Major Merging in CANDELS:
Galaxy-Galaxy Merger Rates during 0<z<3, Plausible Tensions, and Future Prospects

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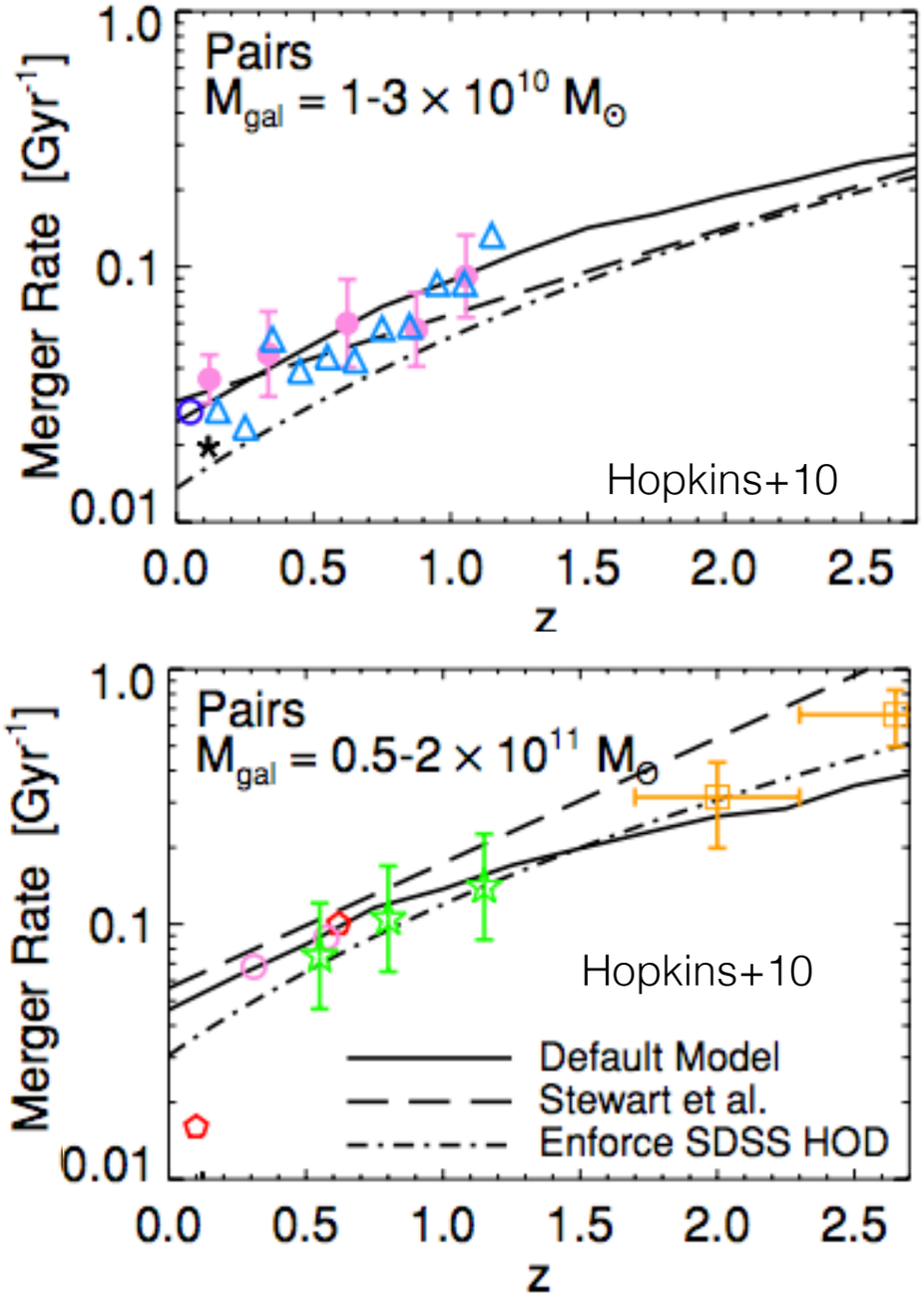
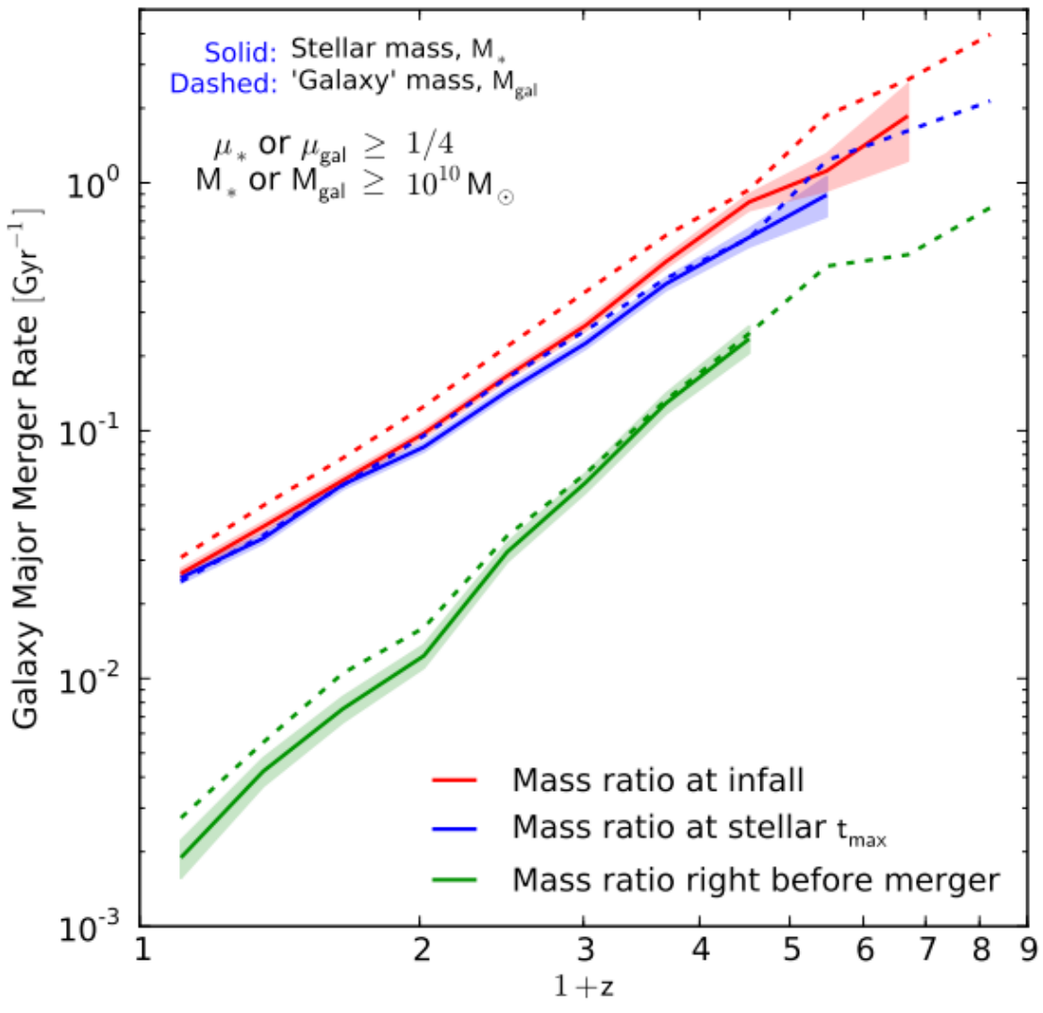
SDSS

Numerical simulations predict increasing Major Merger Rates with increasing redshift





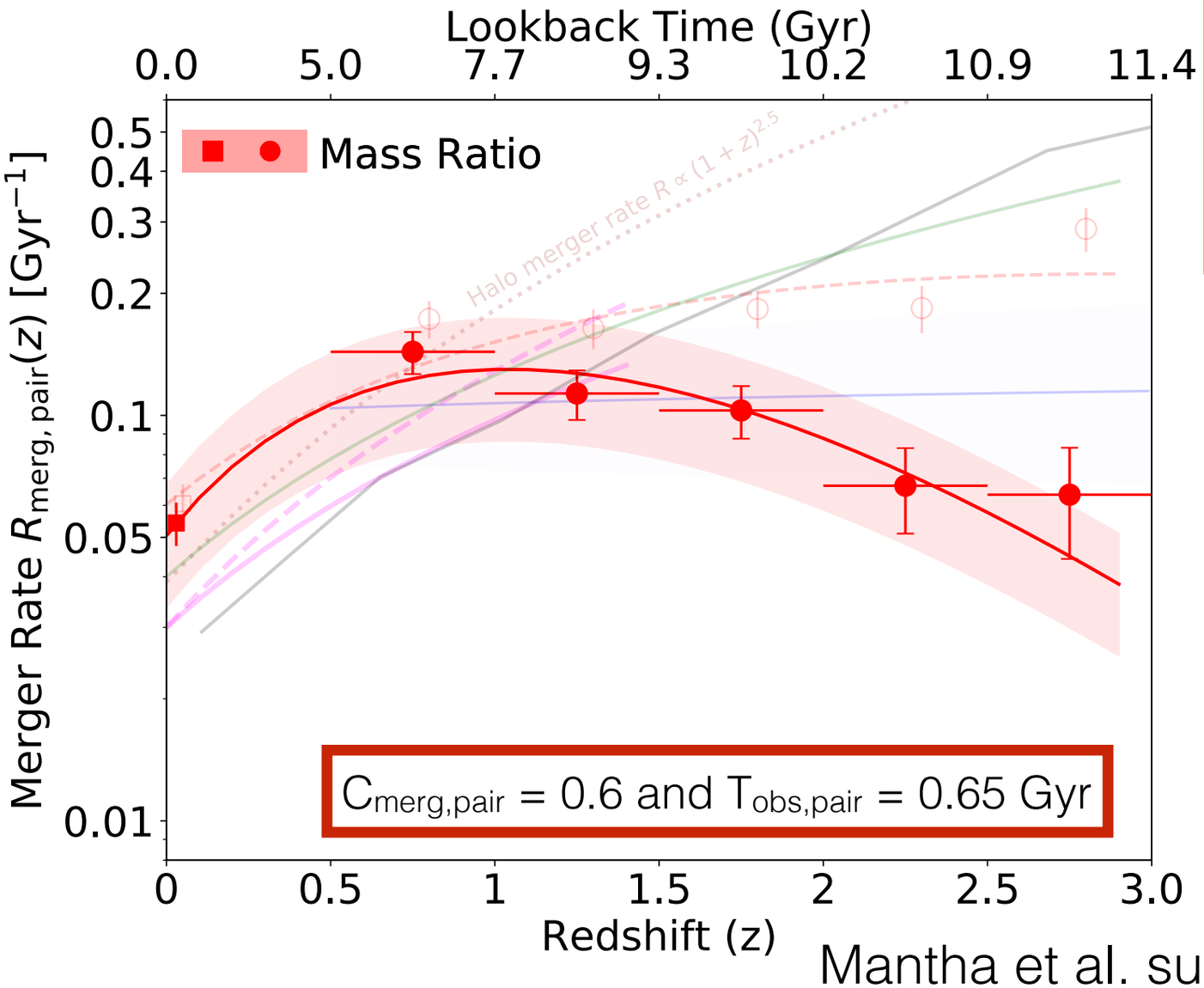
Rodriguez-Gomez+15

Act I :

Empirical Major Merger Rates at 0<z<3

Major Merger Rate vs Redshift:
Stellar Mass Ratio (MR): $1 \leq M_1/M_2 \leq 4$

$$R_{merge,pair} = C_{merg,pair} \times (f_{mc}/T_{obs,pair})$$



Close Companion Fraction (f_{mc}) in the five CANDELS fields and the SDSS:

$\log (M_{stellar}/M_\odot) \geq 10.3$

R_{proj} = 5-50 kpc

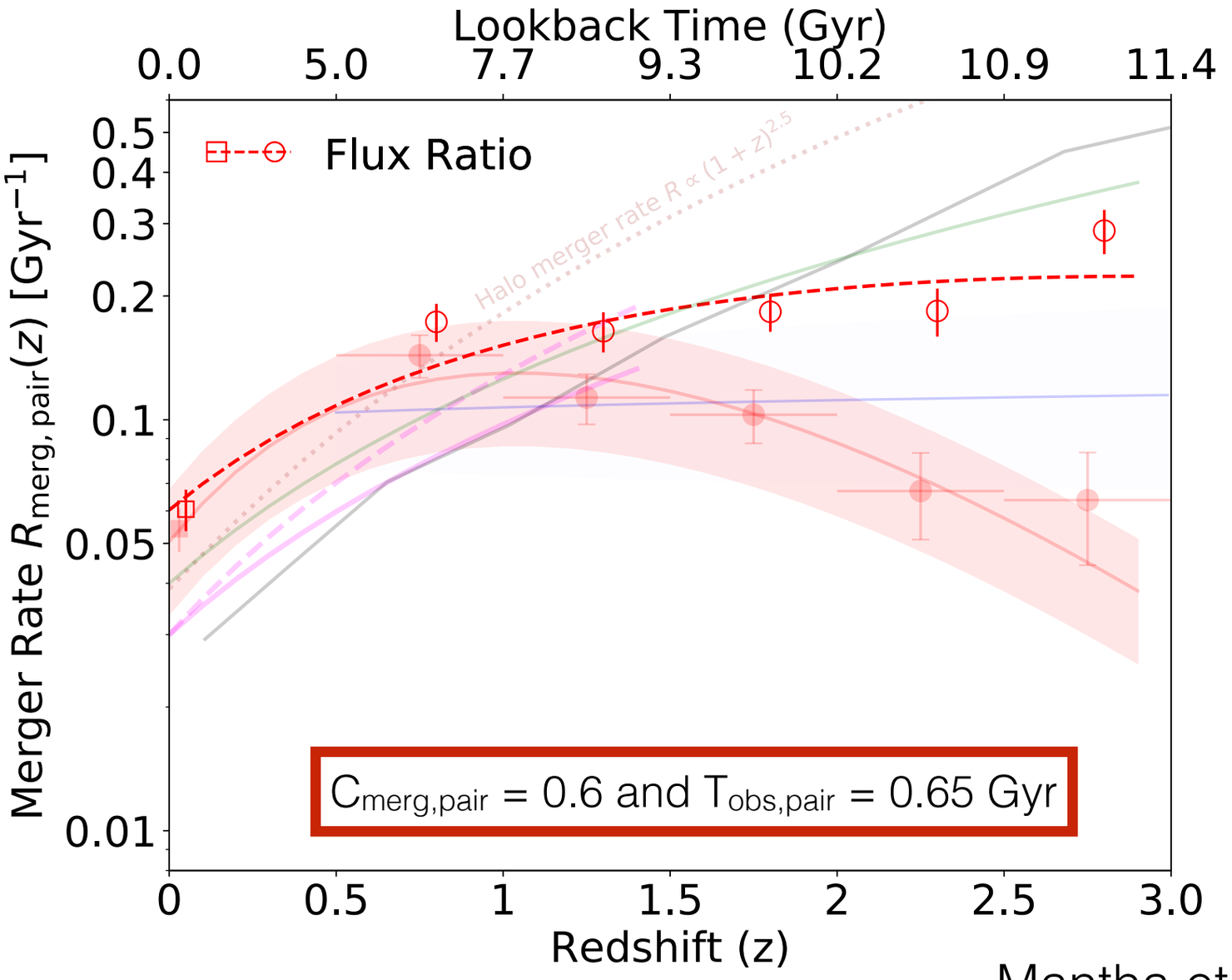
$\Delta z^2_{12} \leq \sigma_1^2 + \sigma_2^2$

Trends are robust to changes in pair selection criteria

Mantha et al. submitted

Major Merger Rate vs Redshift:

H-band Flux Ratio (FR): $1 \leq F_1/F_2 \leq 4$

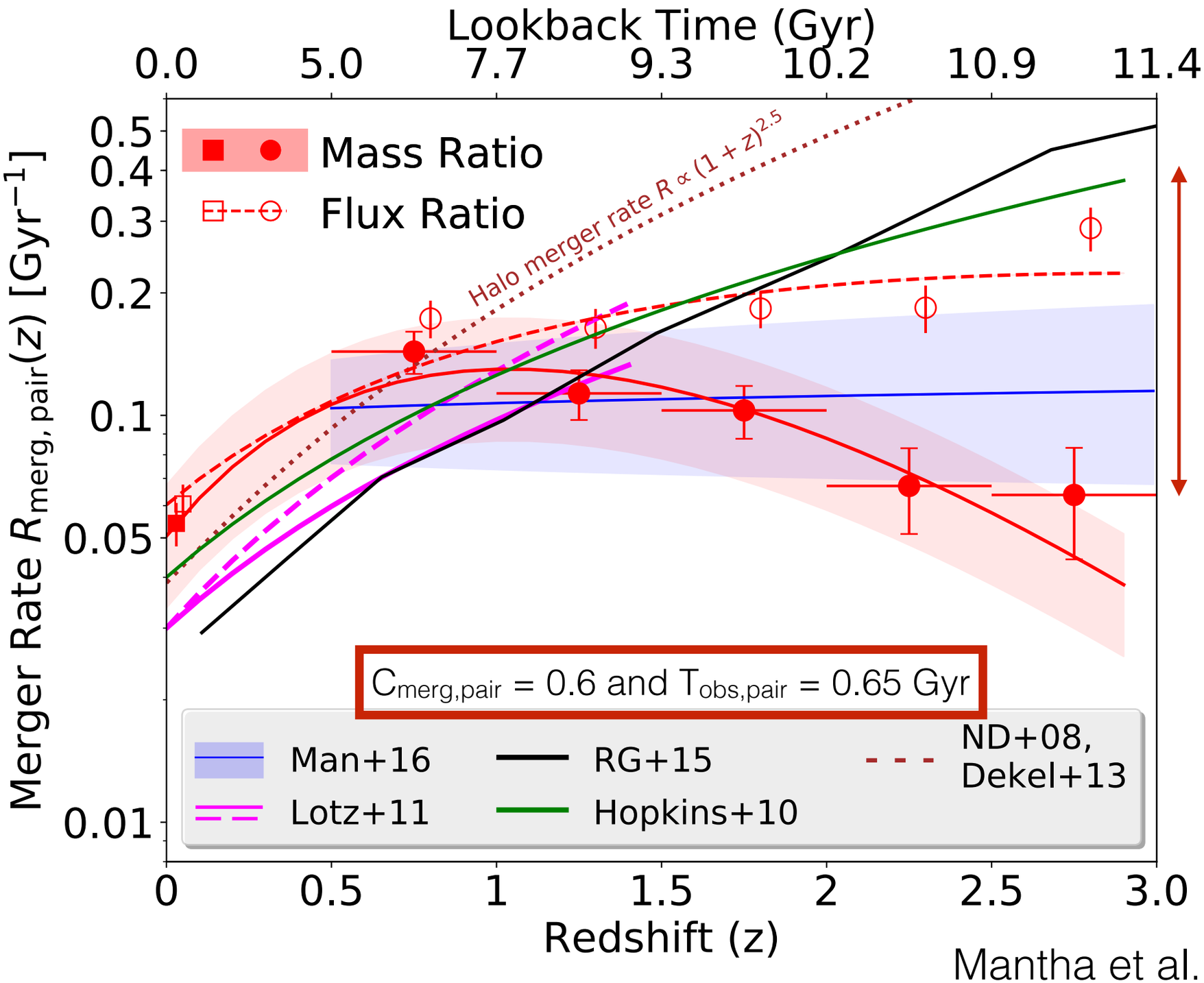


Mantha et al. submitted

Constant Timescale based Rates vs Previous Empirical and Theoretical Studies:

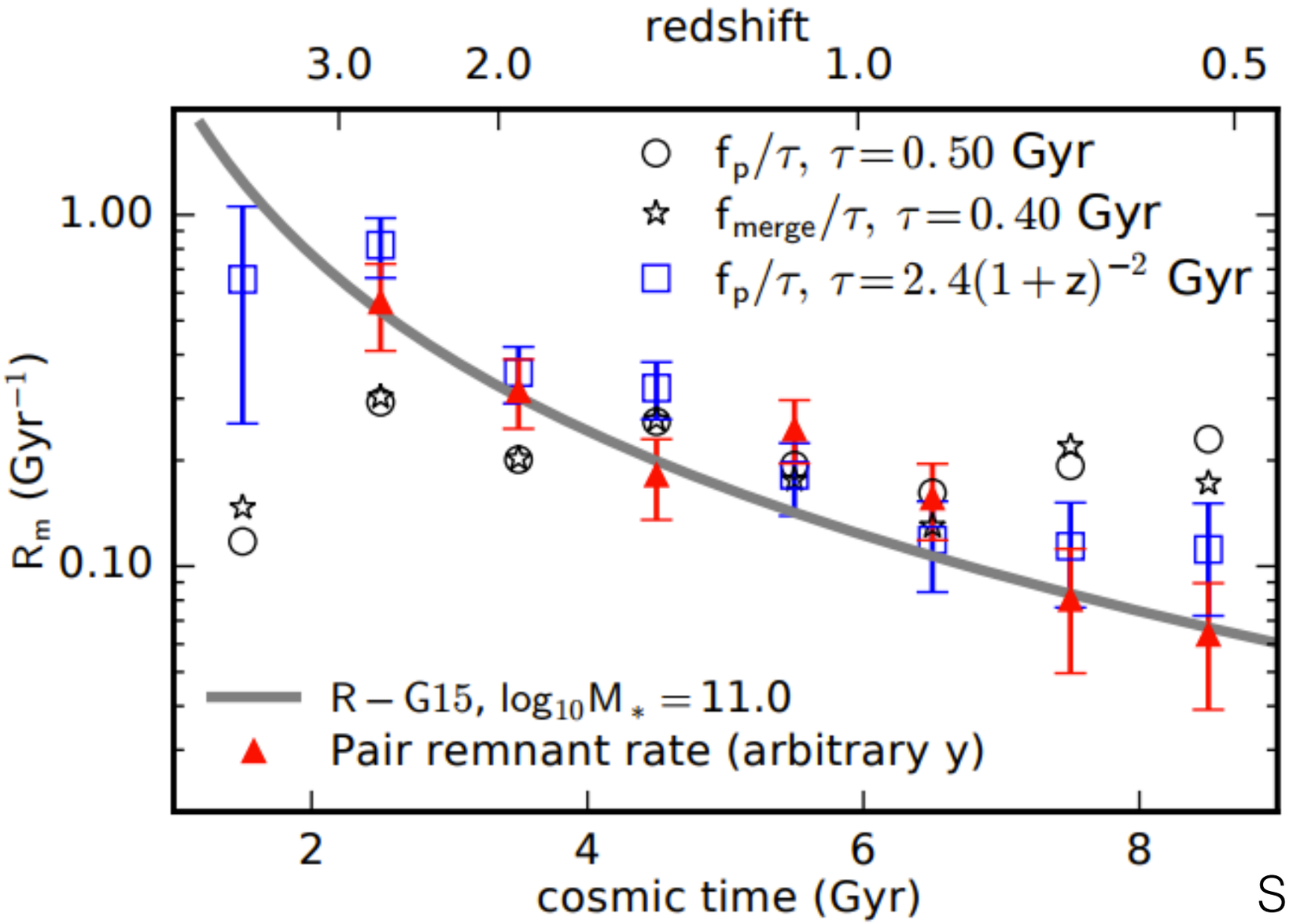
FR broadly agree up to z=3

MR agrees at z≲1.5, but disagrees at z =1.5-3



Mantha et al. submitted

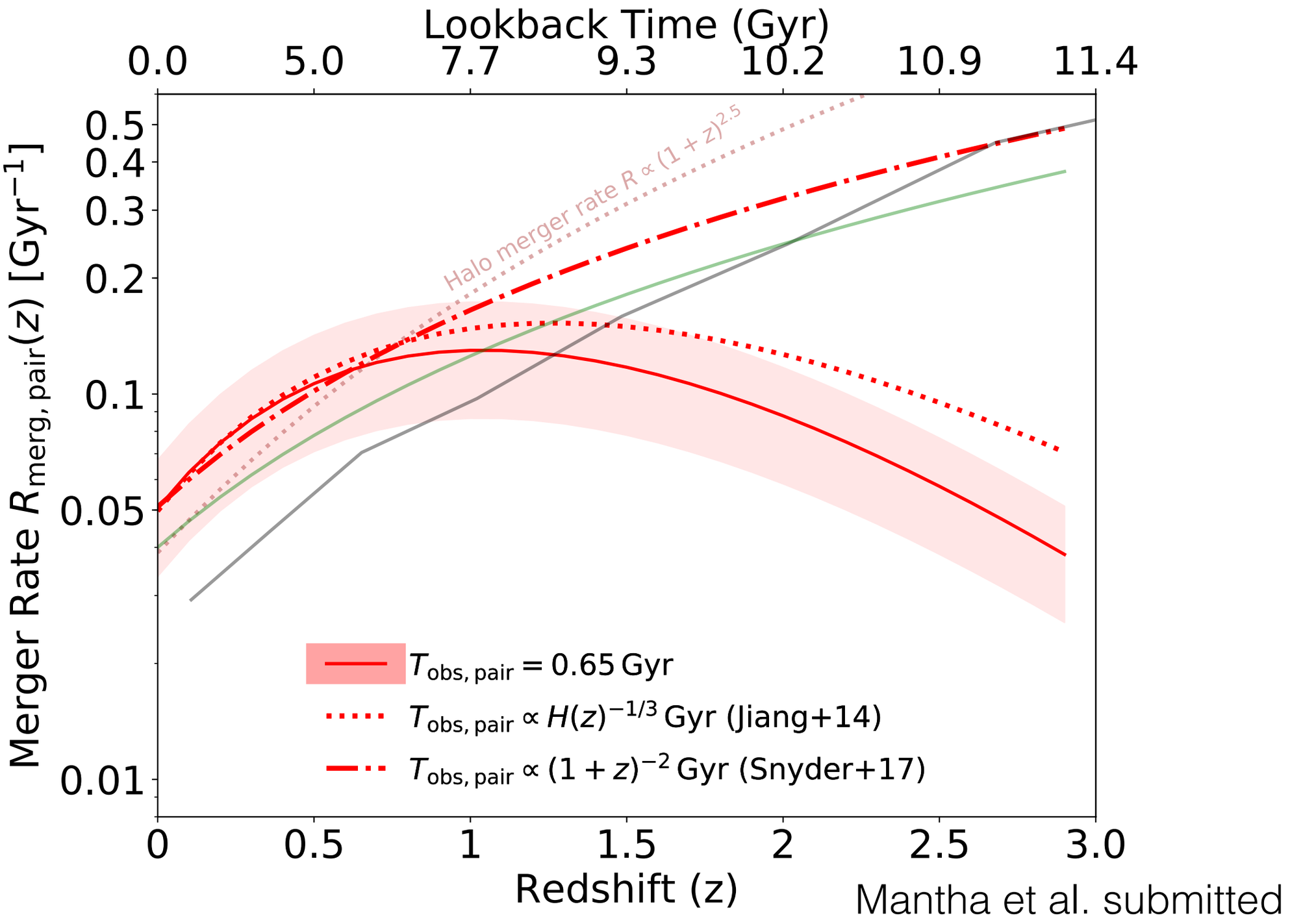
Timescale may be evolving as $T_{obs,pair} \propto (1+z)^{-2}$ to explain theoretical predictions



Snyder+17

Theoretically motivated **Evolving Timescale** Prescriptions:

MR Rates agree with simulations when we use Illustris calibrated $T_{obs,pair} \propto (1+z)^{-2}$



Mantha et al. submitted

Conclusion-I

1. If you trust MR, then timescale may be evolving
2. If you trust FR, then the Timescale may be constant

Timescale	Mass Ratio	Flux Ratio
Constant	Agree at $z<1.5$ Disagree at $z>1.5$	Agrees at $0<z<3$
Evolving as $(1+z)^{-2}$	Agrees at $0<z<3$	Disagrees; They are too high

Act II:

Analyzing Close Pairs in SAMs

(in progress)

We may be limited by the knowledge of $C_{merg,pair}$ and $T_{obs,pair}$ to confidently constrain the Merger Rates

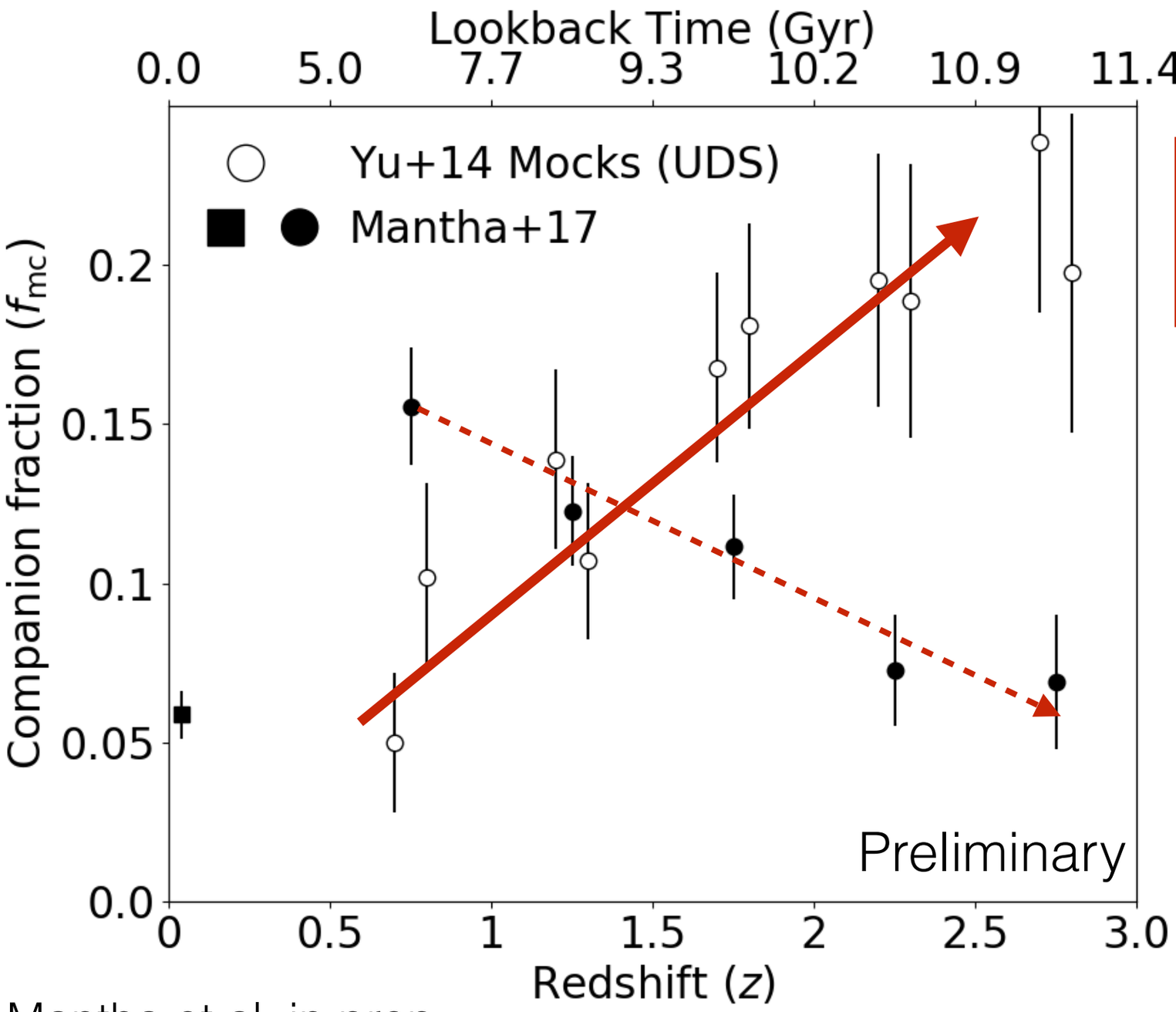
Need for calibrations using SAMs

$$R_{merge,pair} = C_{merg,pair} \times (f_{mc}/T_{obs,pair})$$

$$R'_{merge,pair} = C'_{merg,pair} \times (f'_{mc}/T'_{obs,pair})$$

$$(Quantity)' = Quantity\ (R_{proj,}\ z,\ MR,\ \delta)$$

Analyzing Close Pairs in SAMs :
Rising close pair fraction in SAMs vs Diminishing in CANDELS observations



2x160 sq.arcmin parts in the mock UDS field

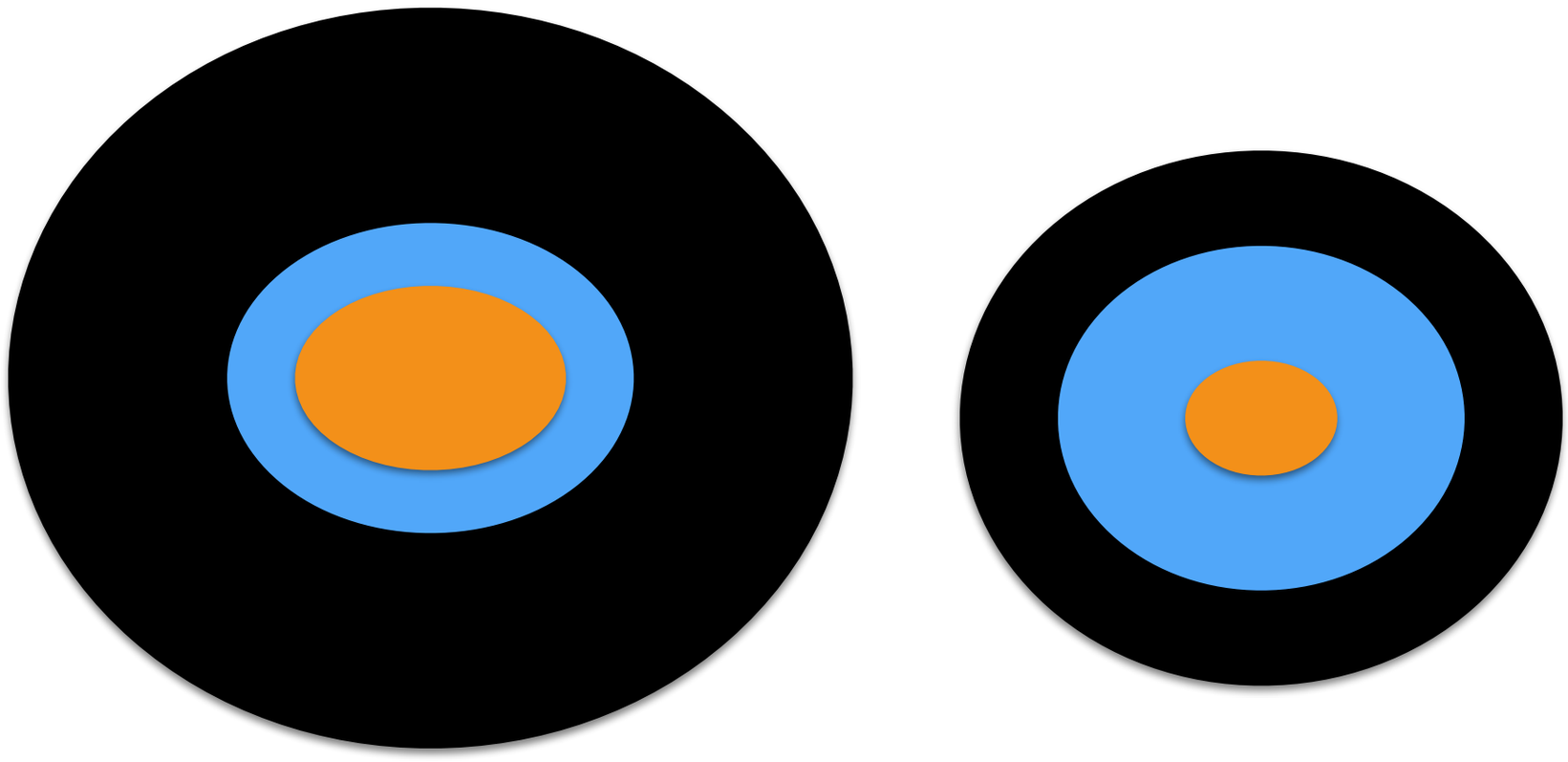
Mantha et al. in prep

Act III:

Halo Mass vs Baryonic Mass vs Stellar Mass

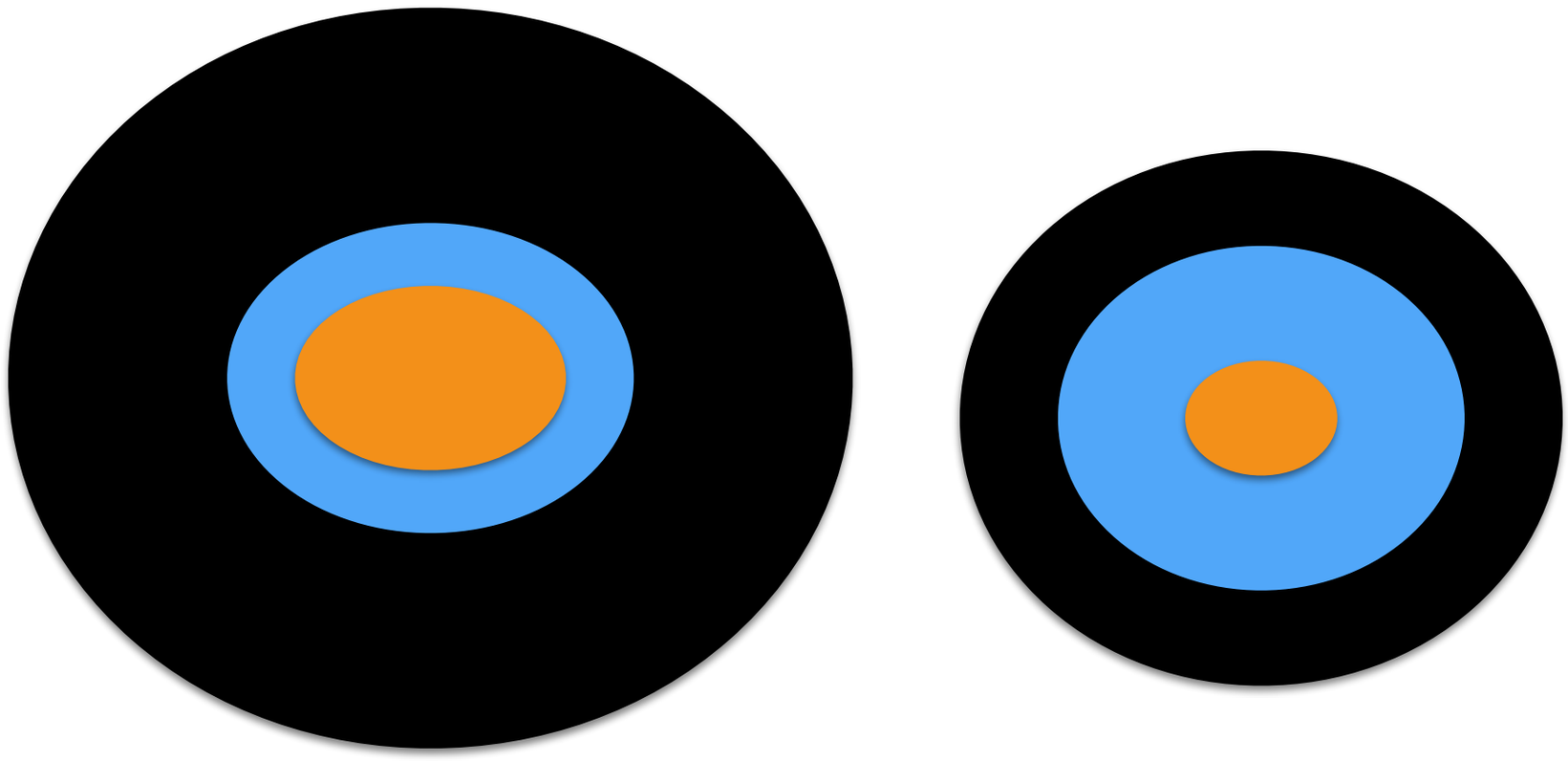
(in progress)

How well does Stellar Mass Ratio represent the underlying Total (Halo+Gas+Stars) Mass Ratio of the Merger?



$M_{DM,1}/M_{DM,2}$ $M_{BM,1}/M_{BM,2}$ $M_{SM1}/M_{SM,2}$

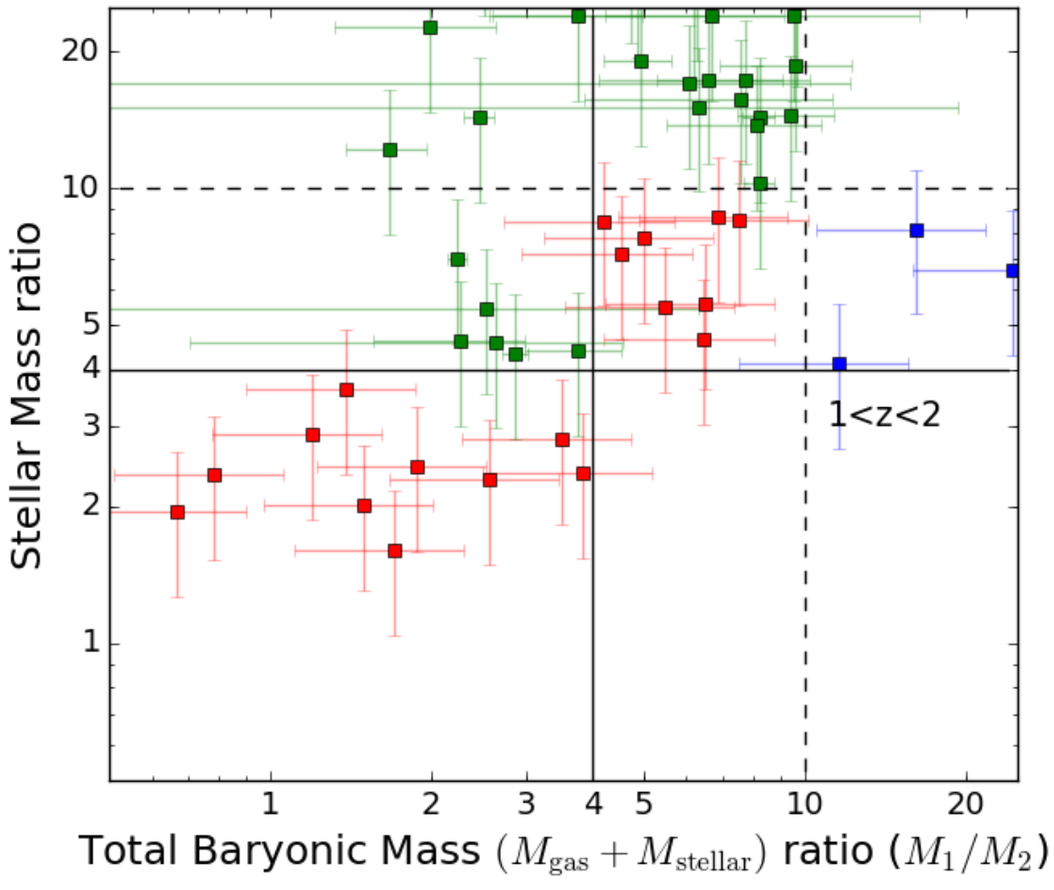
Halo Mass vs Baryonic Mass vs Stellar Mass

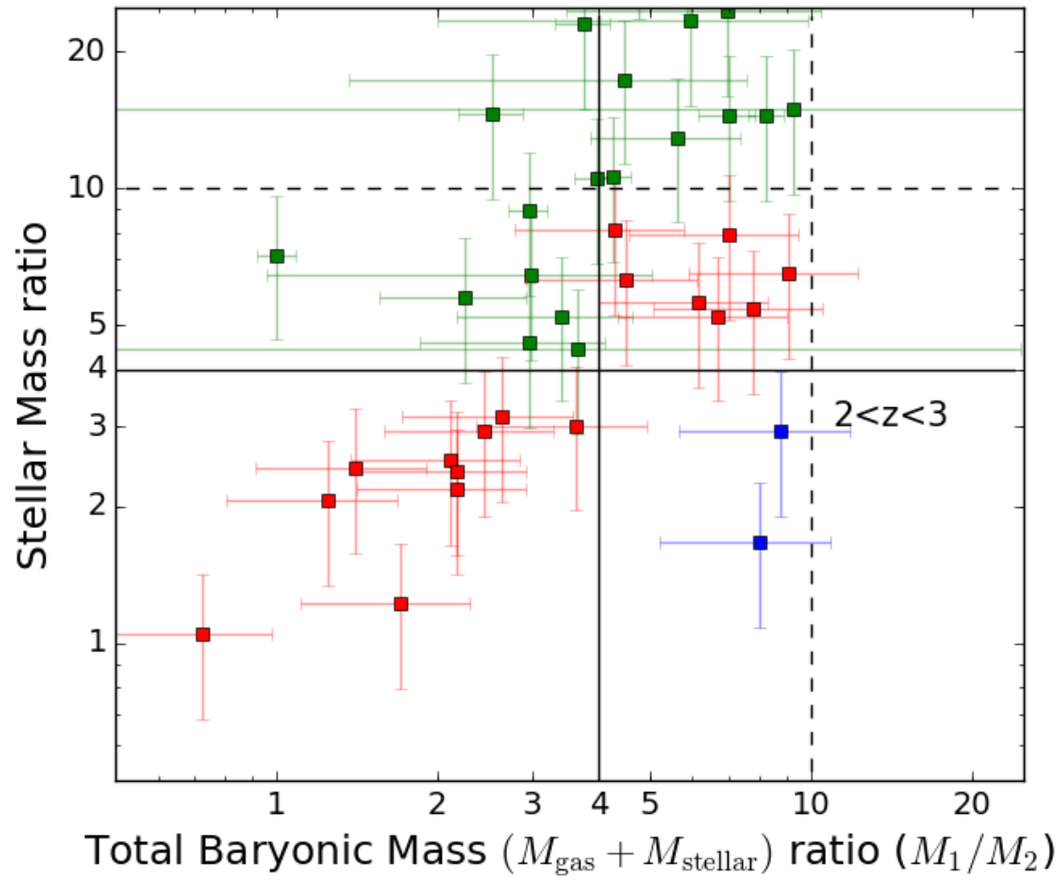


For Example: Speculation that MR>4, but Total Baryonic Mass Ratio (TBR) <4
(see Lotz+11, Man+16)

Possibly first evidence for missing "Major" mergers by using Stellar Mass Ratio

Mantha et al. in prep





Note : Only for galaxies with n<2.5

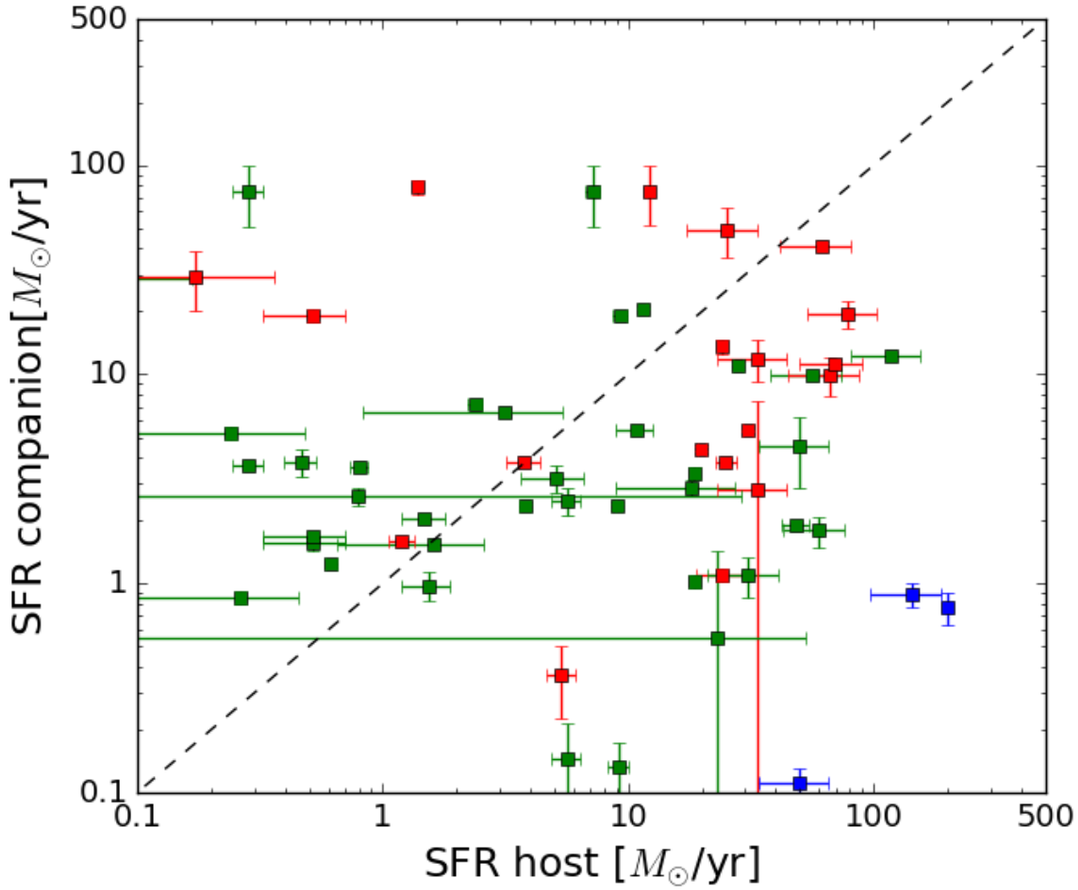
In Collaboration with Popping, Somerville, and Lotz

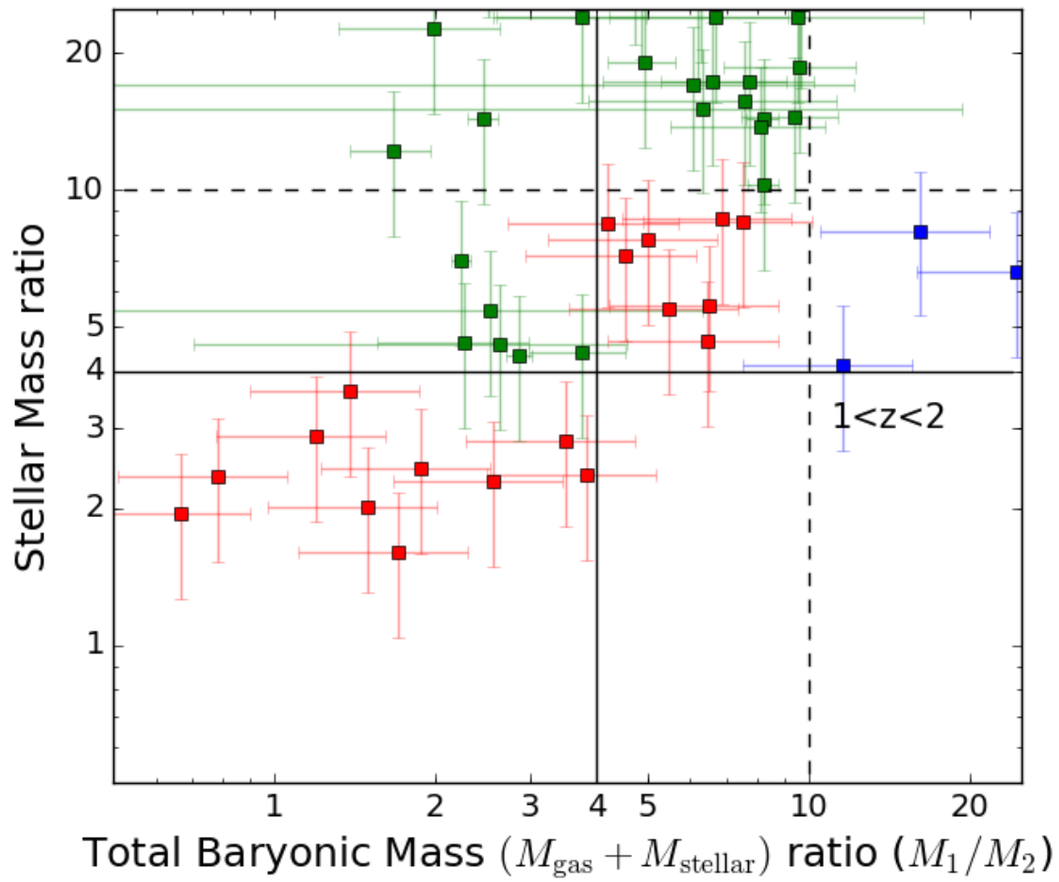
Conclusion and Future

- Act I: Empirical Major Merger Rates at 0<z<3 — MR based estimates agree with simulations if $T_{obs,pair} \propto (1+z)^{-2}$. If $T_{obs,pair}$ = constant, they disagree significantly.
- Act II: Rising close pair fraction towards high redshift. Further investigation is needed.
- Act III: Maybe missing “major” mergers by using stellar-mass ratio.
- **Act IV: See my Sequel Talk on Monday !!!**

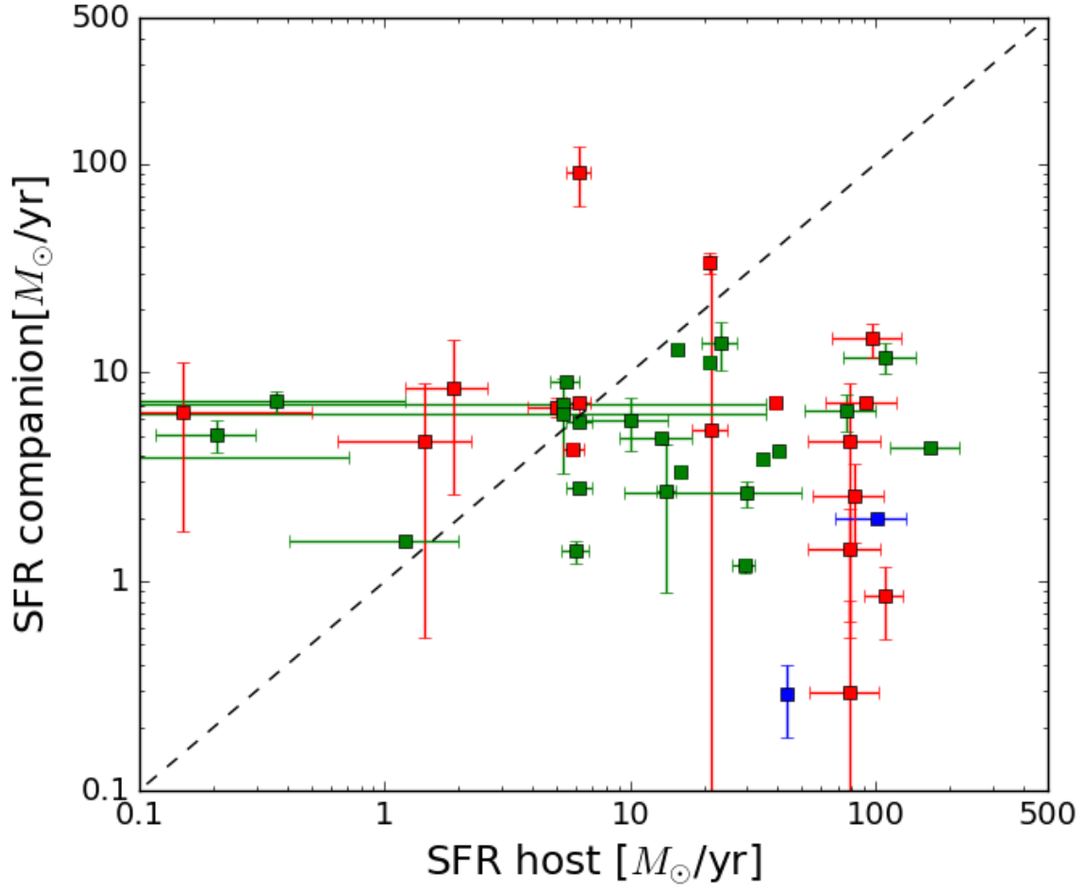
Back up slides

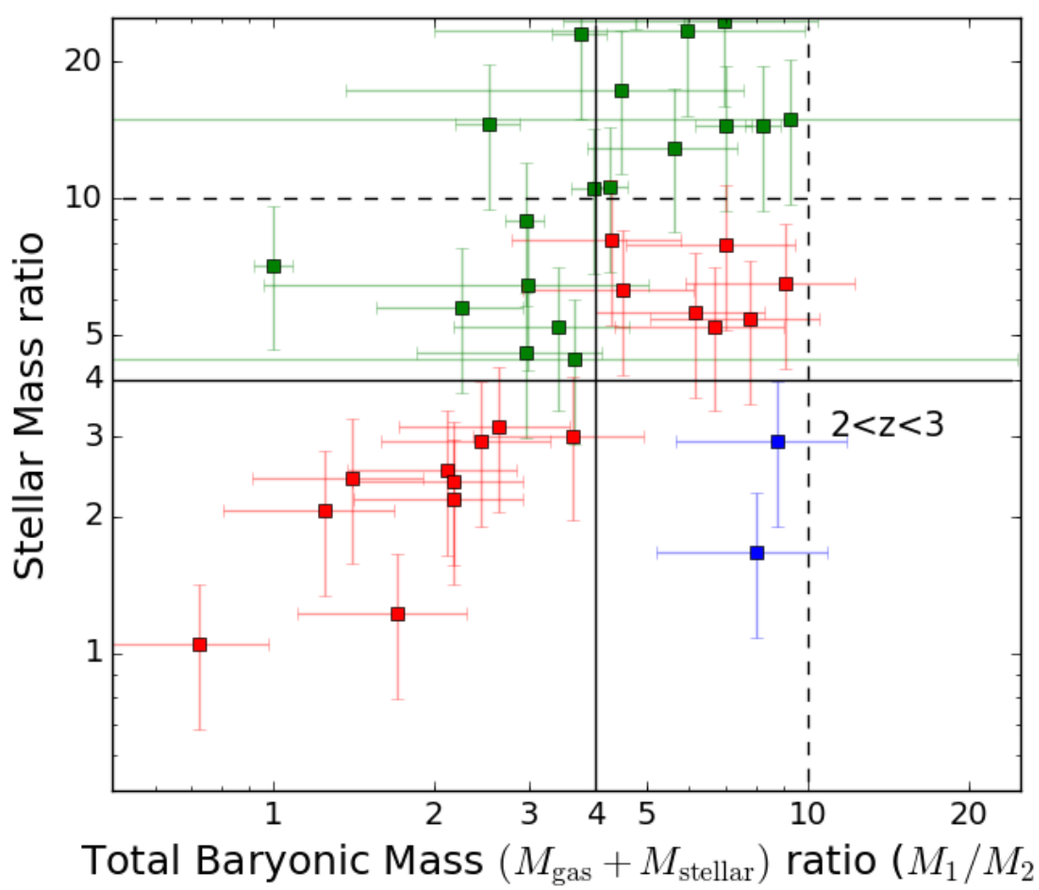
SMR vs BMR with SFRs





SMR vs BMR with SFRs





Flux Ratio vs Stellar Mass Ratio