The Quenching of Star Formation:
Structure vs. Halo

Joanna Woo

The Hebrew University of Jerusalem (HUJI)

Avishai Dekel (HUJI)
Sandra Faber (UCSC)
David Koo (UCSC)
et al.

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Quenching Models

Centrals:

- Virial shock heating in halos > $M_{crit} \sim 10^{12}\ M_{\odot}$ } Halo
- AGN heating } Galaxy + Halo
- Gaseous inflow to a compact bulge ➞ starburst ➞ gas exhaustion
  - Major mergers
  - Inflow within gravitationally unstable disc
- Morphological quenching: bulge stabilises the disc

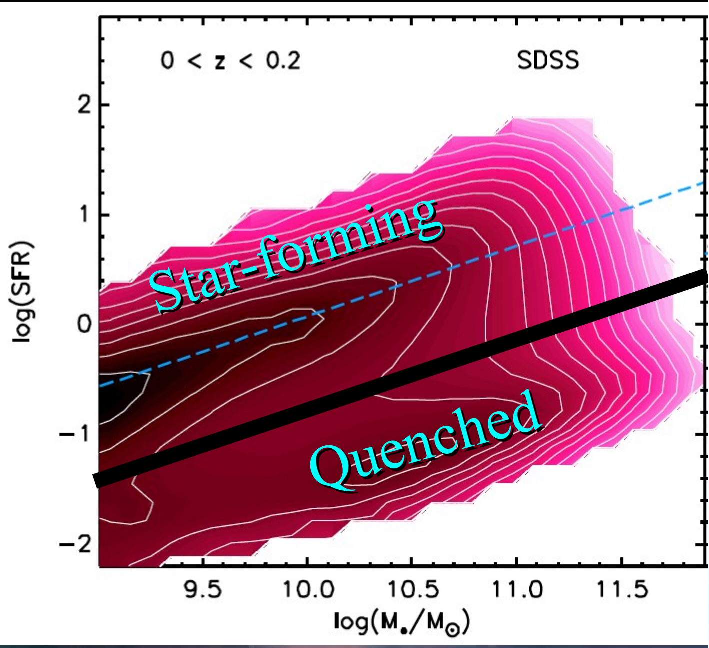
} Galaxy

Satellites:

- Ram pressure stripping: gas (strangulation)
- Tidal stripping: gas and stars
- Harrassment: high speed interactions

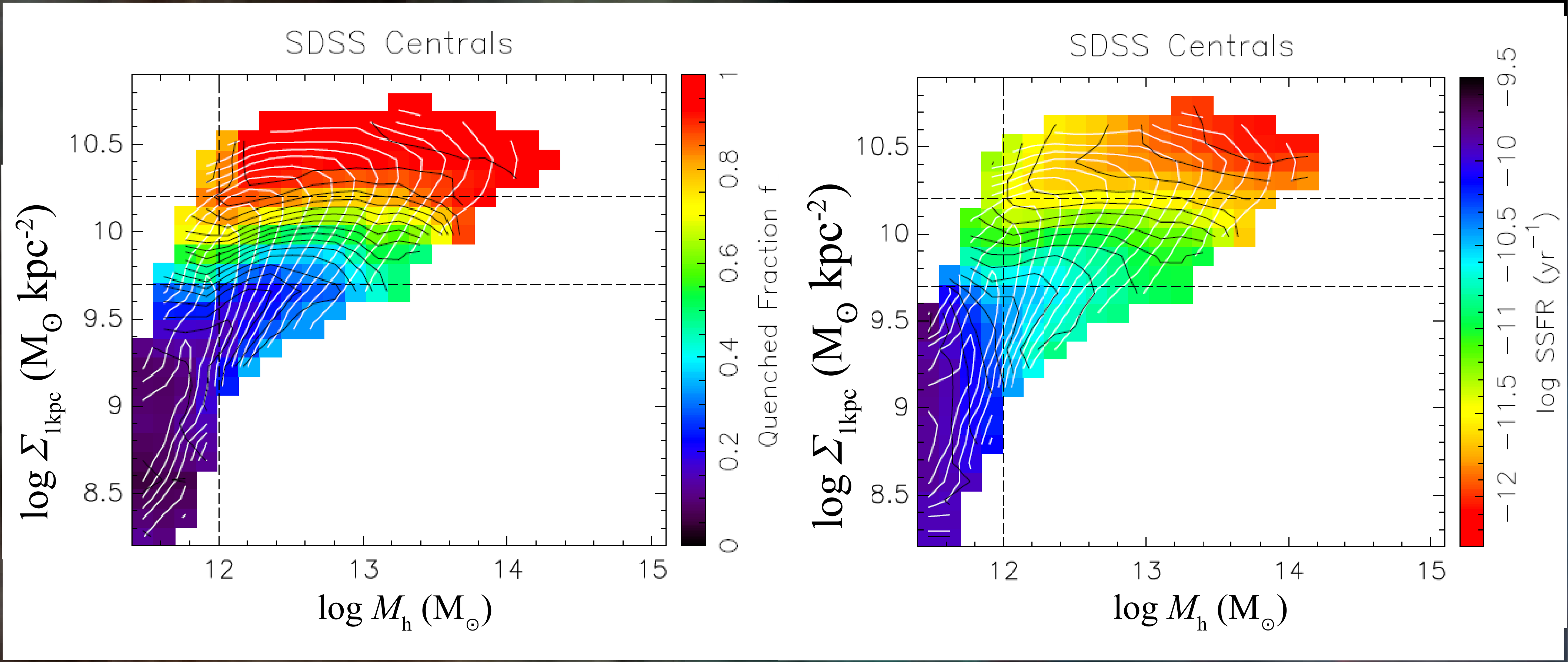
Description of Data

- SDSS DR7: $0 < z < 0.2$
- Quenching = low SFR; $\sigma \sim 0.2$ dex
  - Brinchmann et al. (2004) (spectral lines + photometry)
  - Incorporates dust model

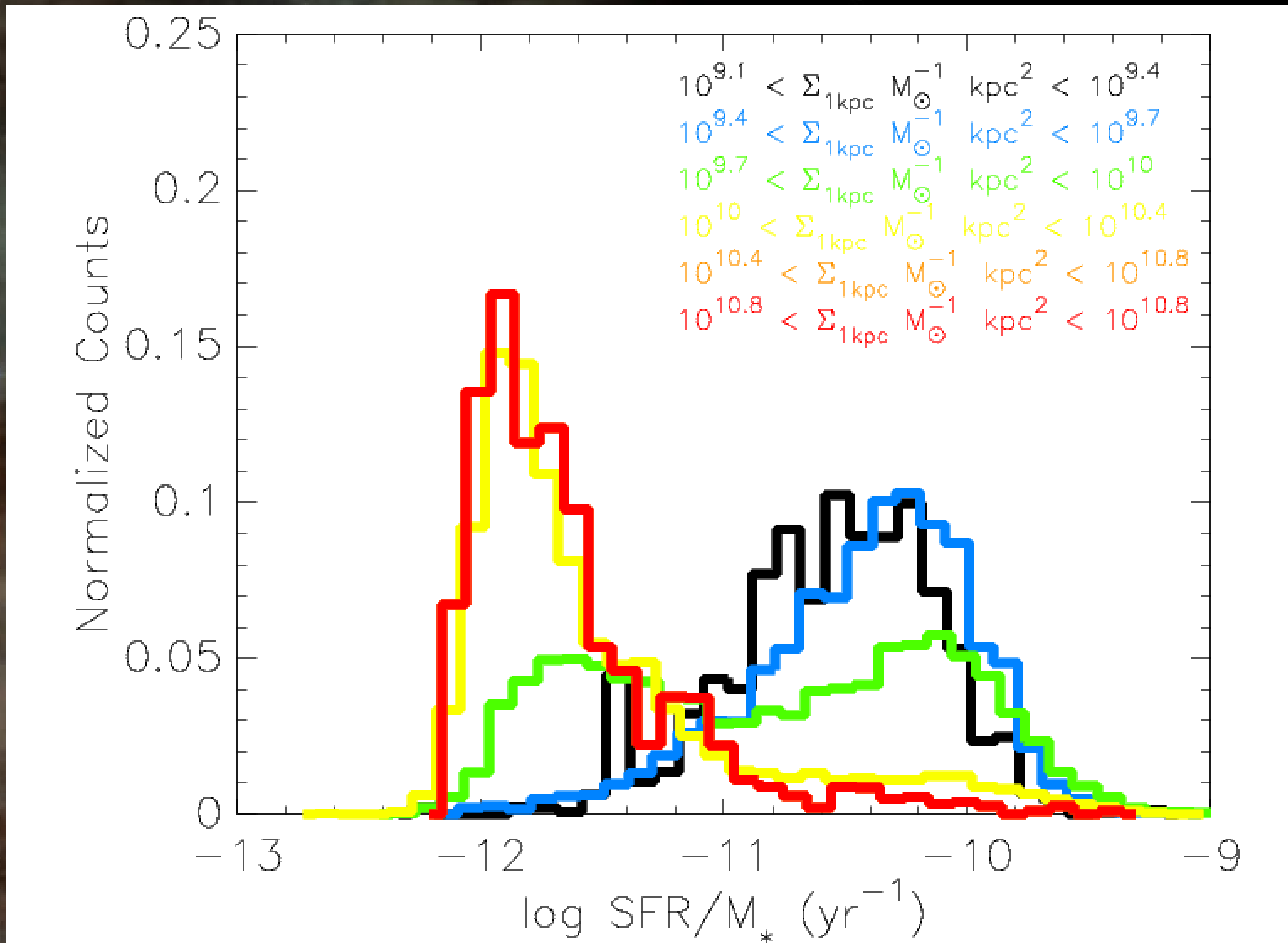


- Mass
  - M_*: $\sigma \sim 0.1$ dex MPA (Brinchmann et al.) (photometry)
  - M_h: $\sigma \sim 0.3$ dex, Group catalogue of Yang et al. (2012)
- Centrals vs. Satellites:
  - Central = Most massive member AND nearest to mass-weighted centre
  - Satellite distance from the central galaxy $D = d_{proj}/R_{vir}$: $\sigma \sim 0.1$ dex
- Morphology/structure: $0 < z < 0.075$
  - Central surface density Σ_{1kpc} : $\sigma \sim 0.1$ dex
  - PSF corrections via Fourier quotient method

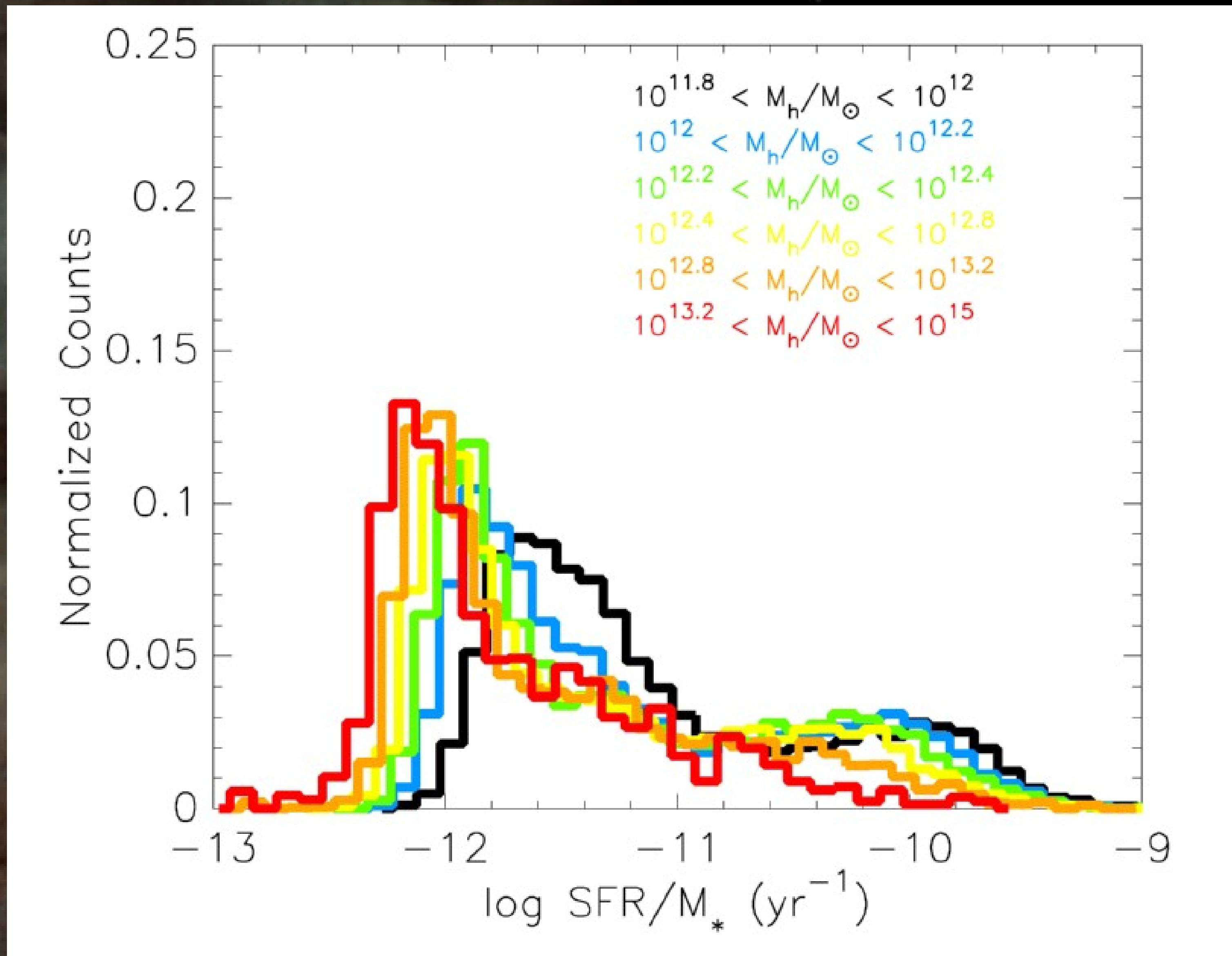
Mass vs. Morphology: Centrals



Woo et al., in preparation



Normalized Counts
log SFR/M* (yr^-1)
0
0.05
0.1
0.15
0.2
0.25
−13
−12
−11
−10
−9
10^9.1 < Σ1kpc M⊙^-1 kpc^2 < 10^9.4
10^9.4 < Σ1kpc M⊙^-1 kpc^2 < 10^9.7
10^9.7 < Σ1kpc M⊙^-1 kpc^2 < 10^10
10^10 < Σ1kpc M⊙^-1 kpc^2 < 10^10.4
10^10.4 < Σ1kpc M⊙^-1 kpc^2 < 10^10.8
10^10.8 < Σ1kpc M⊙^-1 kpc^2 < 10^10.8



$10^{11.8} < M_h/M_\odot < 10^{12}$
$10^{12} < M_h/M_\odot < 10^{12.2}$
$10^{12.2} < M_h/M_\odot < 10^{12.4}$
$10^{12.4} < M_h/M_\odot < 10^{12.8}$
$10^{12.8} < M_h/M_\odot < 10^{13.2}$
$10^{13.2} < M_h/M_\odot < 10^{15}$
Normalized Counts
0.25
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0.15
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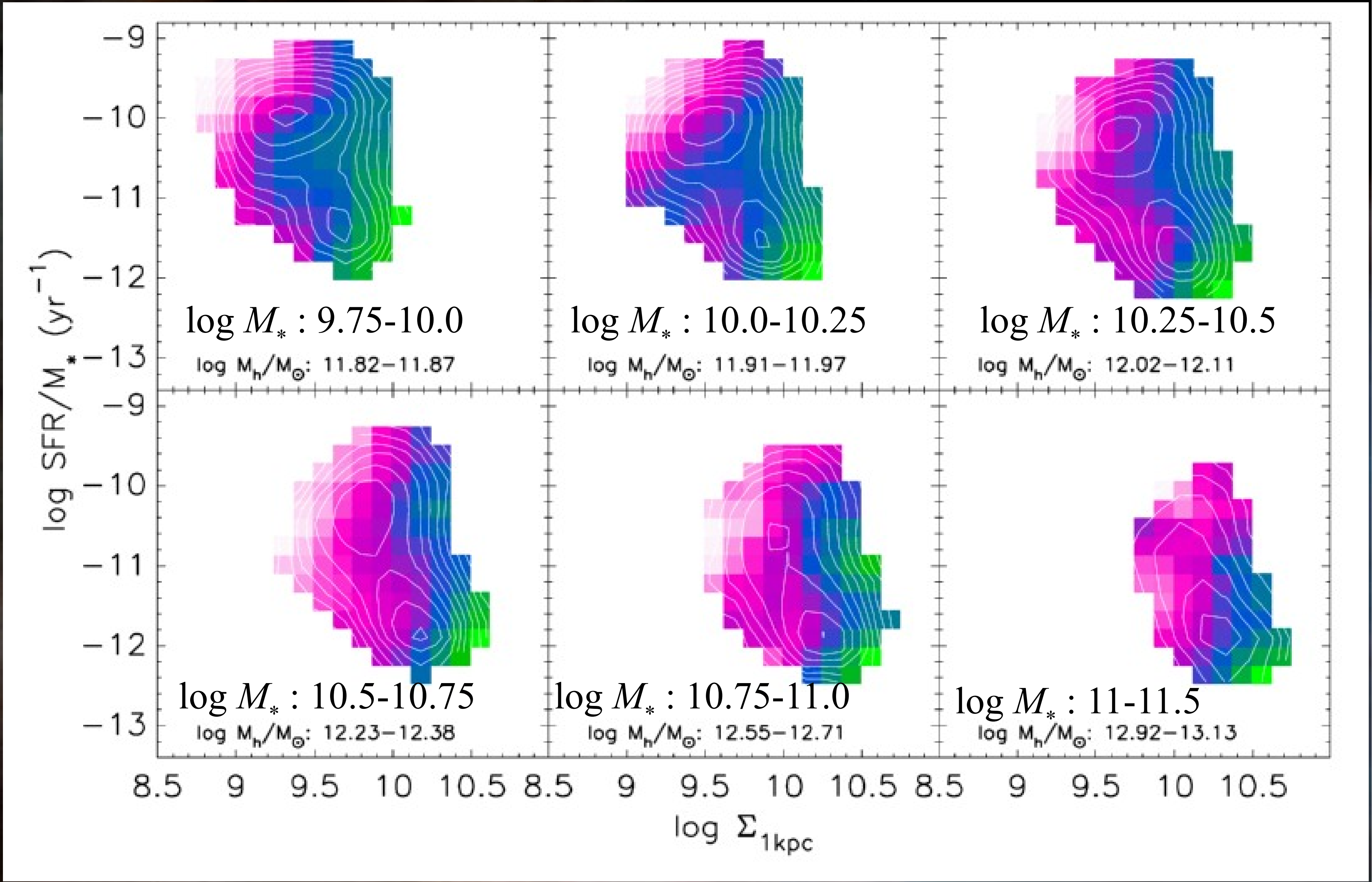
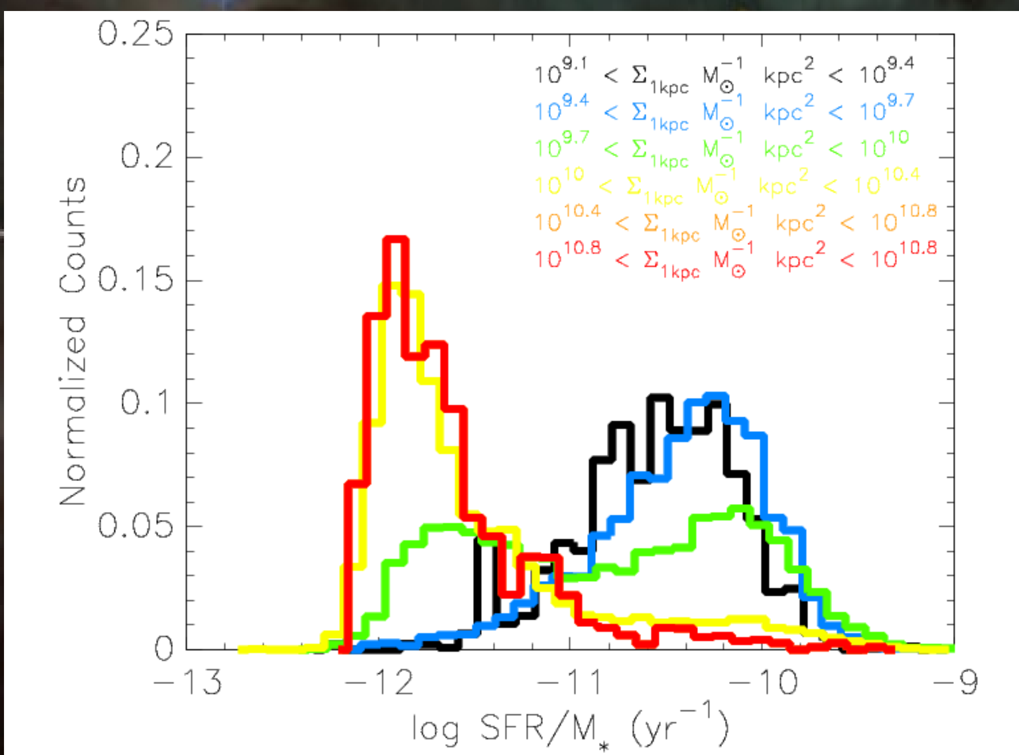
log SFR/M_* (yr^{-1})

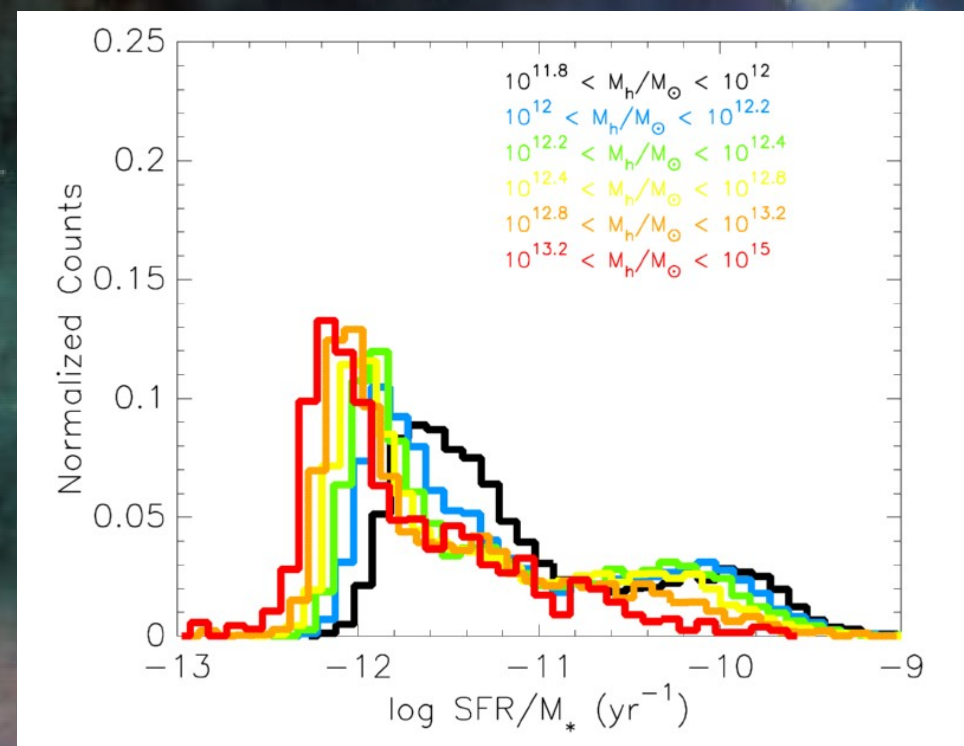


Woo et al., (very preliminary)

Interpretation of Results

- Proposition:
  - Increase of f_q is related to the transfer across bimodality; quick
  - Decrease of SSFR is related to the *slower* fading of star formation
- Therefore Σ_{1kpc} -quenching is fast and M_h -quenching is slow





Interpretation of Results

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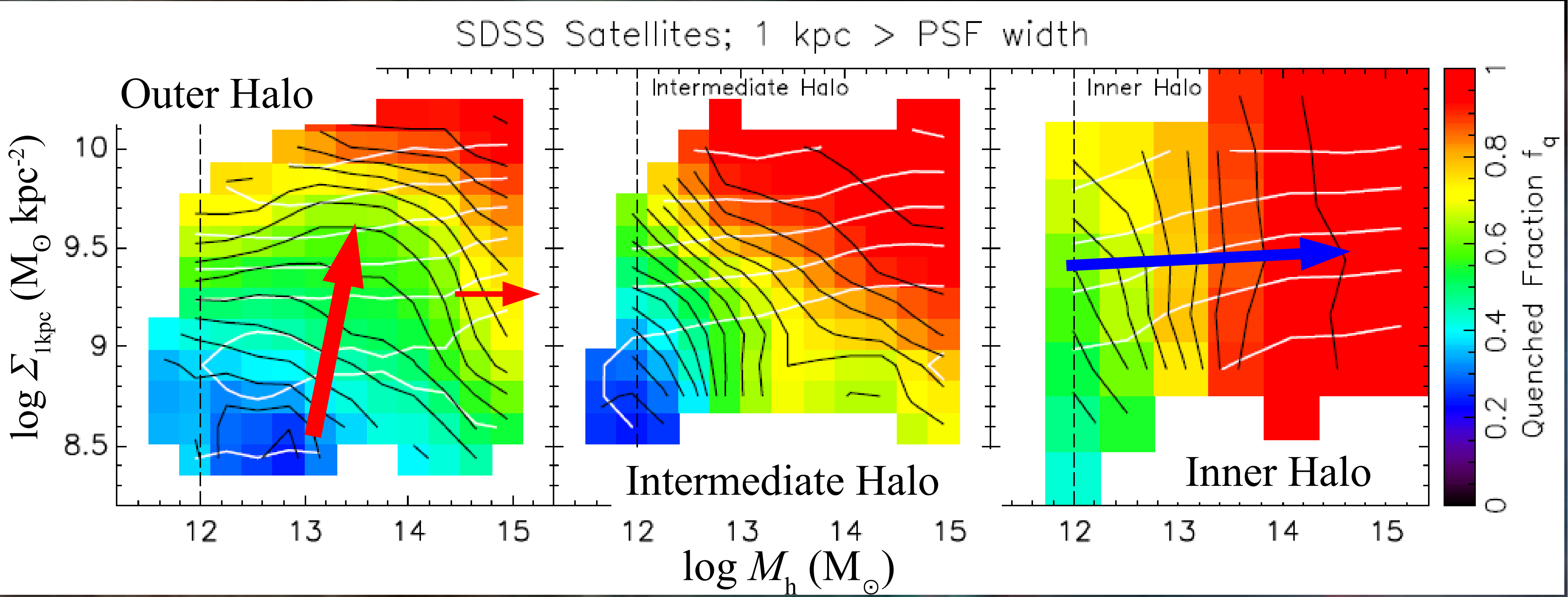
- Therefore Σ_{1kpc} -quenching is fast and M_h -quenching is slow
- Makes sense because:
  - Virial shock heating is expected to cut off accretion; remaining gas is expected to continue forming stars
    - Timescales can be ~ 2-3 Gyr or higher at higher z
  - Mechanisms that result in high Σ_{1kpc} are expected to be violent (VDI, mergers)
    - Once gas is consumed M_h could play maintenance role of quenching (prevents new gas from falling in)
- These ideas need to be tested – initial tests in a SAM look promising!

Quenching and Morphology: Satellites



The quenched fraction depends on Σ_{1kpc} in the outskirts of halos.
The quenched fraction depends on M_h in the inner halo.
Almost all satellites are quenched above $10^{12.8}$ $M_\odot$

Woo et al., in preparation

Quenching Results for Satellites

- Outer regions of haloes:
  - Σ_{1kpc} dominates f_q
  - Satellites only recently fell in; have not had time to experience the slow halo quenching
    - Ie, galaxies on the slow mode can move onto the fast mode
- Inner regions of haloes:
  - M_h dominates f_q
  - Almost all satellites are quenched for $M_h > 10^{12.8}\,M_\odot$
    - slightly greater than M_{crit} perhaps due to quenching delay

Summary

- Both the halo and central density play role in quenching
  - Σ_{1kpc} determines f_q Quick transition
  - M_h determines SSFR Slow fading of star formation
- Satellites:
  - M_h quenching happens in the inner halo (since halo quenching is slow)
    - Nearly all quenched above a few x M_{crit}
  - Σ_{1kpc} -related quenching (fast mode) affects satellites in outer halo