Star Formation Main Sequence in a Hierarchical Universe

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ABSTRACT

motivation, methodology, impact. In observations star forming galaxies form a tight *log* M_* to *log* SFR relation referred to as the *star formation main sequence* (SFMS) out to $z \sim 2$. Beyond the evolution "along" this SFMS, however, the star formation histories of star forming galaxies have not been precisely characterized. The SFH of these galaxies govern SMF, SFMS, and also observed constraints on the stellar mass to halo mass relation.

By combining high-resolution cosmological N-body simulation with observed evolutionary trends of SF galaxies, we construct a model that tracks the evolution of star forming central galaxies over the redshift $z < 1$. Comparing this model

Observations find a remarkably small scatter in the stellar mass to halo mass relation. Somehow the star formation histories of galaxies must

According to observations, star forming galaxies form a tight *log* M_* to *log* SFR relation referred to as the "star formation main sequence" out to $z \sim 2$.

Subject headings: **methods: numerical – galaxies: clusters: general – galaxies: groups: general – galaxies: evolution – galaxies: haloes – galaxies: star formation – cosmology: observations.**

Checklist

- Check the correlation between halo growth rate with different t_{delay} and δt_{abias} with the total halo growth rate between $z \sim 0$ and $z \sim 1$.

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1. Introduction

- Motivate why we think SF galaxies evolve along the main sequence
- Discuss the current thought process on galaxy assembly bias
- Explain the limitation of SFH derivable from observations (Claire's fisher matrix paper would be really good; ask her about the details)
- Observations also can't provide detail host dark matter halo properties
- So the approach with combining observations with N-body (empirical modeling) is very effective in the context of the halo.
- Maybe talk about how the bigger context of why this is important?
- Why only centrals – because our current best understanding of satellites is that they quench after infall, so it doesn't make sense to look at them

2. Central Galaxies of SDSS DR7

We construct our galaxy sample following the sample selection of Tinker et al. (2011). We select a volume-limited sample of galaxies with $M_r 5 log(h) < 18$ and complete in $M_* > 10^{9.4} M_\odot$ from the NYU Value-Added Galaxy Catalog (VAGC; Blanton et al. 2005) of the Sloan Digital Sky Survey Data Release 7 (SDSS DR7; Abazajian et al. 2009) at $z \approx 0.04$. The stellar masses of these galaxies are estimated using the `kcorrect` code (Blanton & Roweis 2007) assuming a Chabrier (2003) initial mass function. The star formation of the galaxies are estimated spectroscopically using the specific star formation rates (SSFR) from the current release of the MPA-JHU spectral reductions[1] (Brinchmann et al. 2004). Generally speaking, SSFR $> 10^{-11}\mathrm{yr}^{-1}$ are derived from H_α emission, $10^{-11} >$ SSFR $> 10^{-12}\mathrm{yr}^{-1}$ are derived from a combination of emission lines, and SSFR $< 10^{-12}\mathrm{yr}^{-1}$ are based on $D_n 4000$ (see discussion in Wetzel et al. 2013). We note that SSFR $< 10^{-12}\mathrm{yr}^{-1}$ should only be considered upper limits to the true galaxy SSFR (Salim et al. 2007).

From our galaxy sample, we identify the central galaxies using the Tinker et al. (2011) halo-based group-finding algorithm, which is based on the **?** algorithm and tested in Campbell et al. (2015). The algorithm assigns a probability of being a satellite galaxy, P_sat, to each galaxy in the sample. Galaxies with $P_\mathrm{sat} \geq 0.5$ are classified as satellites and $P_\mathrm{sat} < 0.5$ are classified as centrals.

In this paper we focus on central galaxies. In any group finding algorithm, galaxies are misassigned due to projection effects and redshift space distortions. The purity of the full

[1] http://wwwmpa.mpa-garching.mpg.de/SDSS/DR7/

central galaxy sample is $\sim 90\%$ with a completeness of $\sim 95\%$ (Tinker et al. 2017). Furthermore, Campbell et al. (2015) find that the algorithm robustly identifies red and blue centrals as a function of stellar mass, which is highly relevant to our analysis.

Wetzel et al. (2012) Wetzel et al. (2013) Wetzel et al. (2014)

Figure 1

2.1. Simulated Central Galaxies

abridged version of the same section Davis et al. (1985) Hahn et al. (2017) Li & White (2009)

2.2. Selecting $z \sim 0$ Star Forming Central Galaxies

- Describe how f_{SFMS} is calculated. Reference to Tjitske in prep
- Then explain how it's not circular because the integrated M_* has to reproduce the same SMF

2.3. Evolving along the Main Sequence

- Talk about the SFR and M_* prescriptions
- parameterization of SFMS
- explicitly talk about the free parameters of the model.
- priors for β_M and β_z encompass the observable constraints
- talk about inference using ABC

3. Results

3.1. The duty cycle of star formation

- Figure that illustrates the fit to observables
- Figure of sigma M star as a function of duty cycle compared to observations

3.2. The need for a galaxy assembly bias

- discuss how t_{duty} is not enough to be consistent with σ_{M_*}.

- first clarify what you mean by galaxy assembly bias
- discuss implementation of galaxy assembly bias
- Figure (pedagogical) of dlogSFR versus dMh dt for different correlation amounts
- Figure of different tdelay and dtabias
- Figure of sigma M star as a function of duty cycle and realistic dt abias and t delay

4. Discussion

4.1. Rethinking the Main Sequence?

- Test the SMHMR for Louis's SFHs

5. Summary

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Louis Abramson

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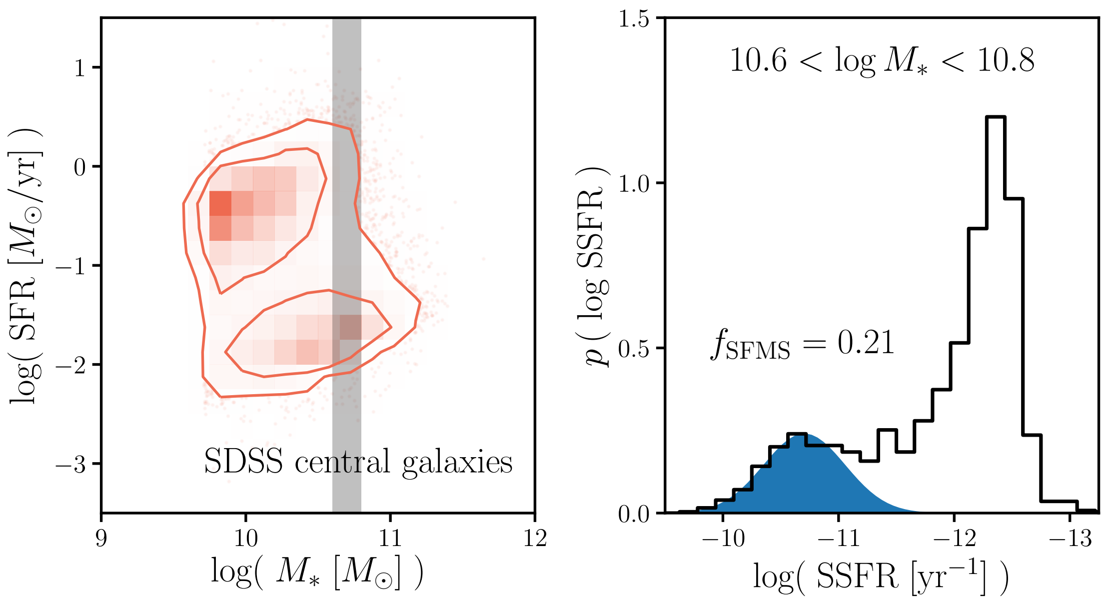

Fig. 1.— SDSS DR7 Group Catalog. Fitting of the SFMS.

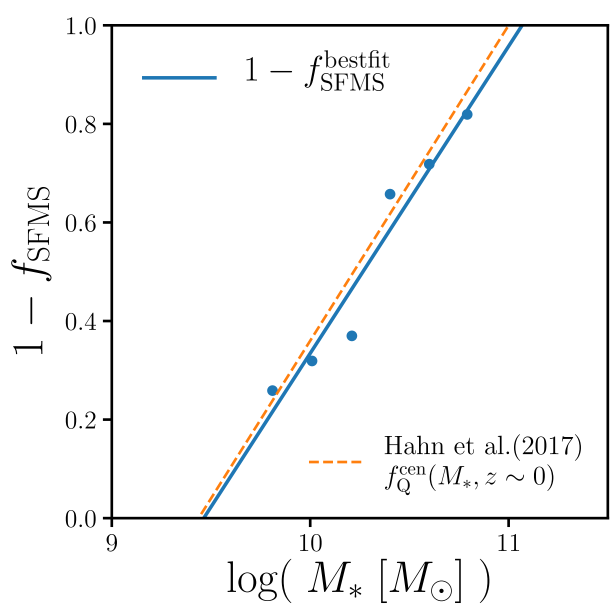

Fig. 2.— SFMS fraction versus quiescent fraction from Hahn

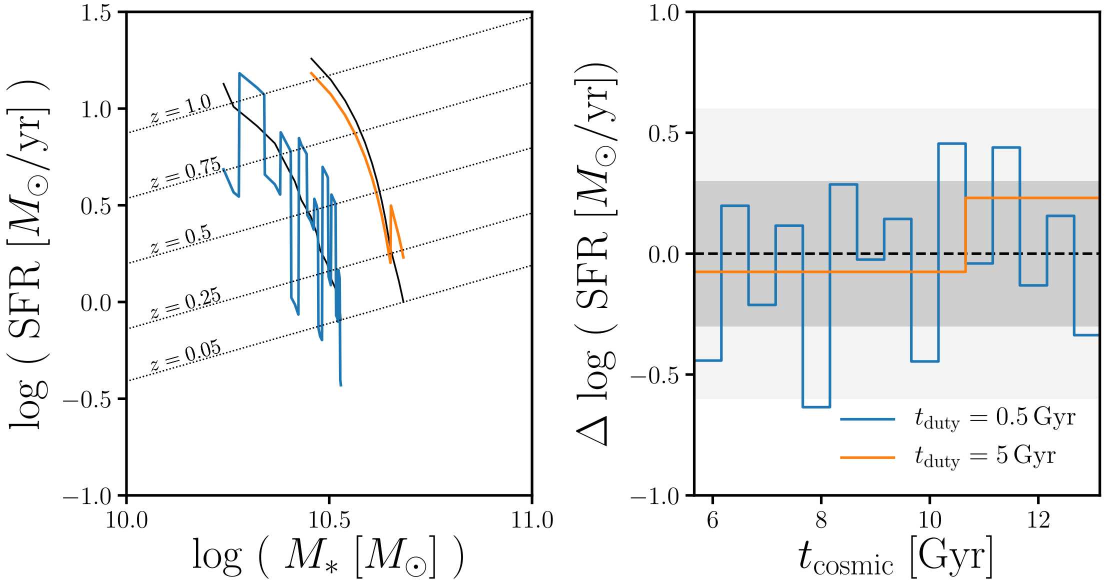

Fig. 3.— Pedagogical figure that illustrates how star forming central galaxies in our model evolve along the SFMS.

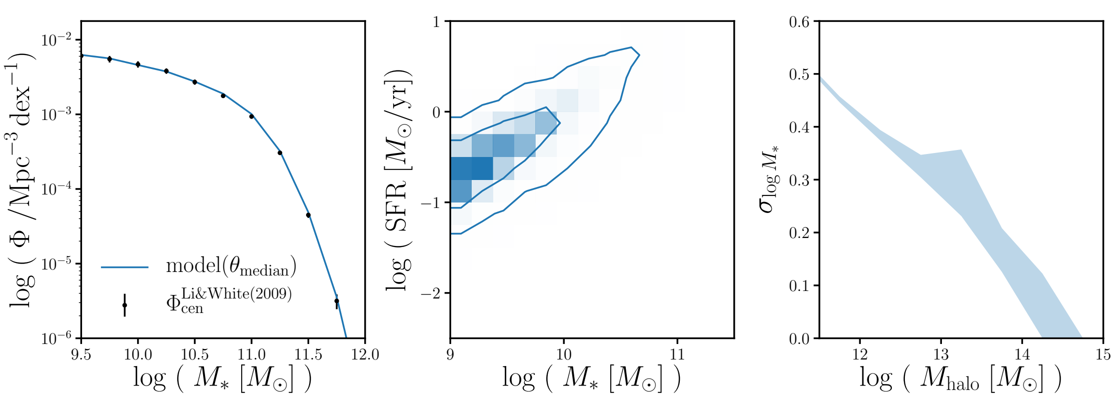

Fig. 4.—

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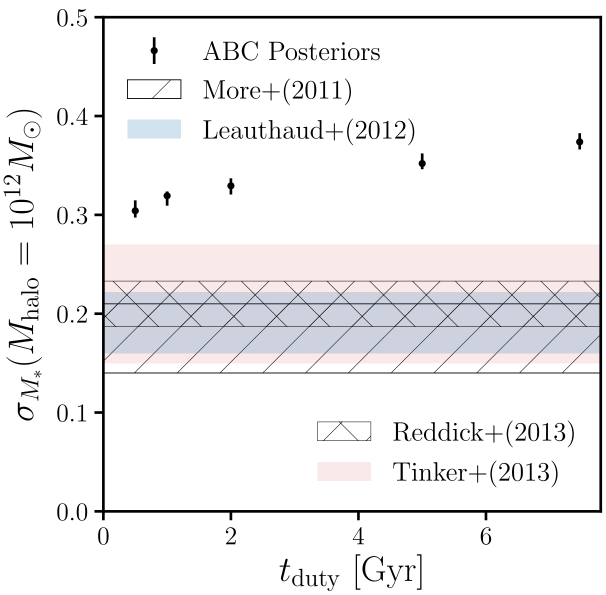

0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
ABC Posteriors
More+(2011)
Leauthaud+(2012)
Reddick+(2013)
Tinker+(2013)
$\sigma_{M_*}(M_{\rm halo} = 10^{12} M_\odot)$
$t_{\rm duty}$ [Gyr]

Fig. 5.—