Are major mergers important drivers of galaxy evolution?

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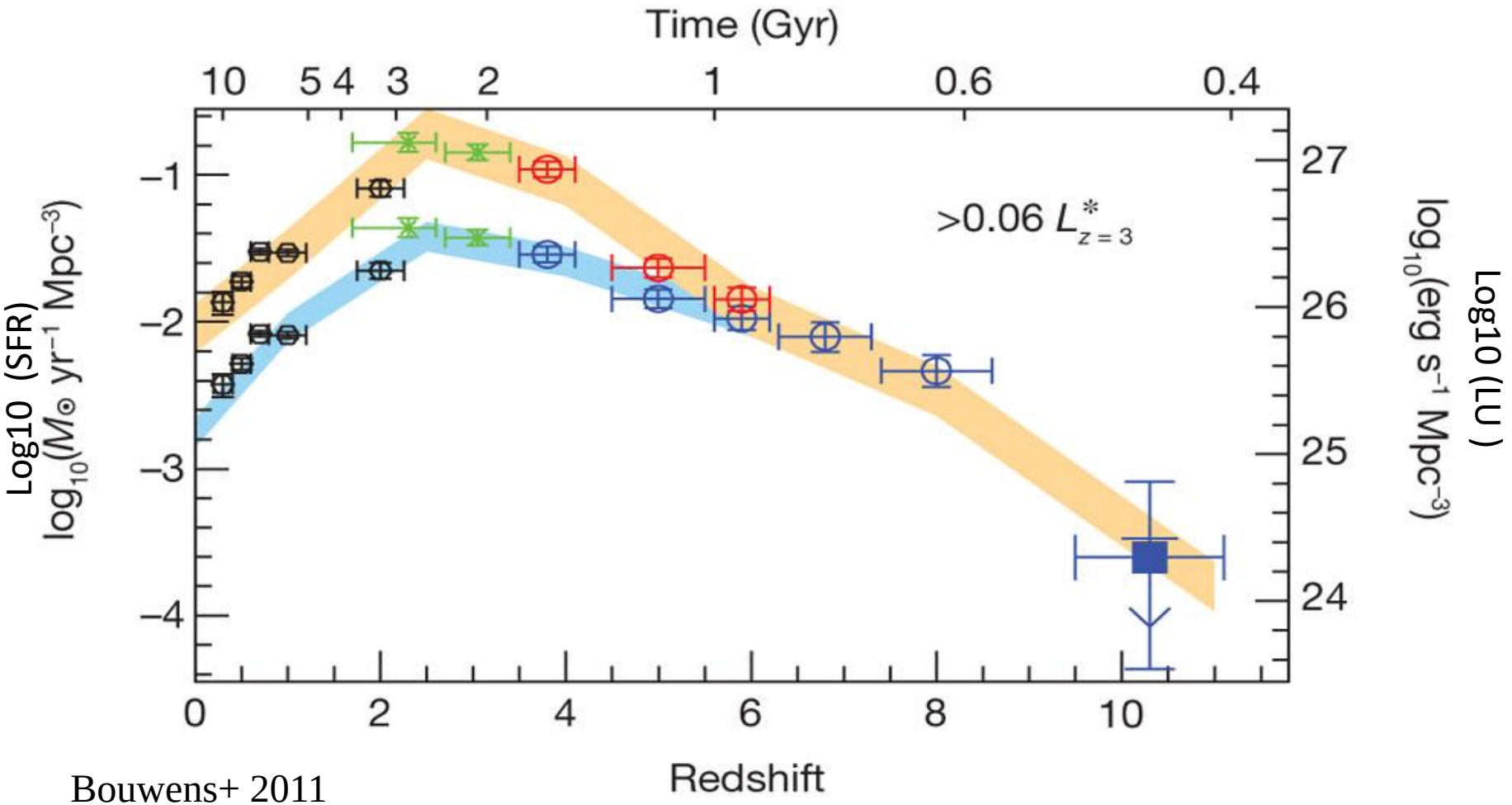
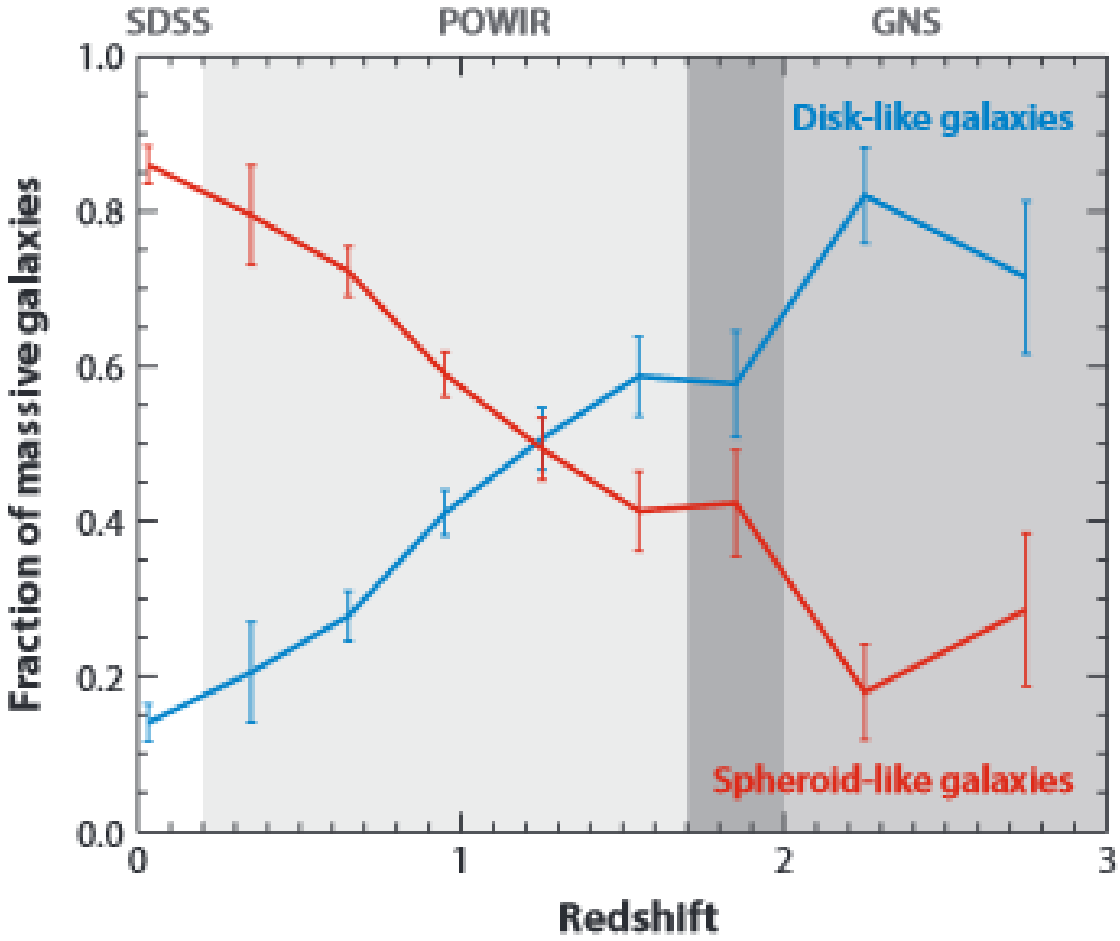
Star Formation Rate peaks at z~2



Bouwens+ 2011

Changing Galaxy Morphology



Buitrago+ 2013

Aims

(1) Do major mergers significantly influence SF at z~2?
(2) Do major mergers create Spheroids at z~2?

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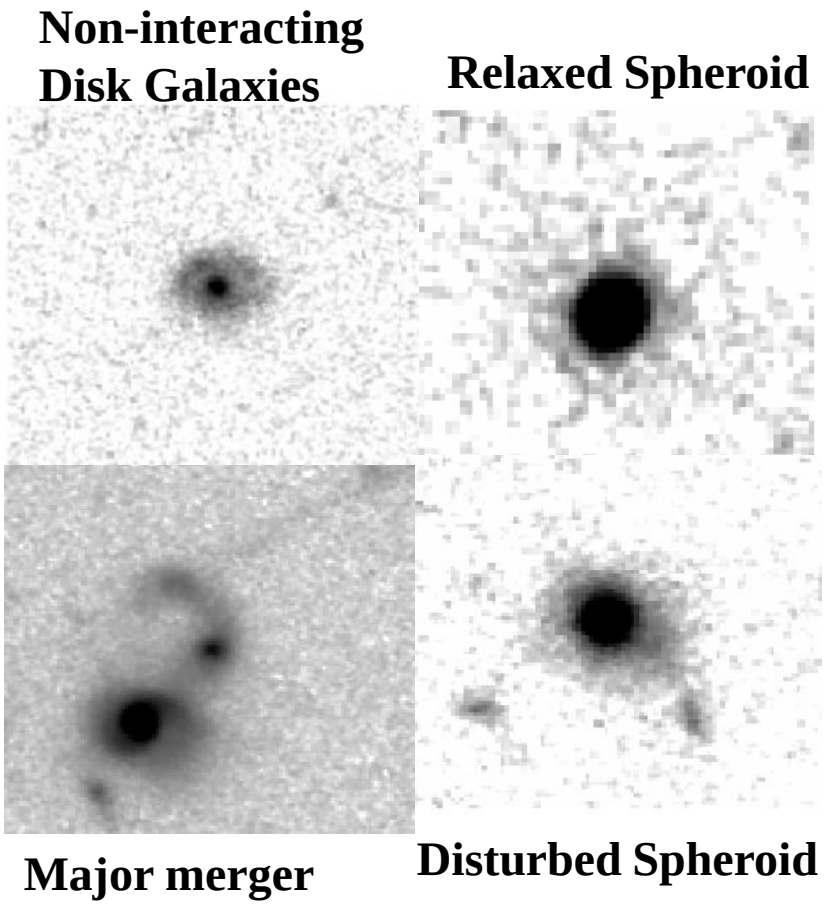
Luminosity Budget

Visual classification

Aim 1: *do major mergers significantly influence SF budget at z~2?*

- 595 galaxies from CANDELS

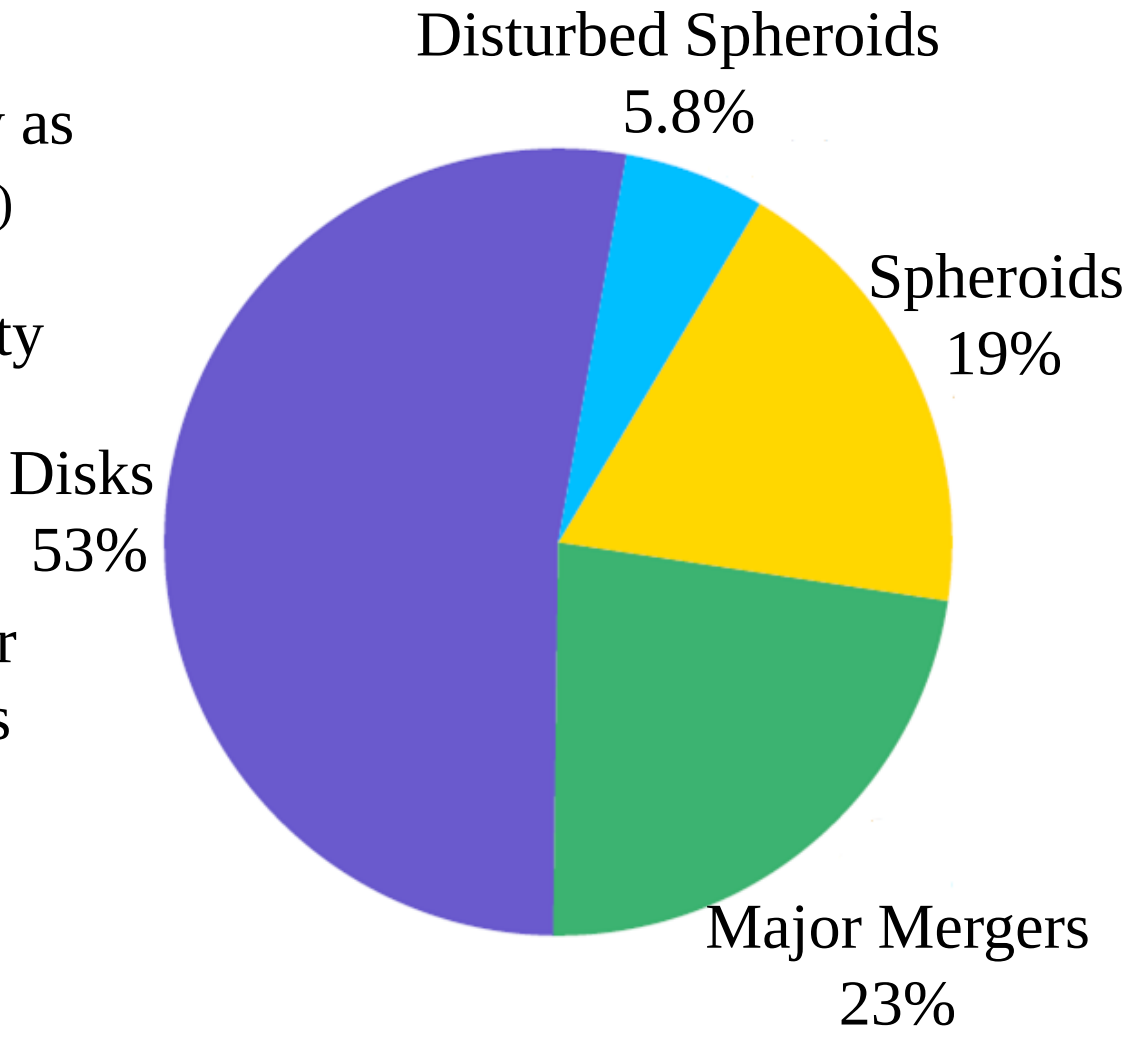
- Visually classify galaxies:
  - Disk Galaxies (287; 48%)
  - Relaxed Spheroids (152; 26%)
  - Major mergers (119; 20%)
  - Disturbed Spheroids (37; 6%)



Luminosity Budget

U-Band Luminosity

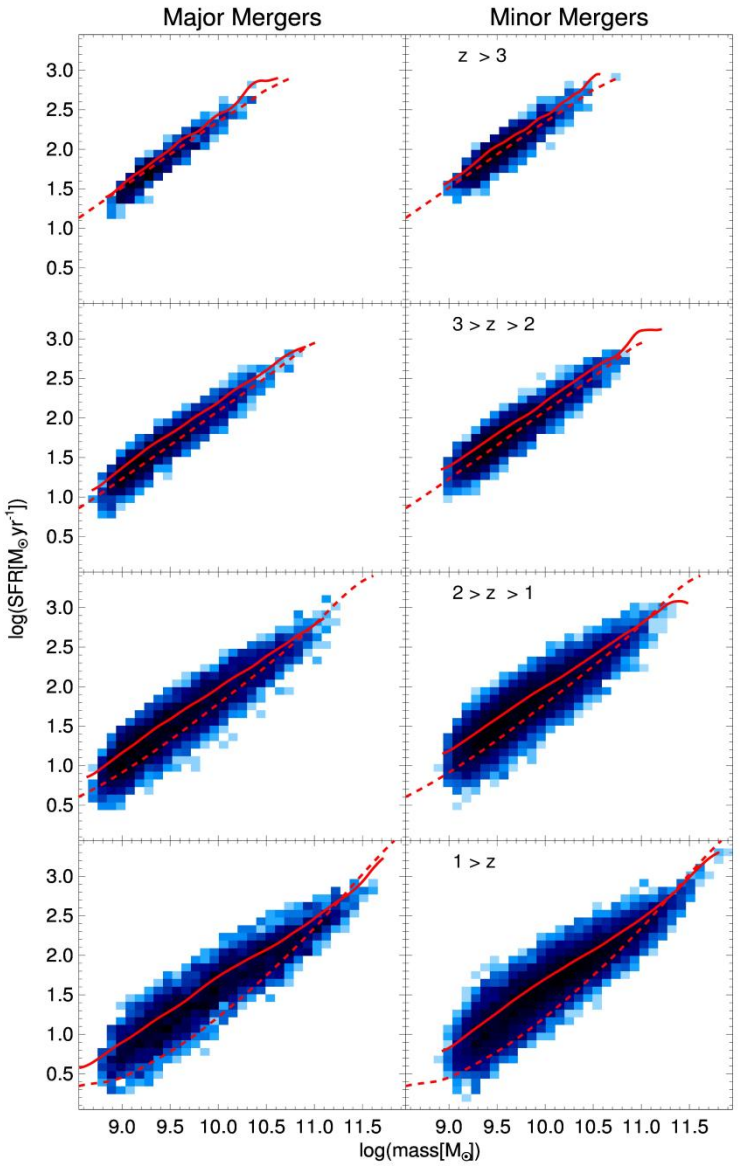
- Use U-band luminosity as proxy for SF (Hopkins+03)
- Sum U-band Luminosity for each morphological type
- Ratio of Luminosity for major mergers to disks is 1.25:1



Luminosity Budget

SFR Enhancement from Simulation

- Horizon-AGN simulation (Dubois+14)
- Enhancement at low redshifts, particularly at lower masses
- Little enhancement in SFR for mergers at high redshift

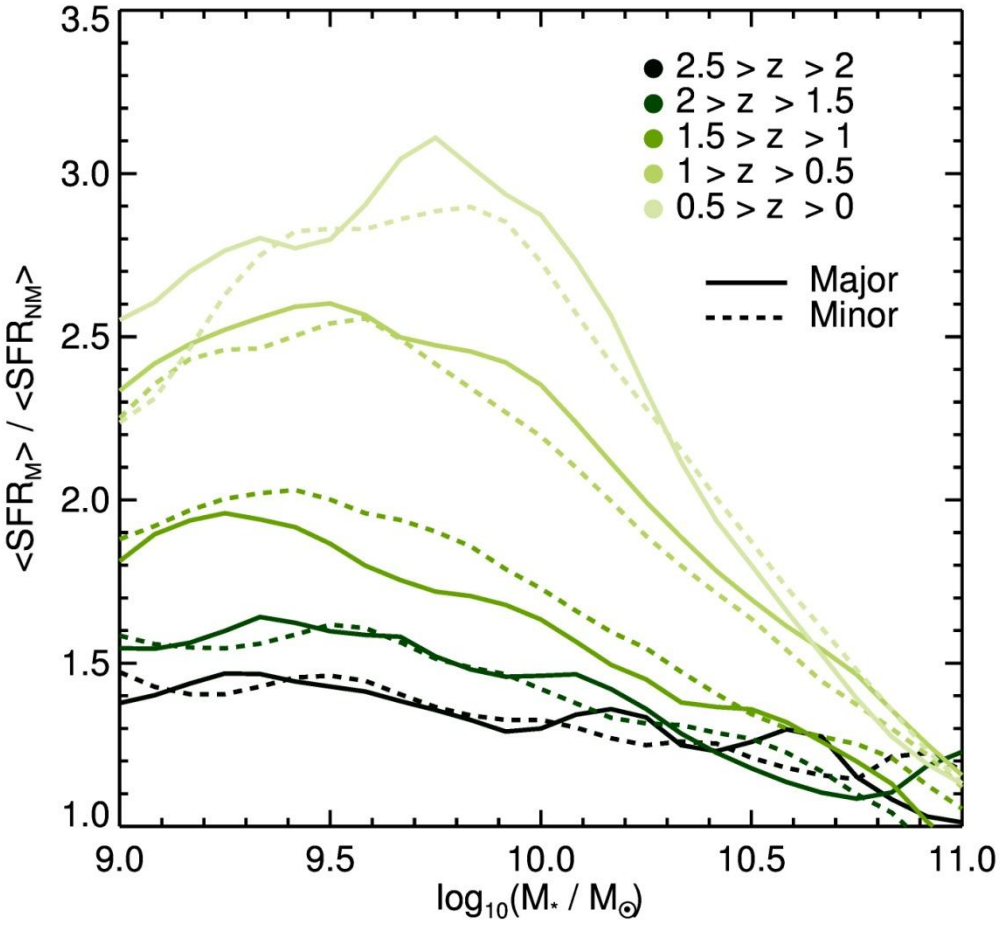


Martin+ (in prep)

Luminosity Budget

U-Band Luminosity

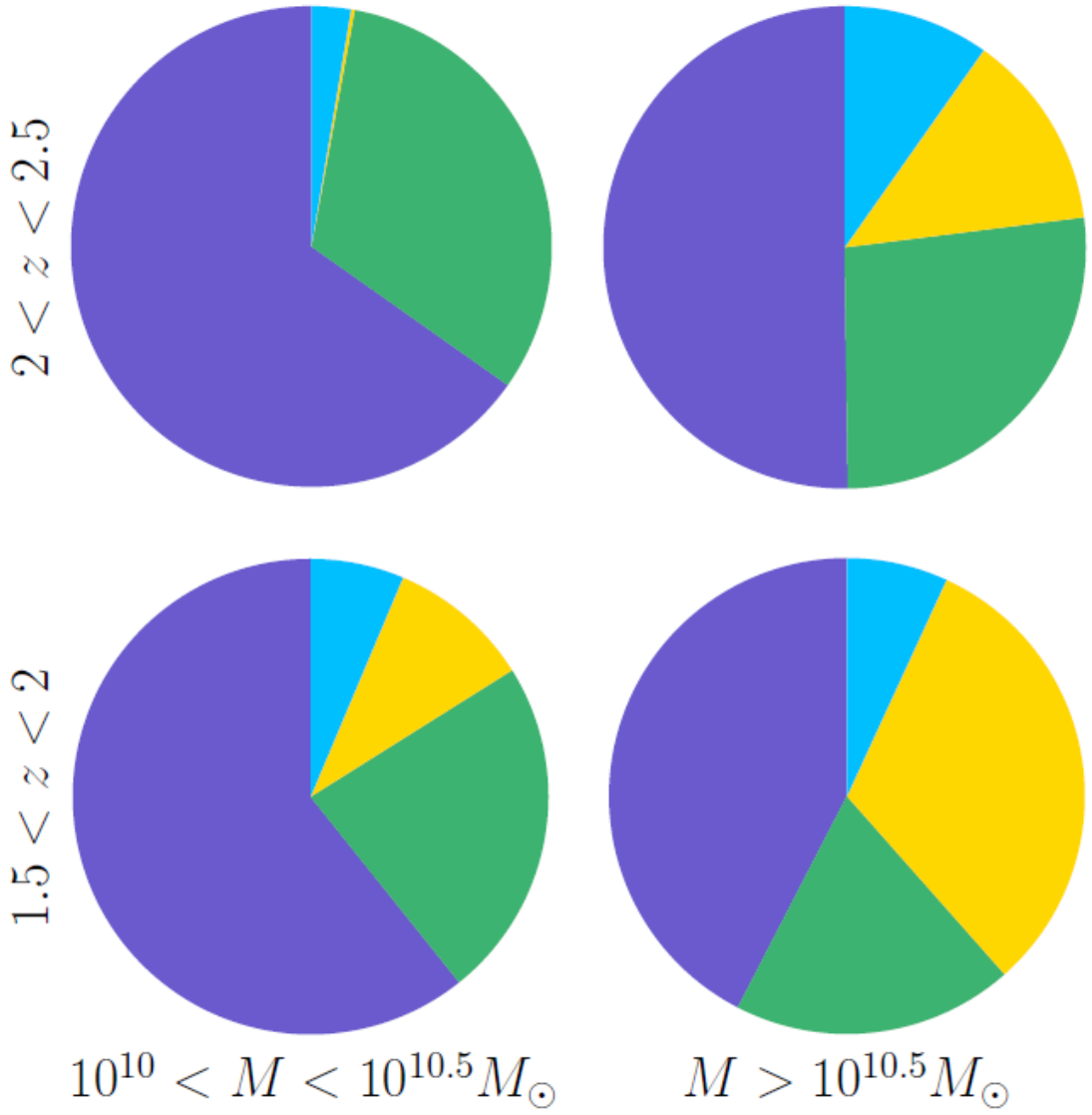
- Enhancement at low redshifts, particularly at lower masses
- Little enhancement in SFR for mergers at high redshift
- Agrees with enhancement of 1.25:1 from observations (and Jeremy's Talk yesterday)



Martin+ (in prep)

Luminosity Budget

U-Band Luminosity by mass and redshift

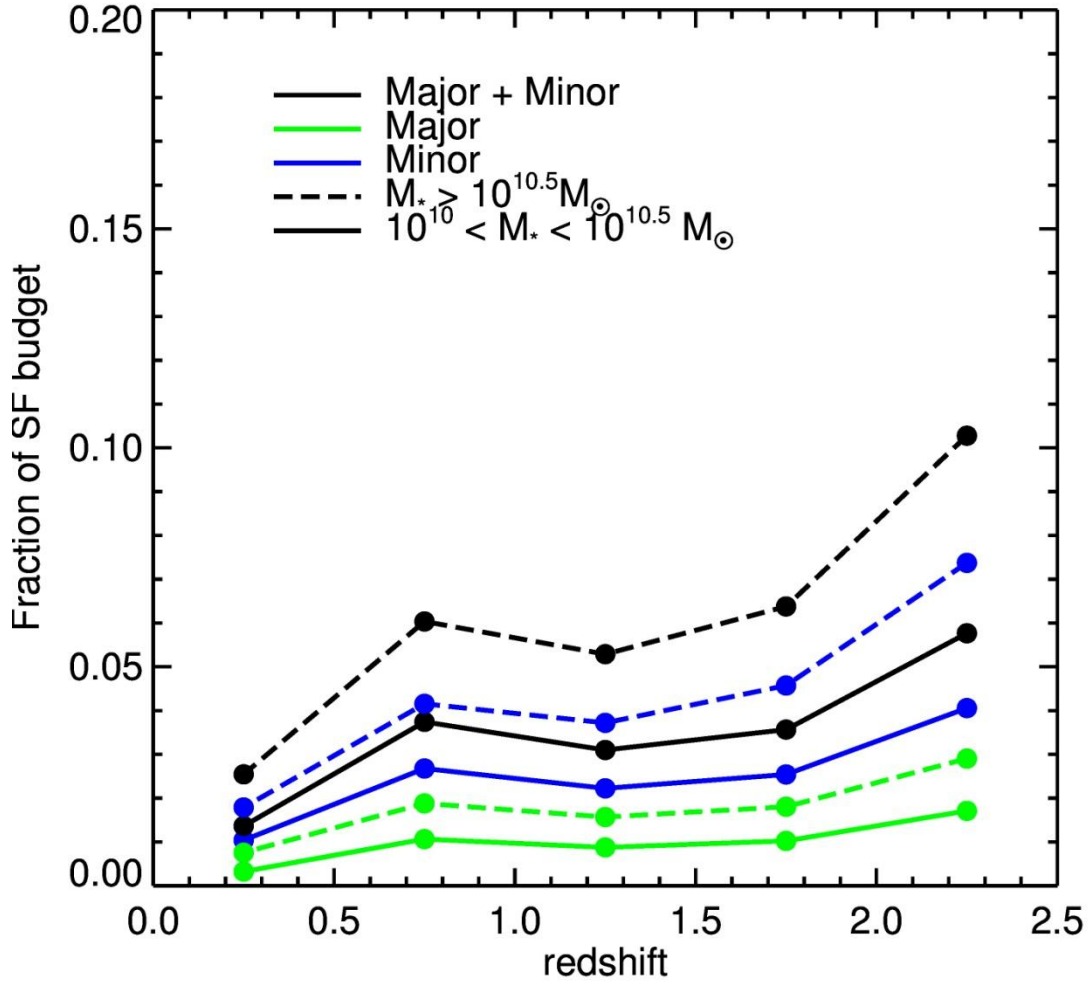


Purple = Disk Galaxies
Light Blue = Disturbed Spheroids
Green = Major Mergers
Yellow = Relaxed spheroids

Luminosity Budget

U-Band Luminosity by mass and redshift

- Horizon-AGN simulation
- Mergers defined via merger trees and selected at final coalescence
- Mergers host small fraction of SF budget



Martin+ (in prep)

Aims

(1) Do major mergers significantly influence SF at z~2?

(2) Do major mergers create spheroids at z~2?

Tidal Debris in Blue Spheroids

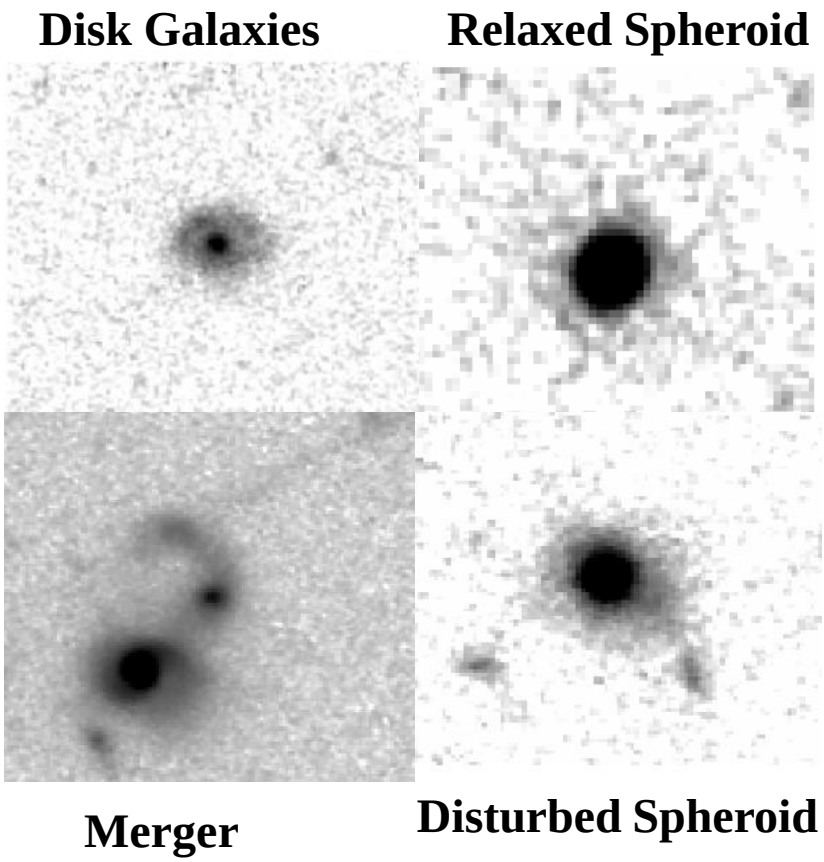
Visual classification

- Aim 2: *do major mergers create spheroids?*

- Morphological mix of galaxies rapidly changing

- Blue → star-forming

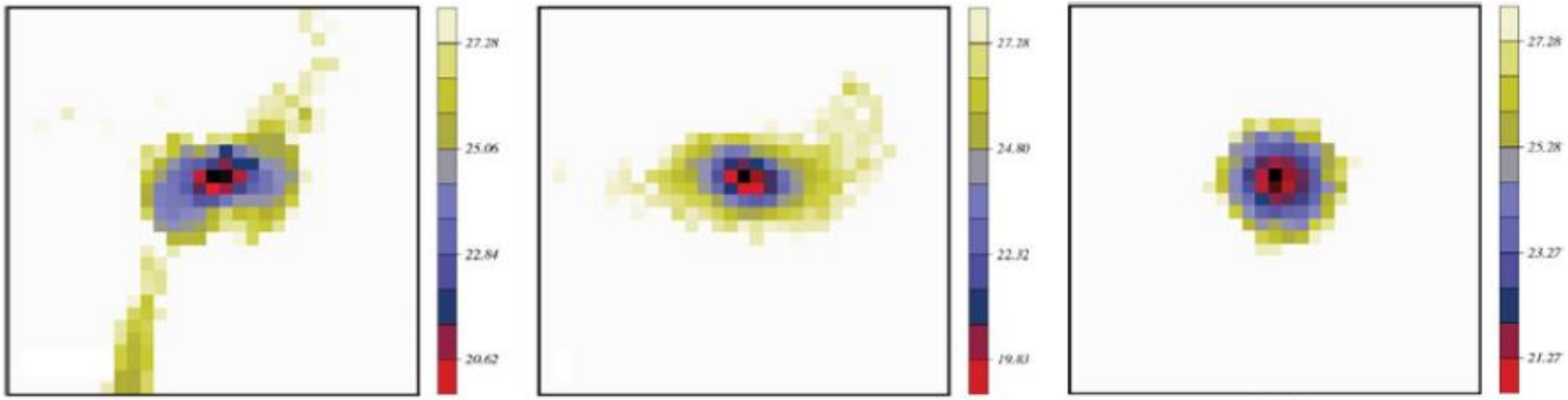
- High alpha enhancement
  → see spheroids as they form



Tidal Debris in Blue Spheroids

Visibility of tidal features

• Simulations show MAJOR mergers will leave clear tidal features at the depth of the CANDELS images



1:2 1:5 1:10

Kaviraj+13

Tidal Debris in Blue Spheroids

Results

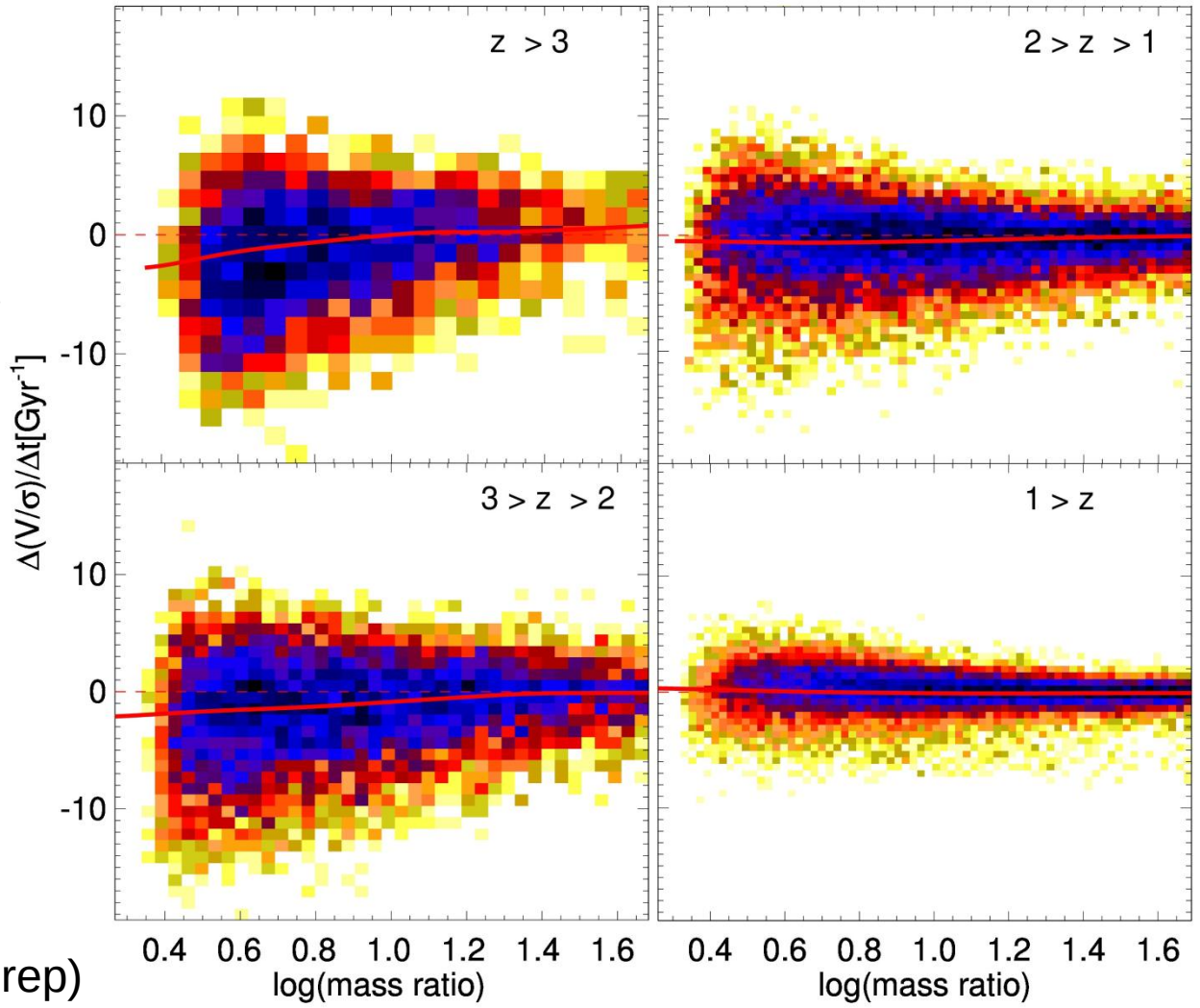
- **21 ± 4%** of blue spheroids have tidal debris

- **Major mergers are not the dominant mechanism for creating spheroid galaxies**

Tidal Debris in Blue Spheroids

Results – Horizon-AGN

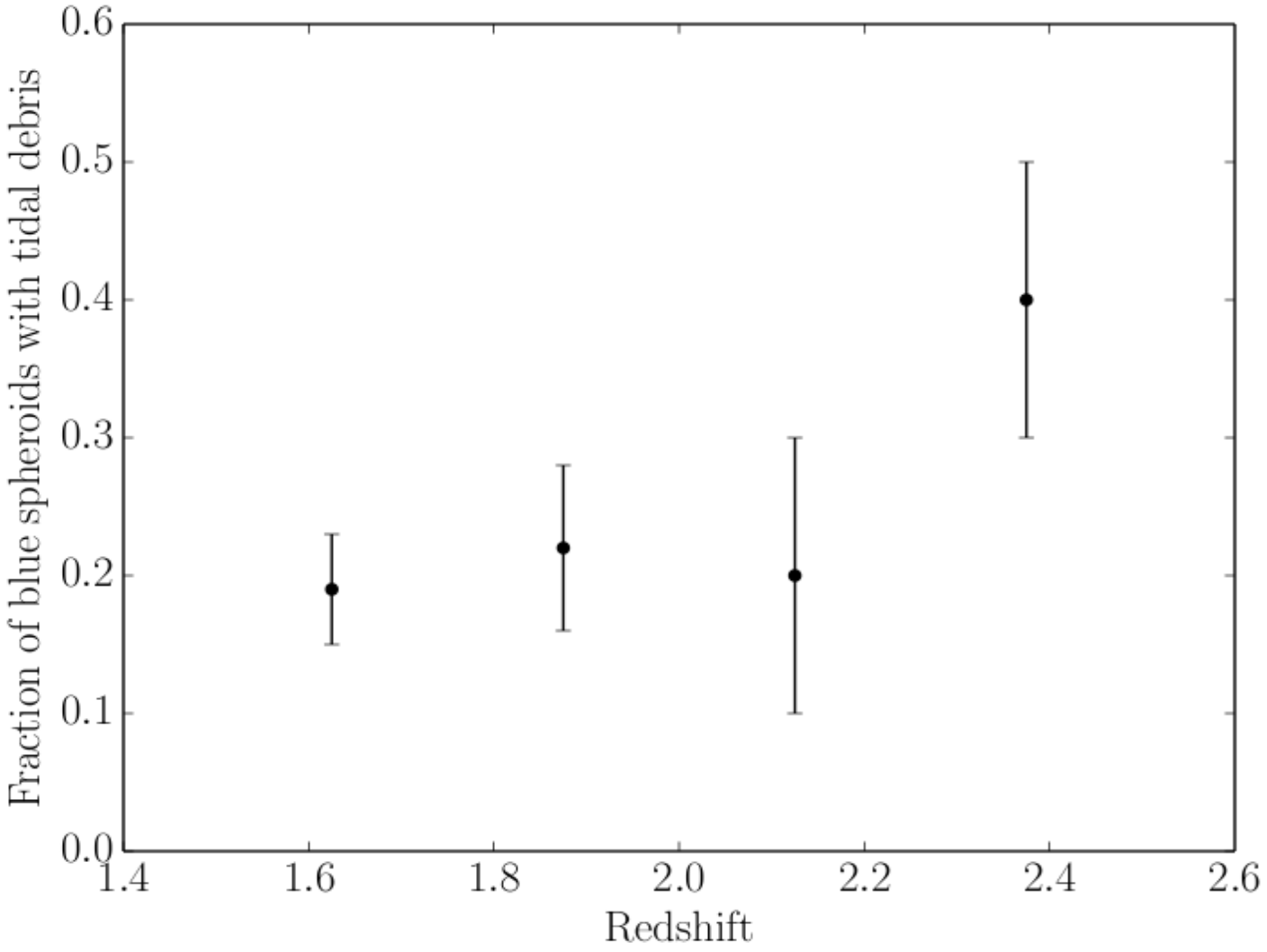
- Minor mergers are able to create spheroids
- Star formation in turbulent discs can also form bulge-like systems (e.g. Julien's talk)



Martin+ (in prep)

Tidal Debris in Blue Spheroids

Redshift results



Summary

- At peak of SF, z=2:
  - A minor fraction of U-band luminosity (<30%) is in major mergers
  - Horizon-AGN also shows small fraction of SFR is in major mergers and small SFR enhancements.
  - Only 21±4% of blue spheroids have tidal debris

- Major mergers are not the dominant mechanism in the formation of spheroidal galaxies & triggering SF

(Lofthouse et al., 2016) **arXiv:1608.03892**