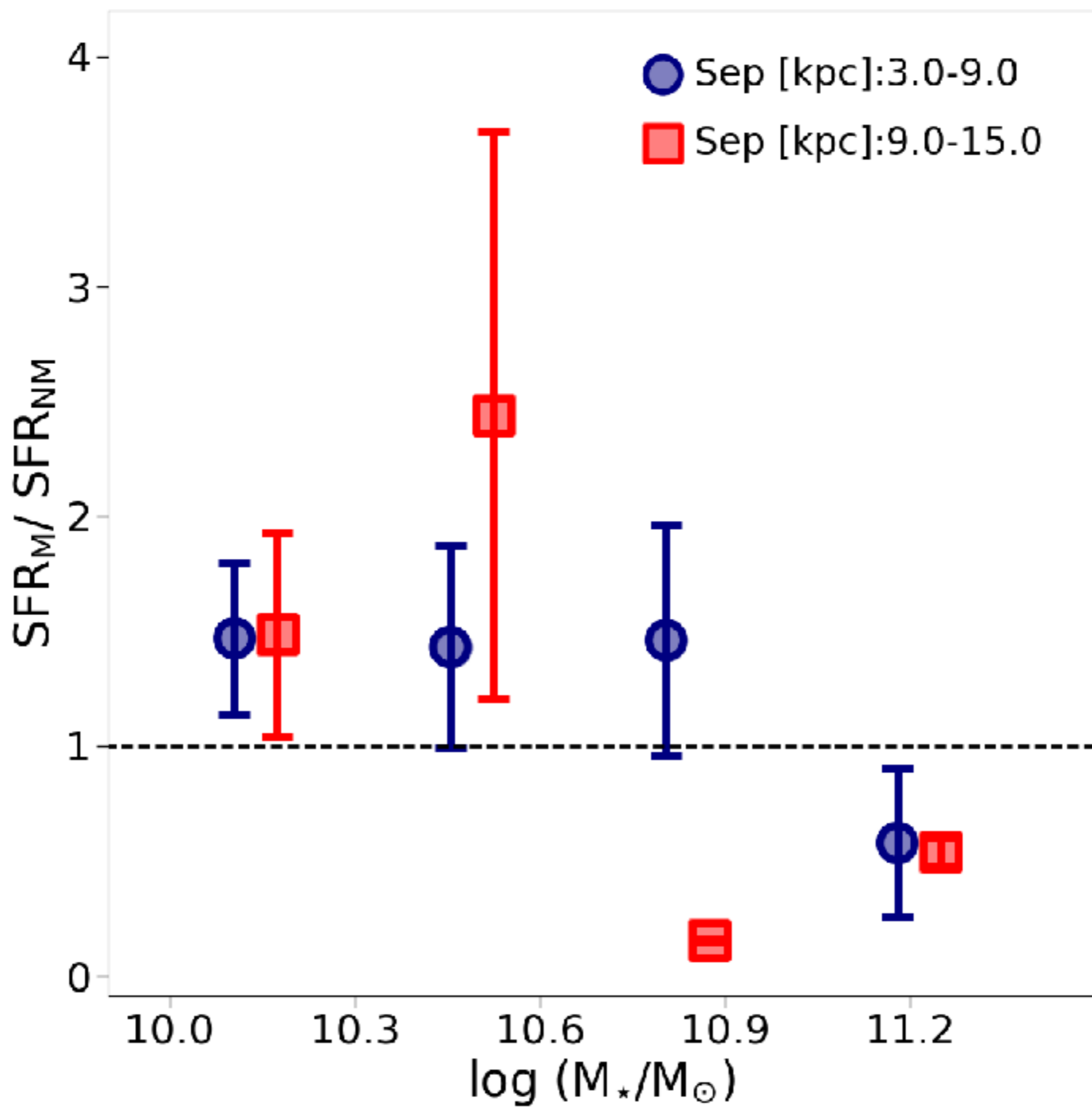
# At masses $\log(M_{\star}/M_{\odot}) < 10$

*KS test: Different population*

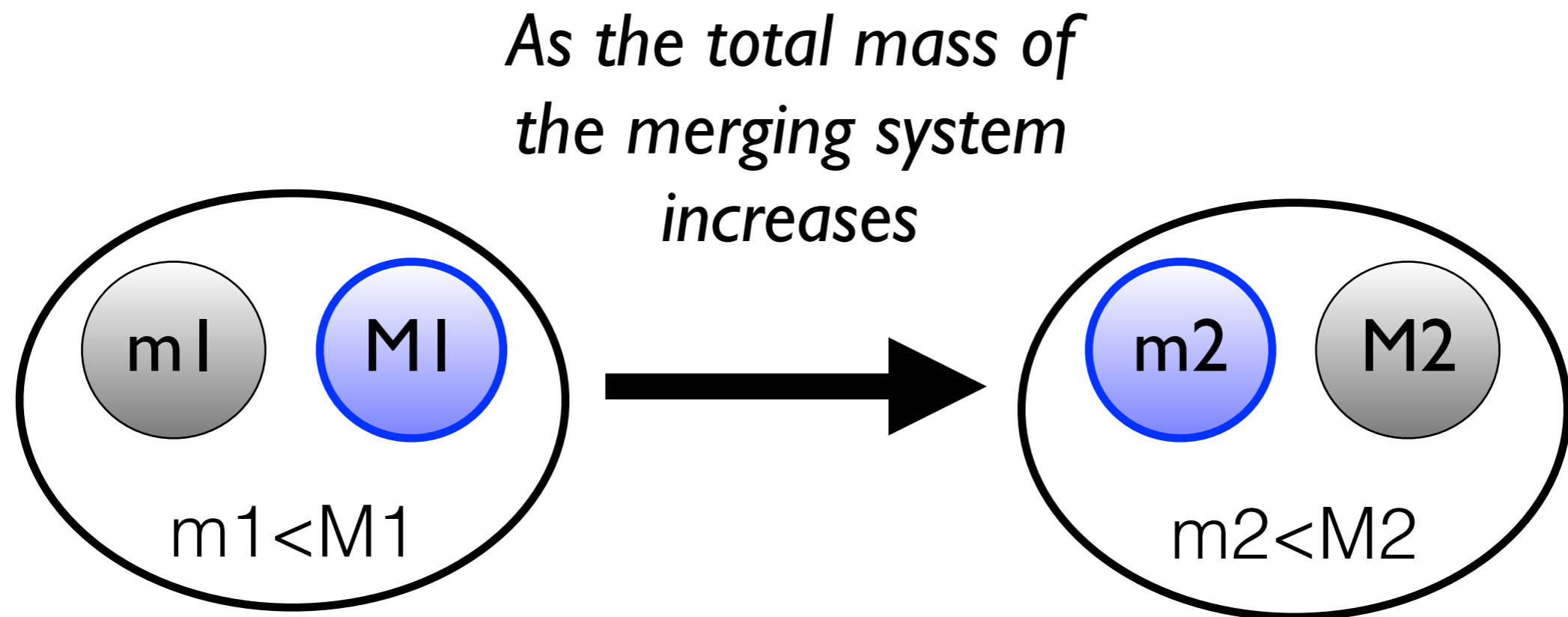
*Higher fraction of starbursts (20%) in merging galaxies*

*Higher enhancement in SF activity in low mass merging galaxies*





# Which of the merging galaxies is more affected?



***The SF activity of the less massive member is more affected***

**% of less massive member have higher sSFR**

Both $\log(M/M) < 10$	31%
One $\log(M/M) > 10$	37%
One $\log(M/M) > 10.5$	56%

# Conclusions

- ❖ *We find no significant difference between the star formation activity in mergers and nonmergers → In agreement with recent simulations (e.g. Fensch+17). This merger sample is still in early stage yet to reach its maximum SF activity*
- ❖ *Lower mass and dusty merging galaxies are more affected by interaction → SF enhancement depends on properties of the galaxies*

*Silva et al. 2018, ApJ 868*