



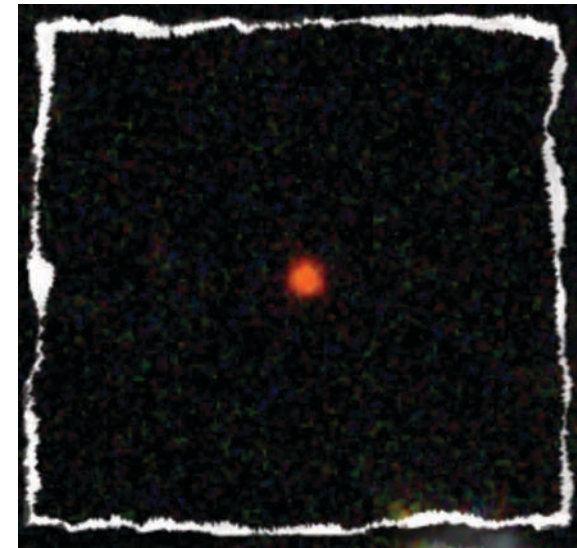
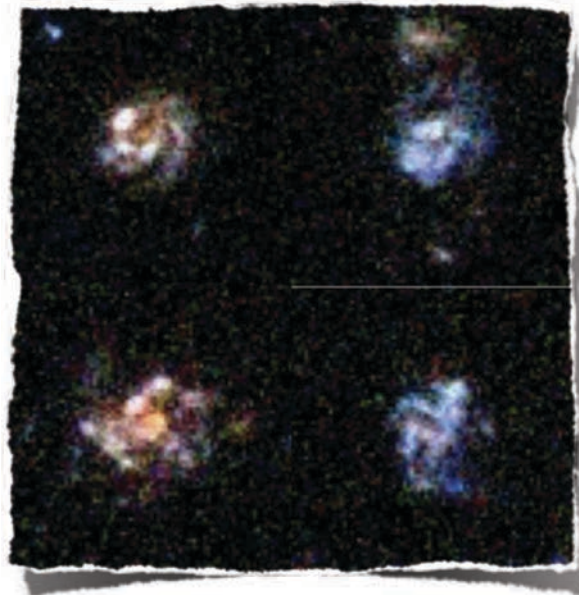
Live fast, die... small:

Properties of compact SFGs, tracing the formation of red nuggets

Barro et al., ApJ 2013

Barro et al., ApJ 2014 (accepted)

Barro et al., ApJ (arXiv 1405.7042B)

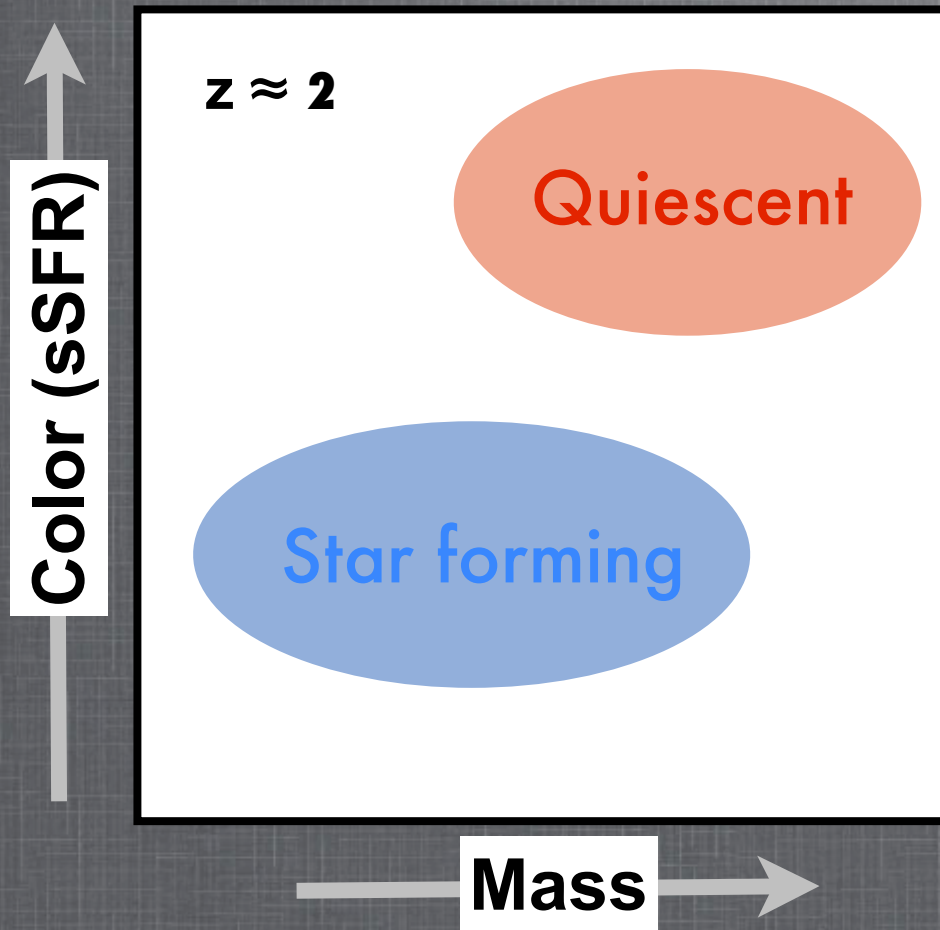


Guillermo Barro (UCSC)

S. Faber, P. Perez-Gonzalez, D. Koo, J. Trump, D. Kocevski, E. McGrath, L. Porter, R. Somerville, J. Primack, C. Pacifi, C. Moody, A. van der Wel, S. Wuyts
+ CANDELS collaboration

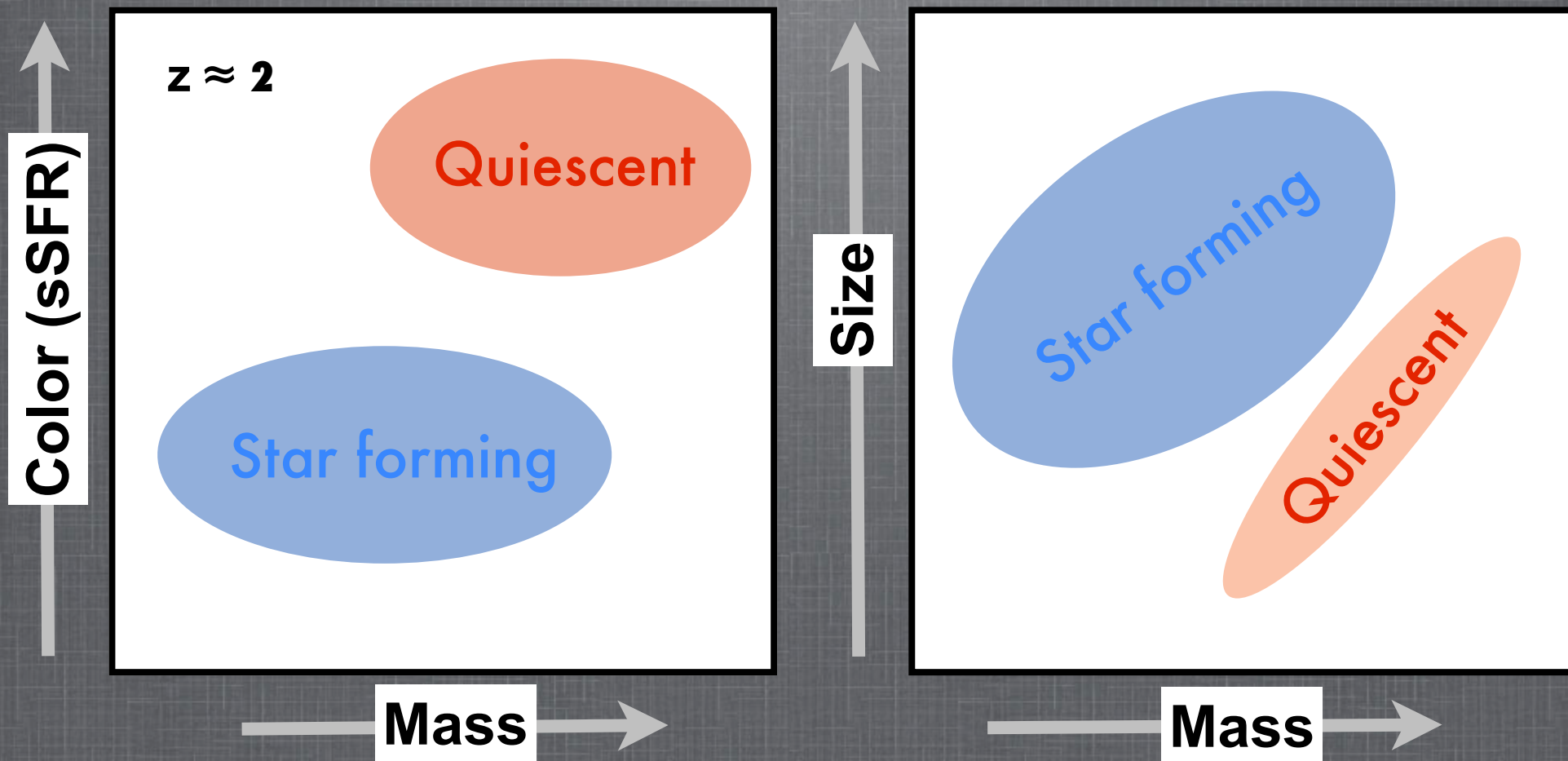
August 13th 2014, Santa Cruz

Galaxy bimodalities



(Faber+07; Brammer+09,11; Williams+09; Ilbert+10; Whitaker+11, Wuyts11b, Muzzin+13, etc.)

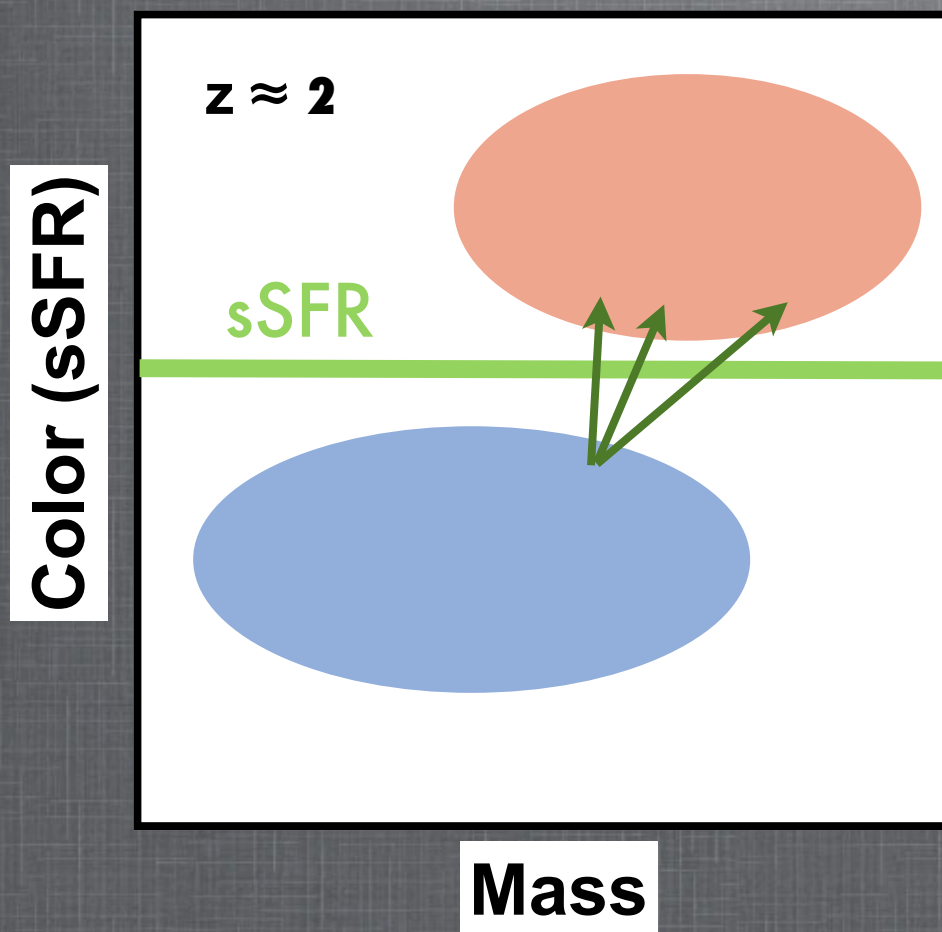
Galaxy bimodalities



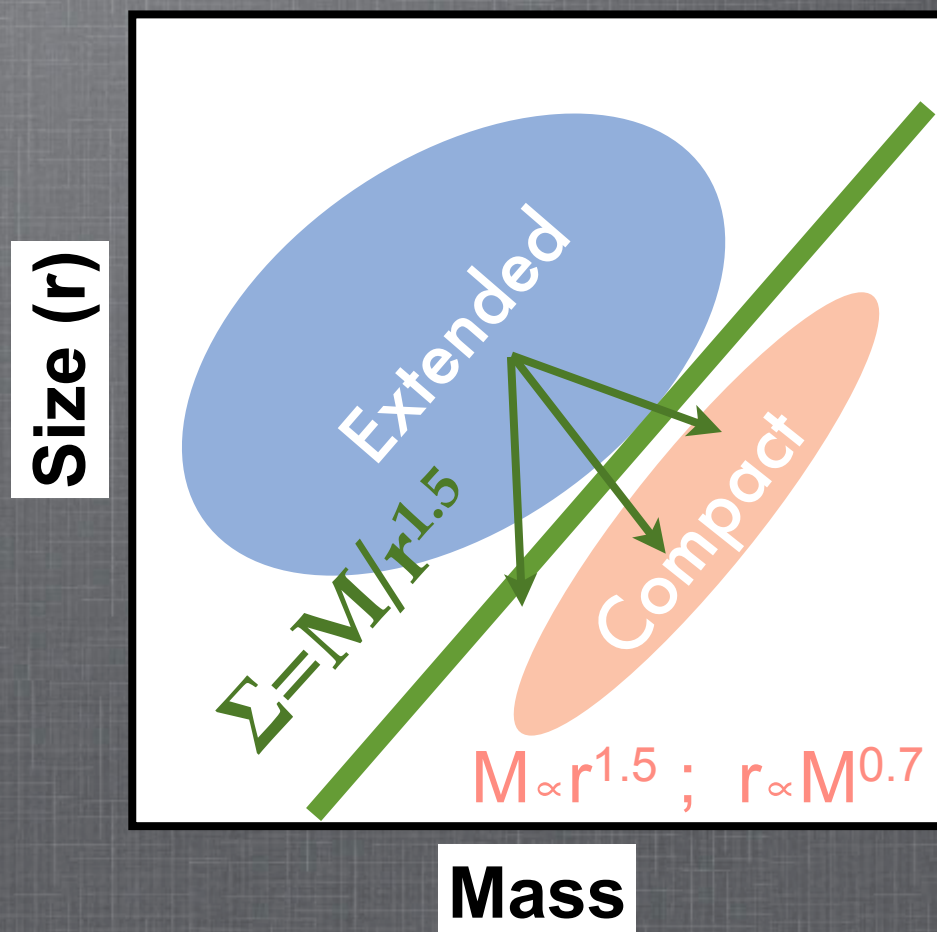
(Faber+07; Brammer+09,11; Williams+09; Ilbert+10; Whitaker+11, Wuyts11b, Muzzin+13, etc.)

(Daddi+05; Trujillo+07; Buitrago+08; van Dokkum+08, Cassata+10; Saracco+10,11; Newman+12; van der Wel+14 etc.)

Galaxy bimodalities

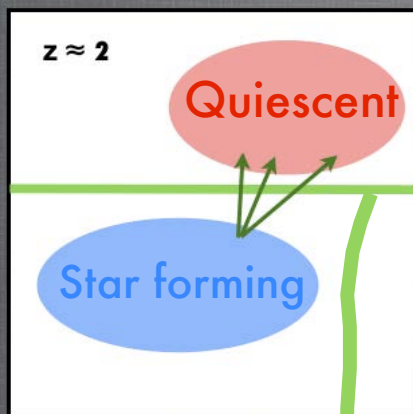


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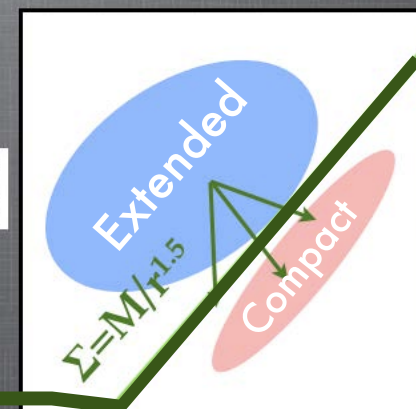
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Color (sSFR)

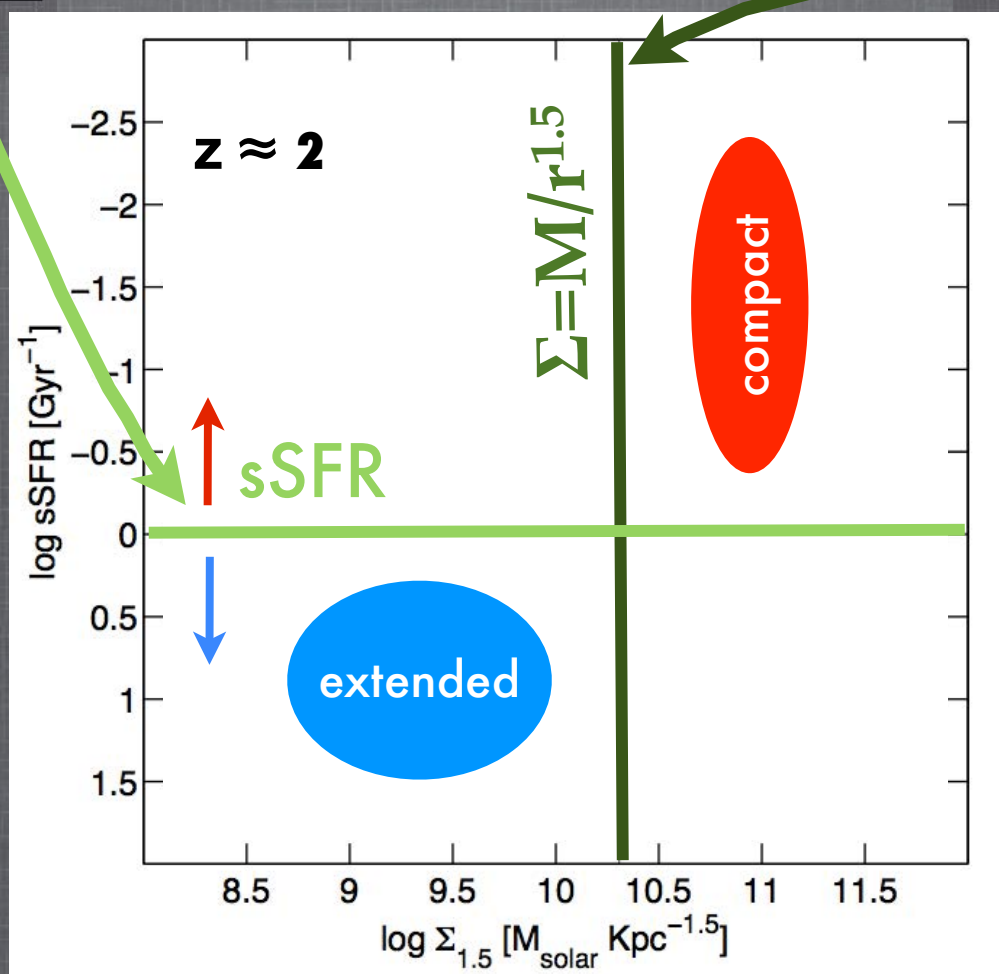


Mass

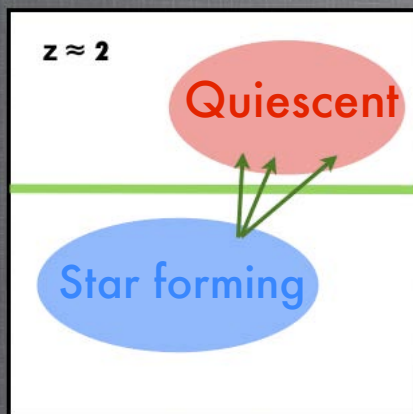
Size



Mass



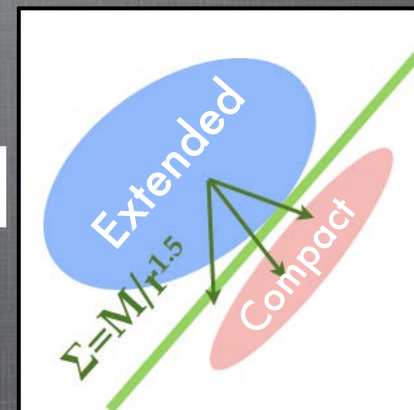
Color (sSFR)



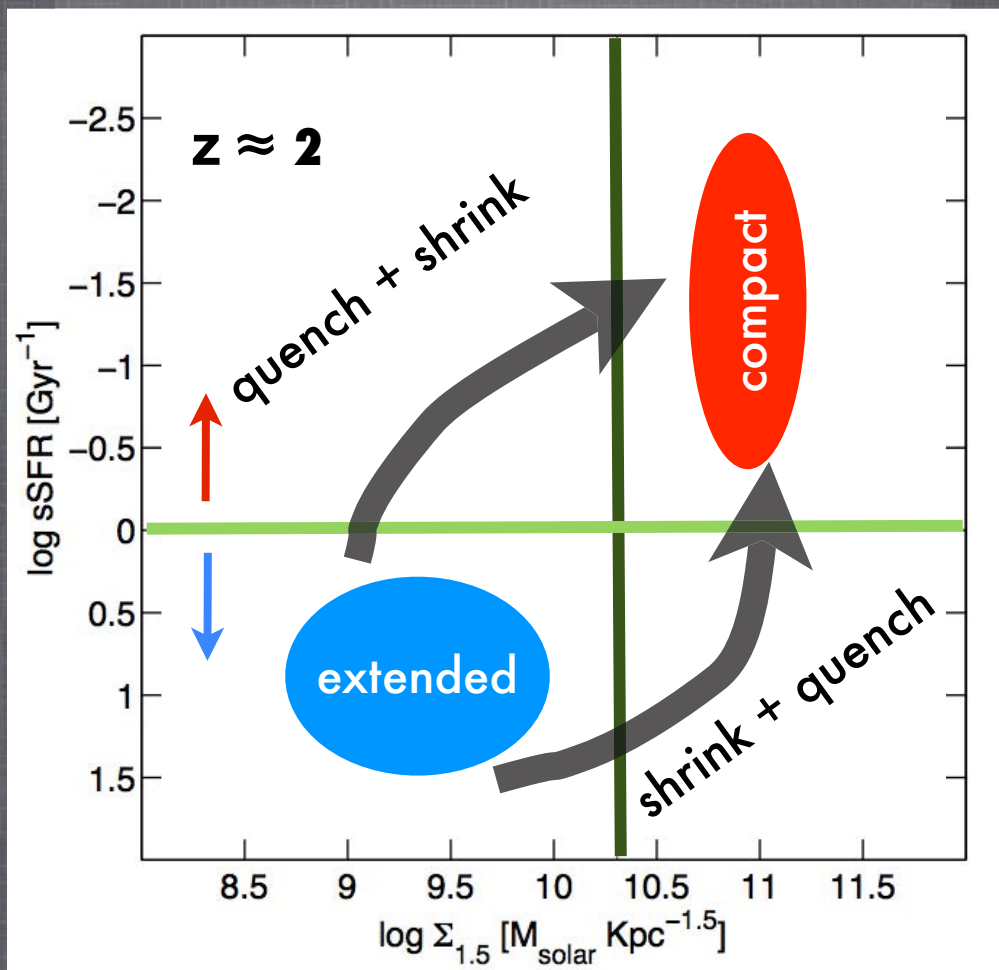
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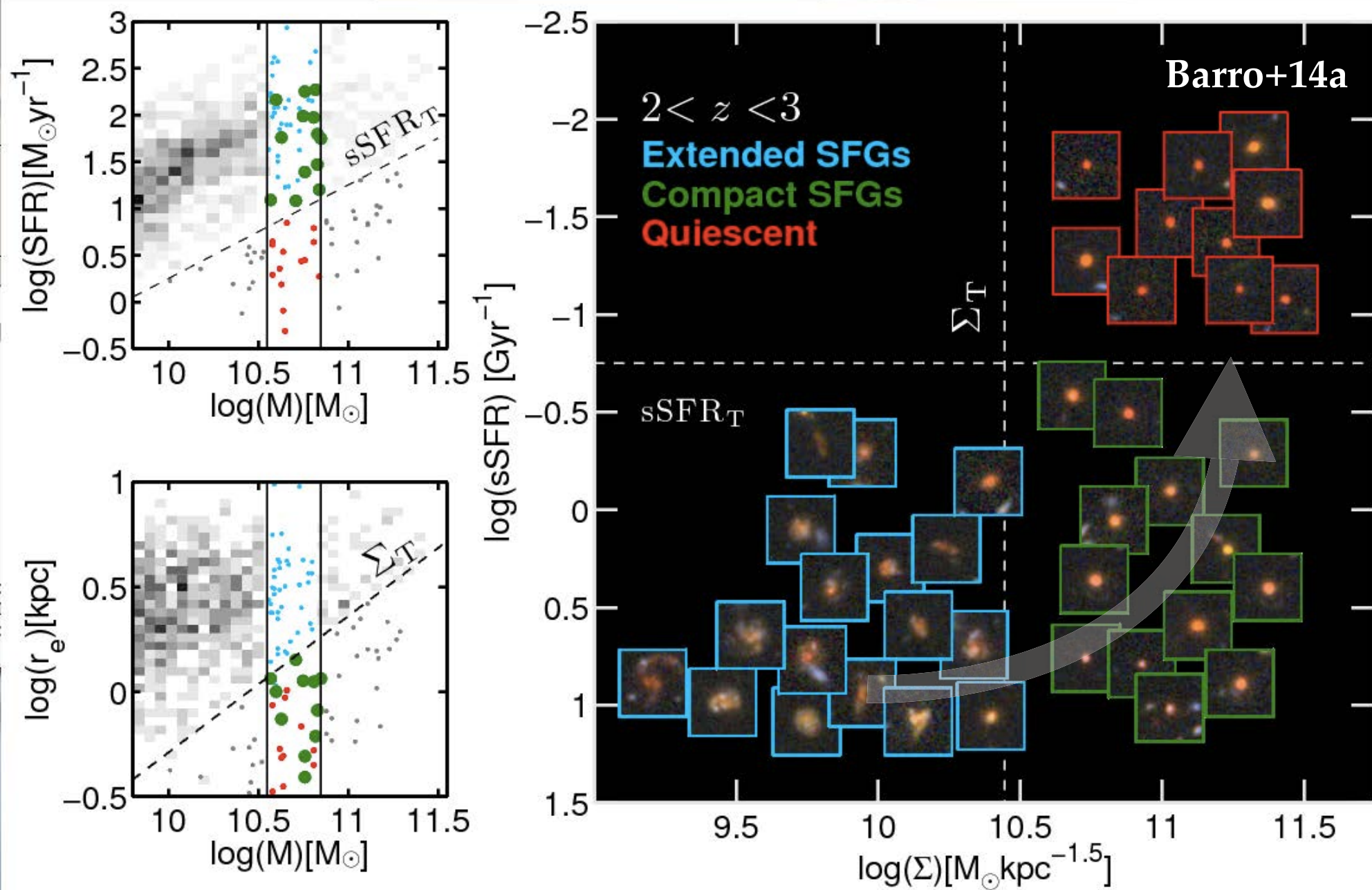
?

Size



Mass

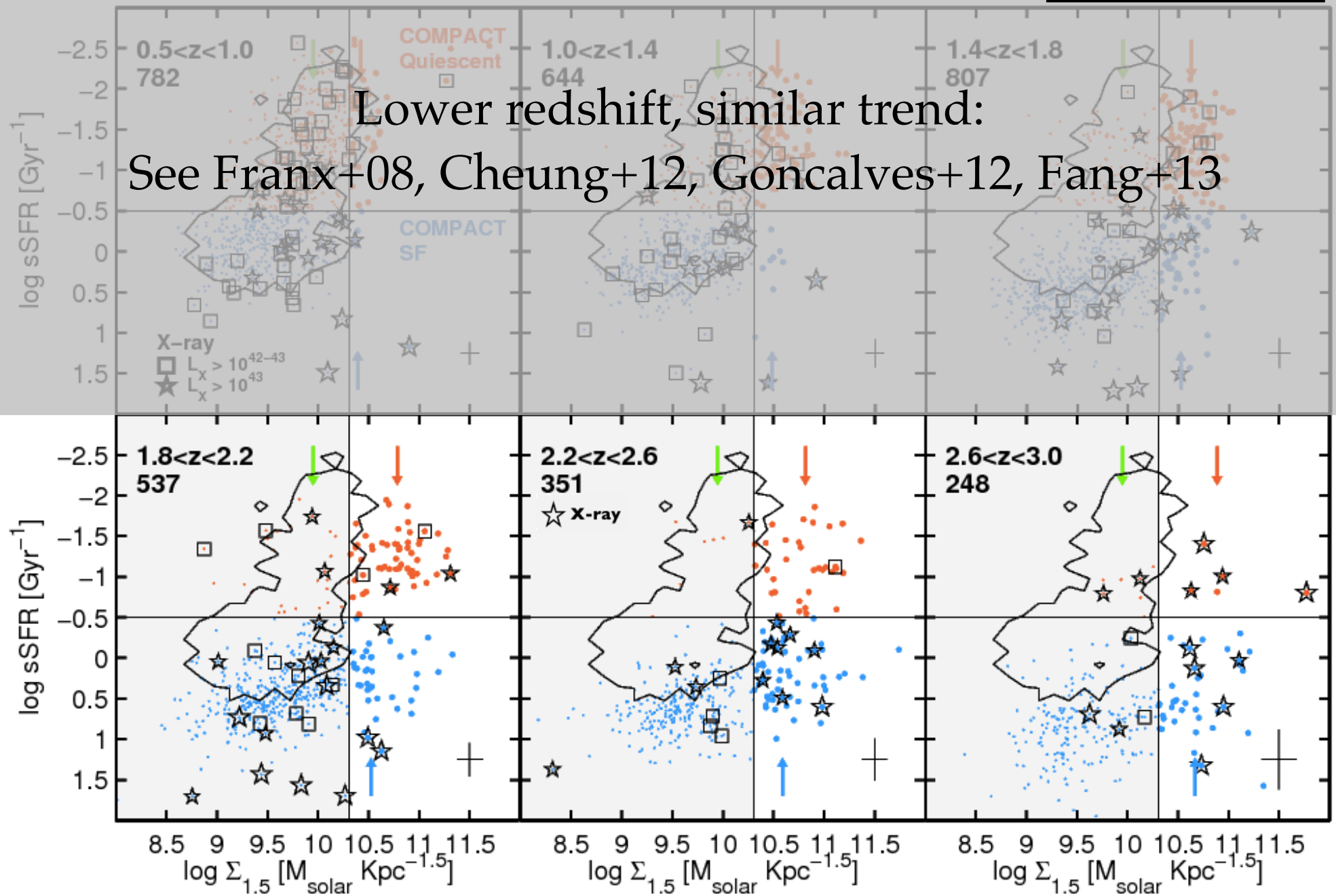




- CANDELS H-band selected in GOODS-S , $\log(M/M_{\text{sun}}) > 10$
 See also Patel+13, Stefanon+14, Williams+14, Marchesini+14, Toft+14

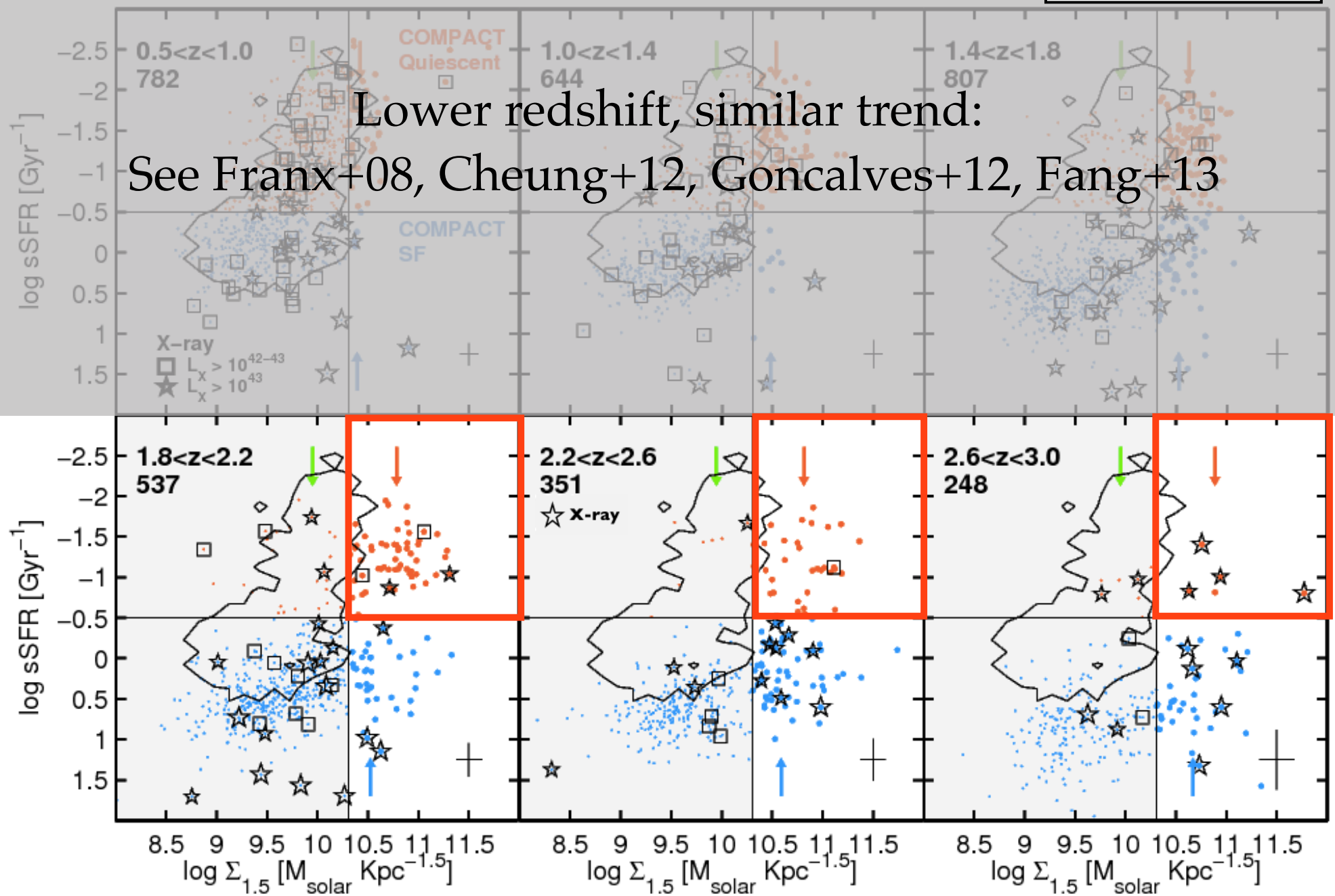
Compact quiescent and SFGs

Barro et al. 2013



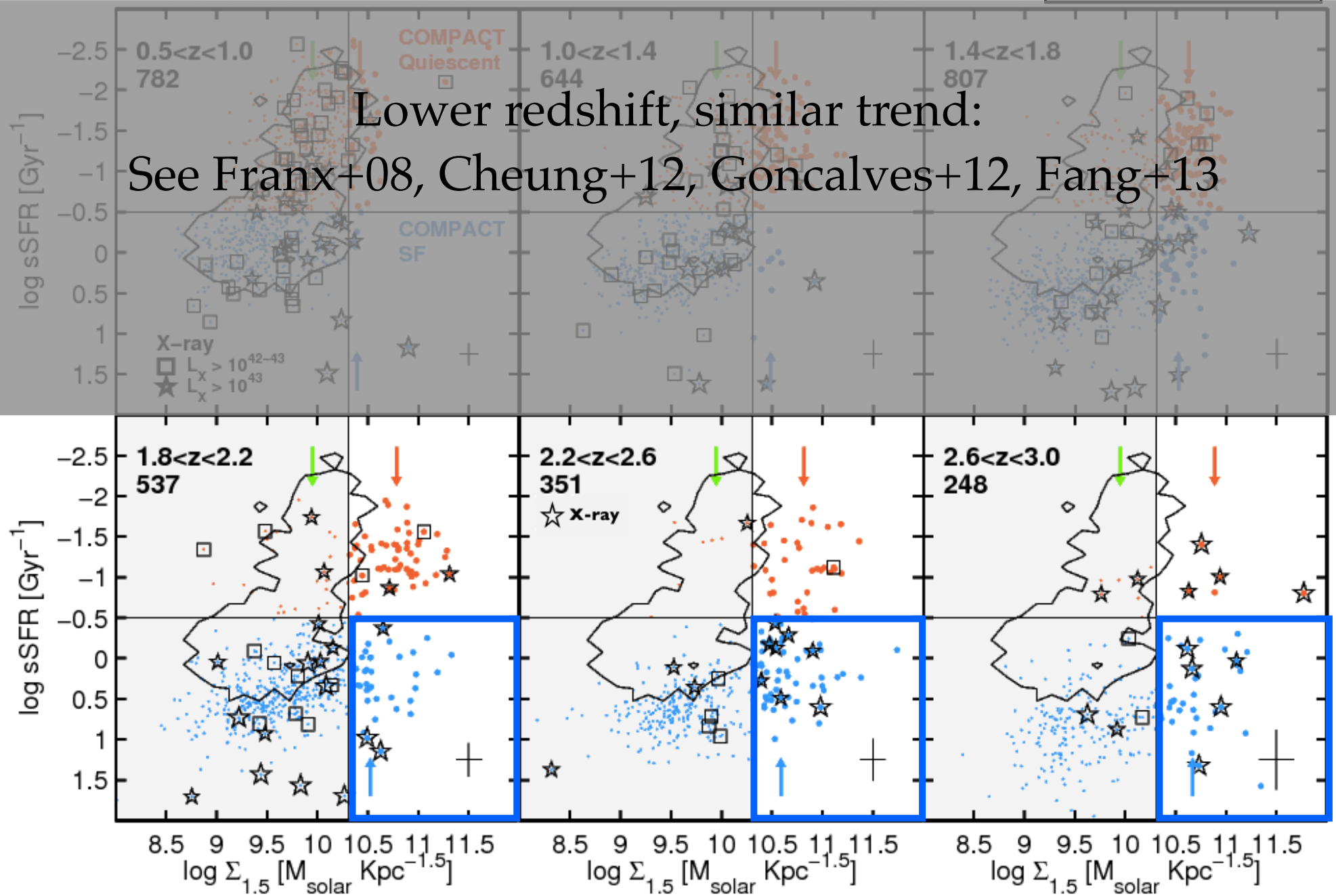
Compact quiescent and SFGs

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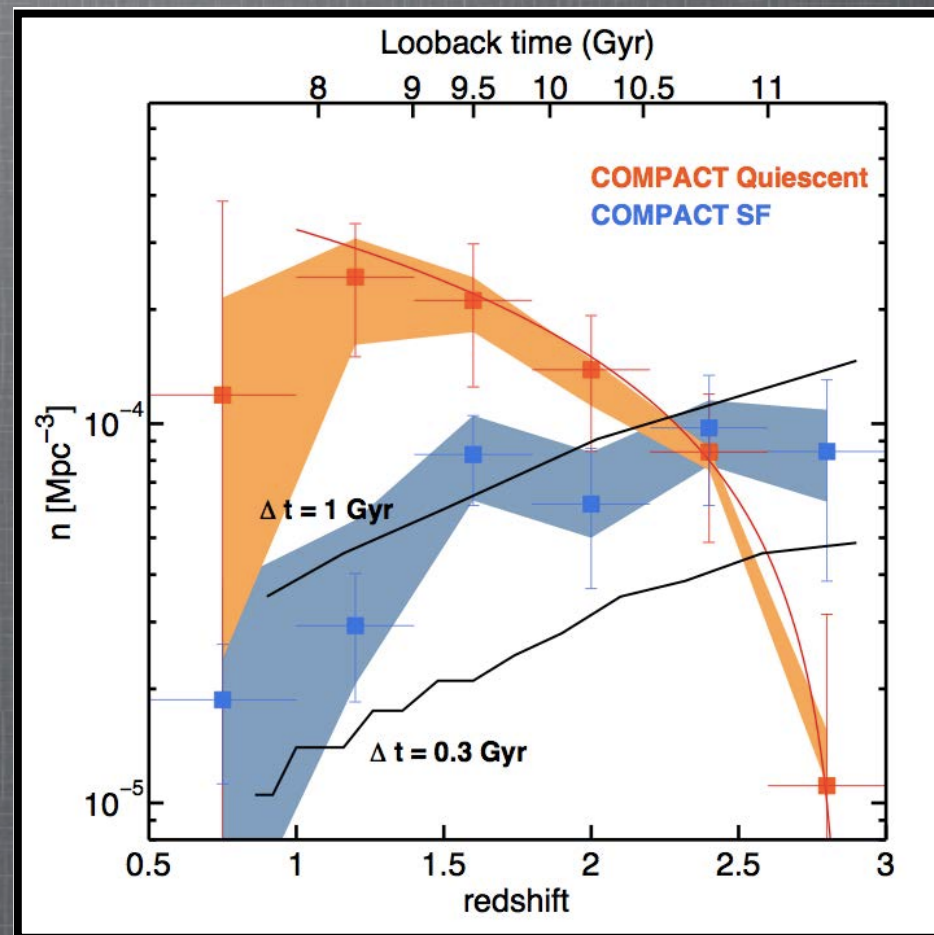
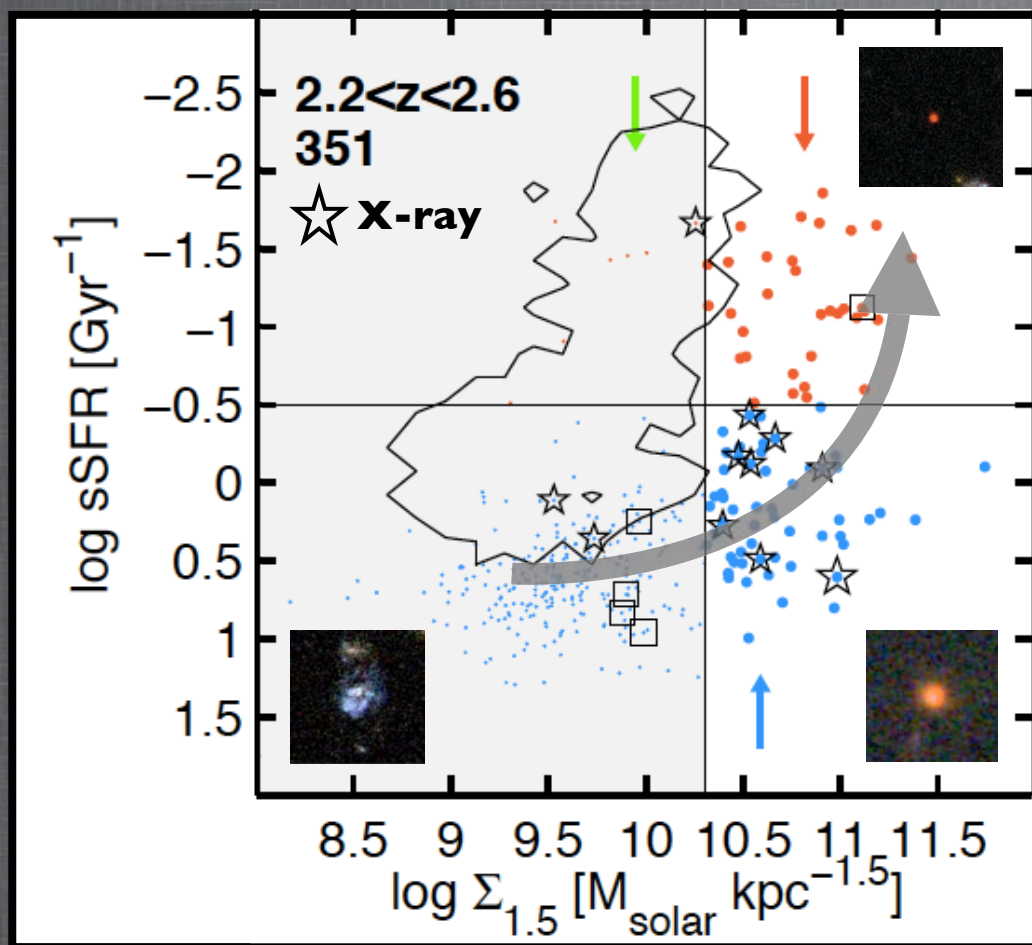


Compact quiescent and SFGs

Barro et al. 2013

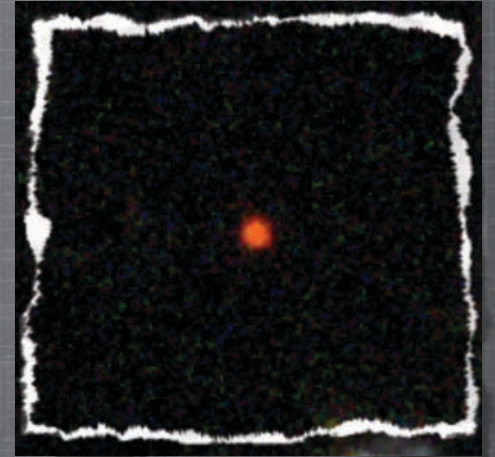
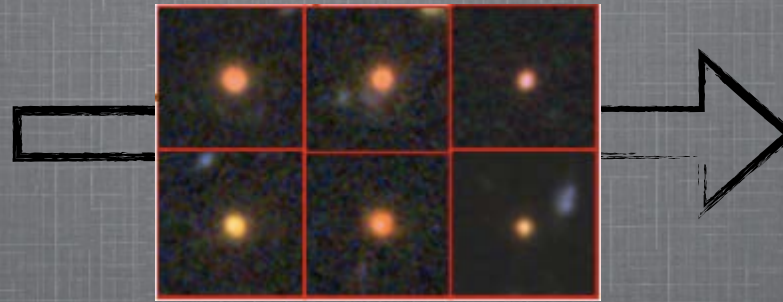
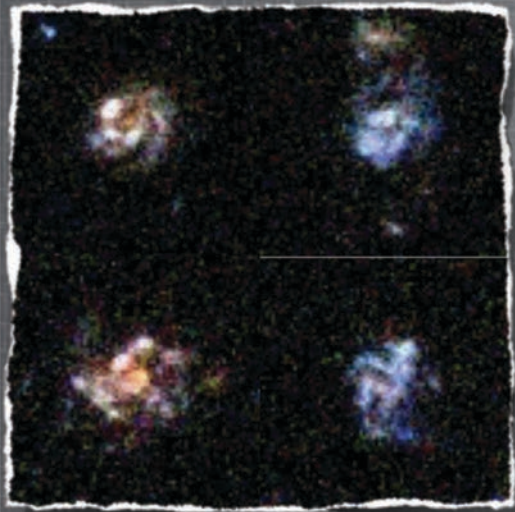


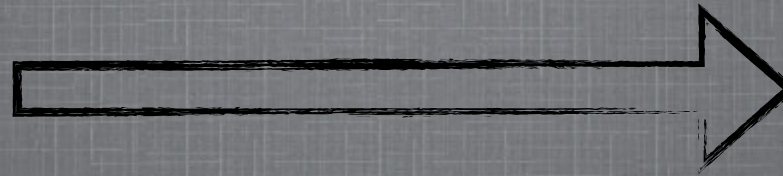
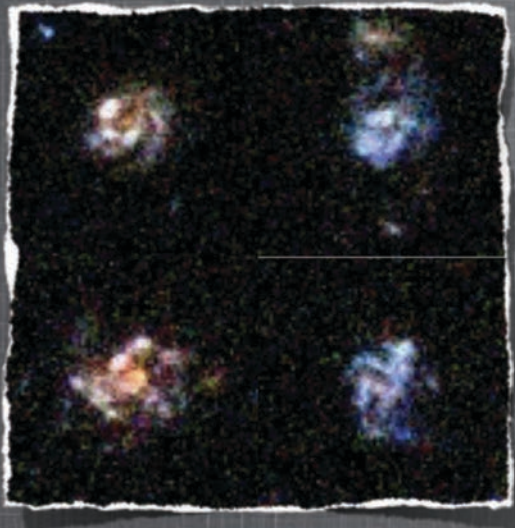
Build up of the red-sequence from cSFGs



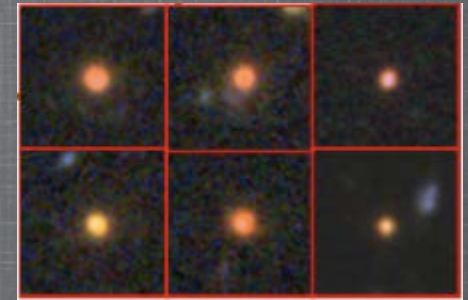
Barro et al. 2013

compact SFGs





compact SFGs



How are these galaxies formed?

Major mergers

- Dissipational galaxy interaction
- Triggers strong starburst

(Hopkins+06,-08; Naab+06,09; Johansson+09;
Wuyts+10; Oser+10,12, etc.)

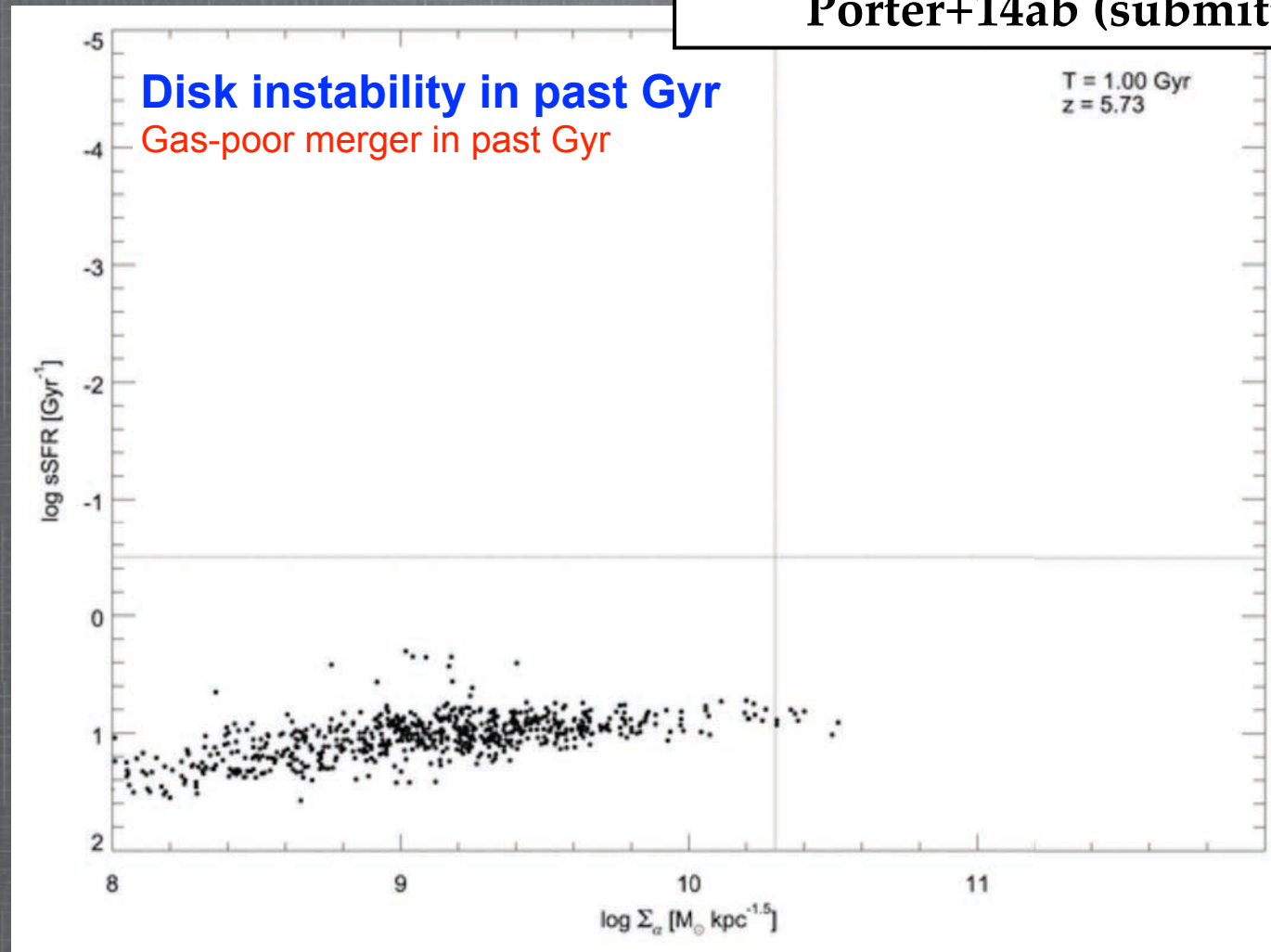
Disk instabilities

- Unstable dynamics -> gas inflow
- Dissipational SF in the center
- Signaled by SF clumps

(Keres+05,Cox+06,Dekel+09,
Hopkin+09,Ceverino+10, etc.)

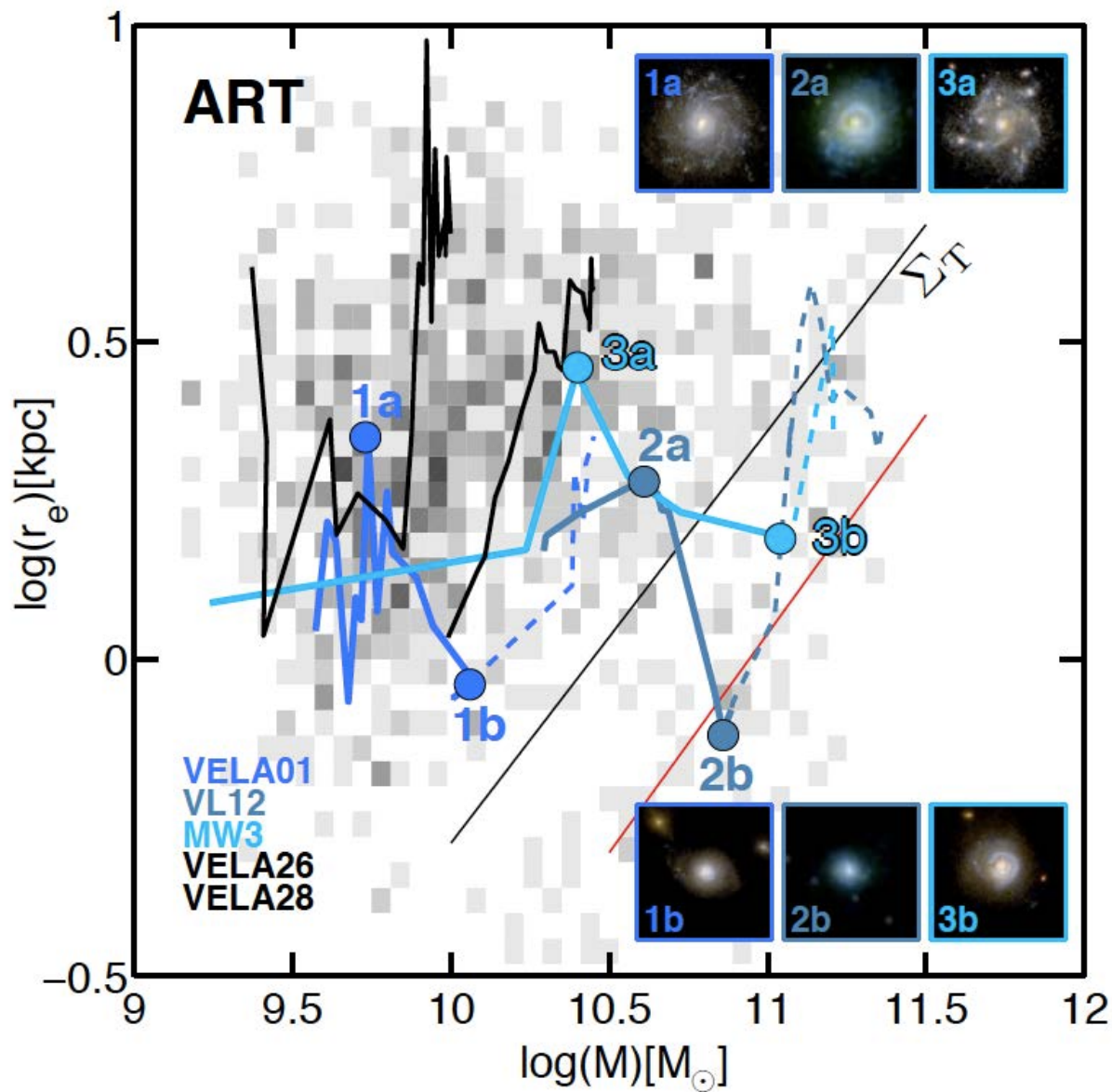
Life-paths of cSFGs from SAMs

Somerville & Primack+14 (in prep)
Porter+14ab (submitted)



- Galaxies become more compact due to disk instabilities (60% vs. 40% mergers)

Life-paths of cSFGs from ART-Hydro

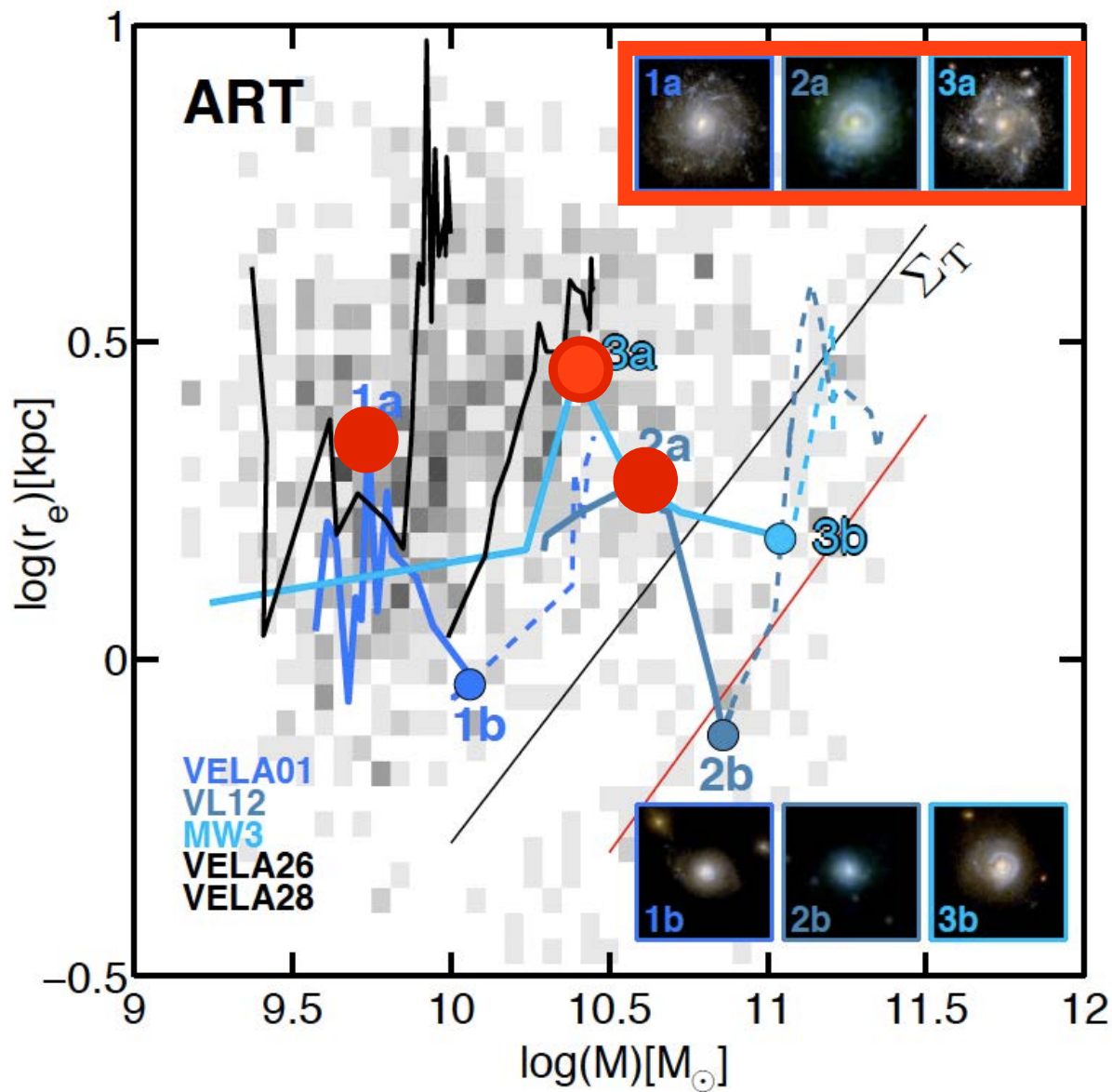


- 20-30 ART-Hydro simulations
(Ceverino+10,12;
Dekel+13b)

- Violent disk instabilities, gas infall & bulge growth (Ceverino, Zolotov in prep).

Barro+14a

Life-paths of cSFGs from ART-Hydro

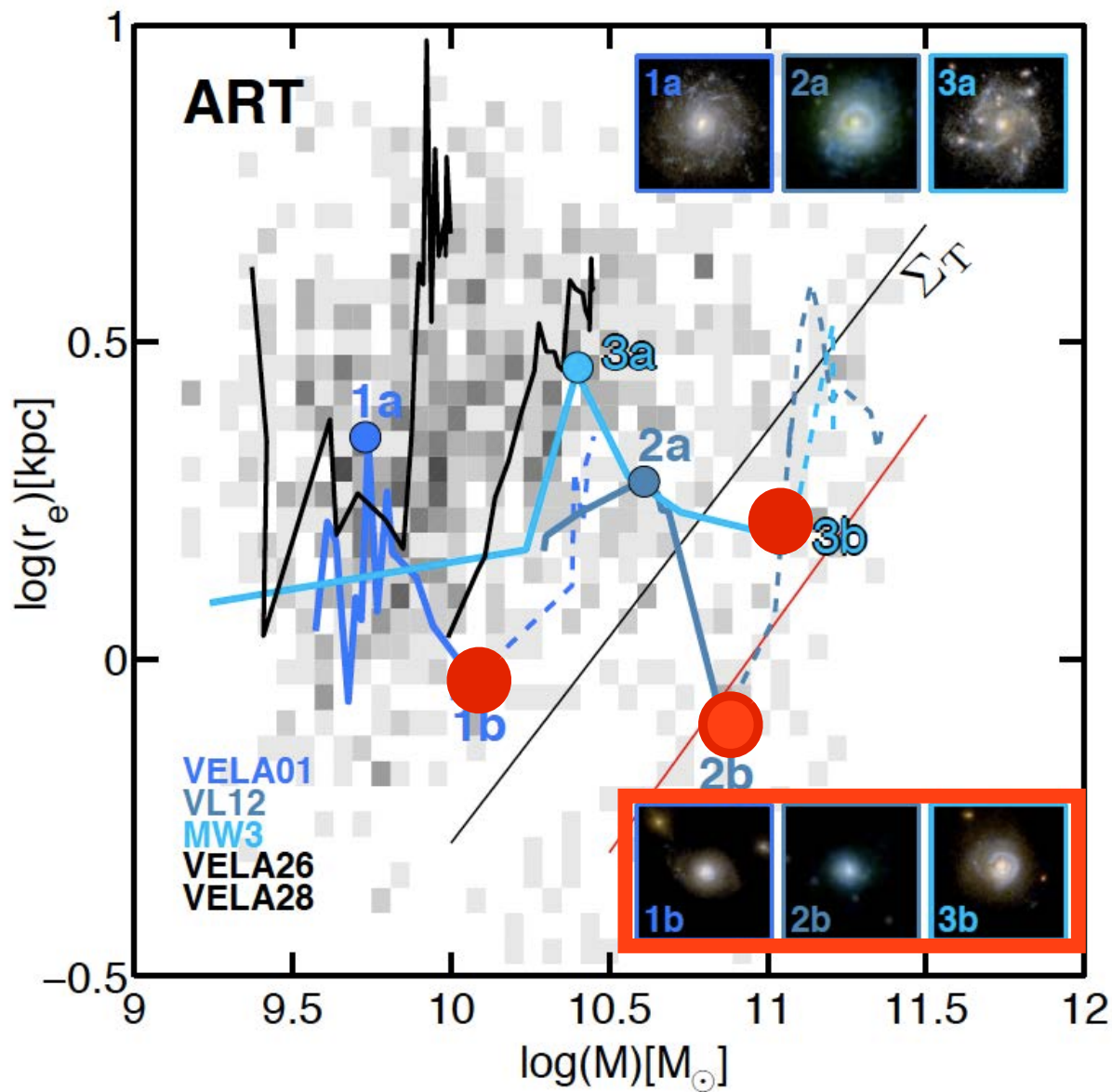


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Barro+14a

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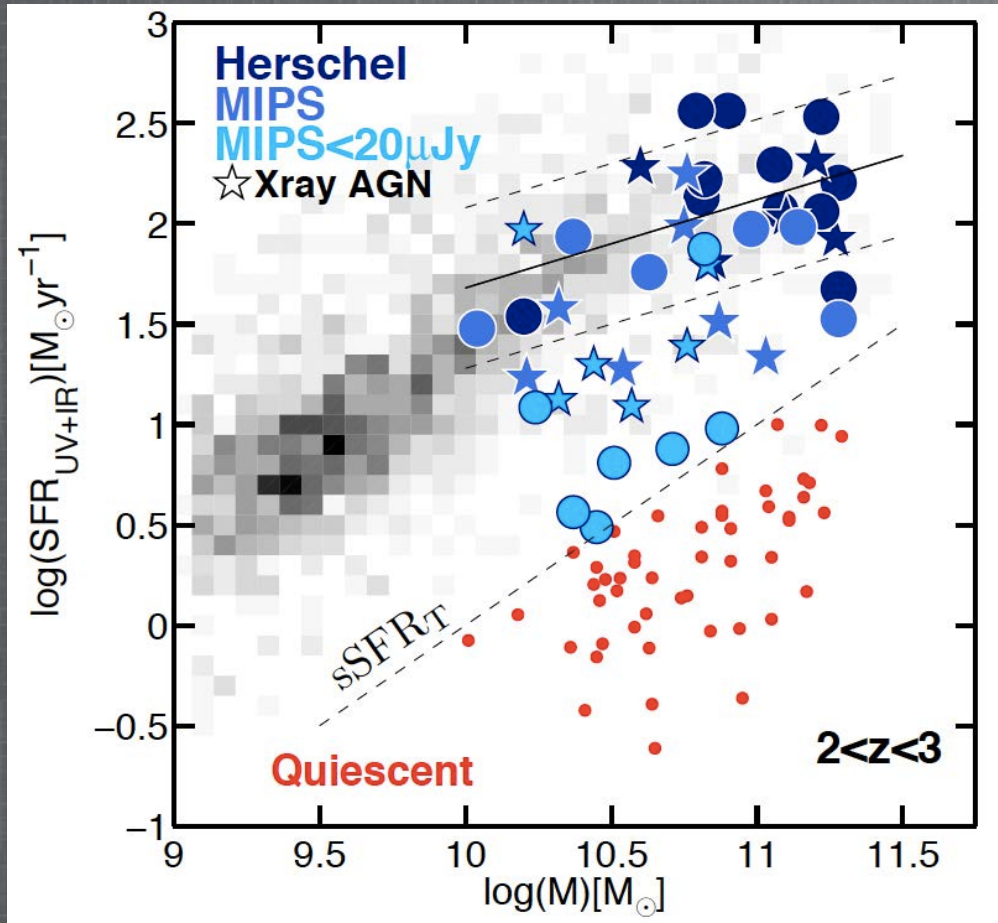


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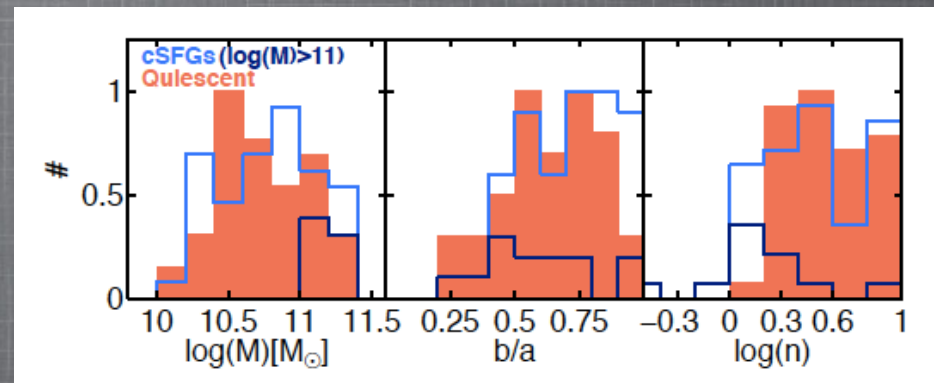
- Violent disk instabilities, gas infall & bulge growth (Ceverino, Zolotov in prep).

Barro+14a

SFRs and dust properties of compact SFGs $2 < z < 3$



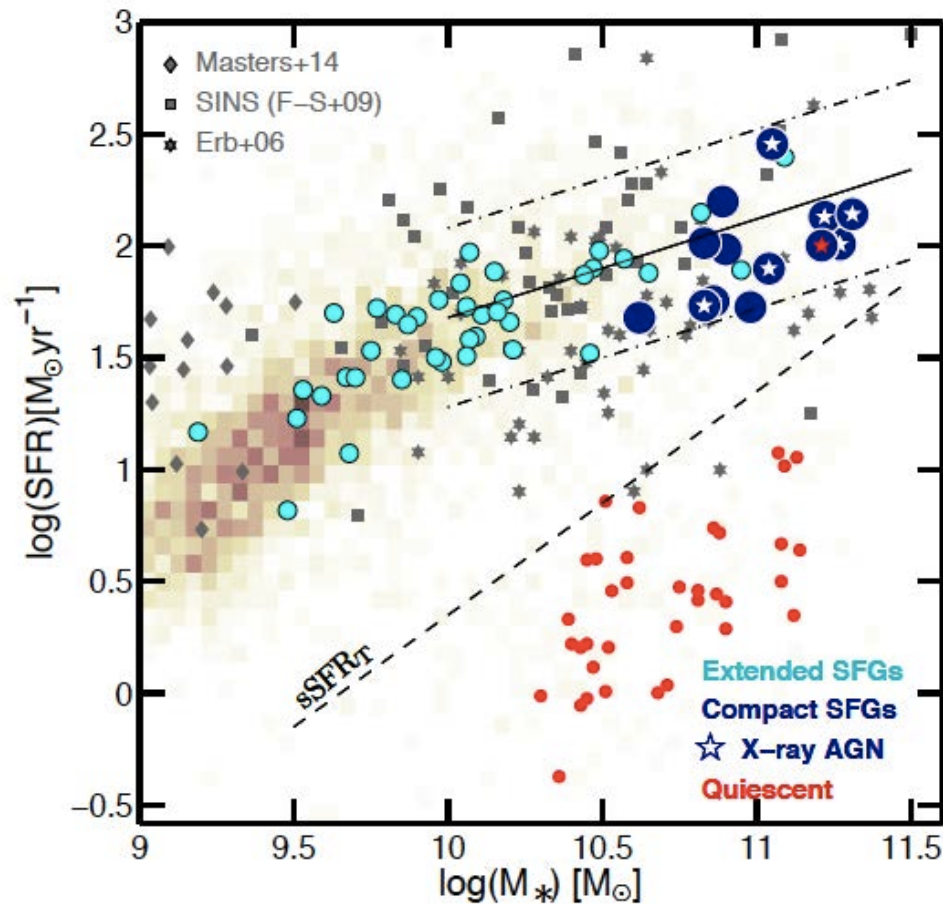
Barro+14a



- 70% are dusty (far-IR)
 - Only 2 starburst
 - 50% are AGNs
 - Range in sSFR
- Consistent w/ quiescent:
- Mass range
 - Sersic index
 - axis ratio

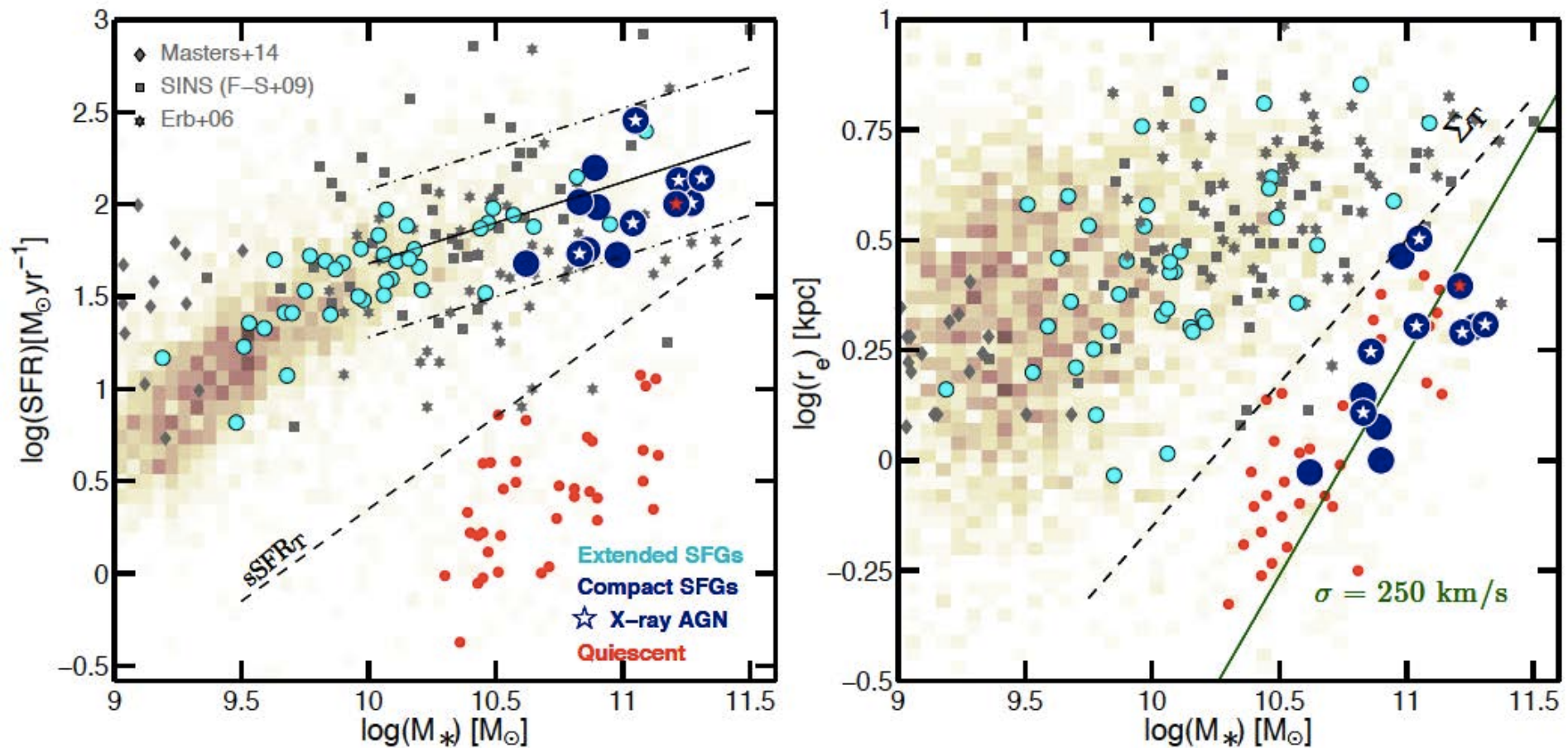
MOSFIRE/NIR - spectroscopic follow-up of compact SFGs

Barro+14b



NIR - spectroscopic follow-up of compact SFGs

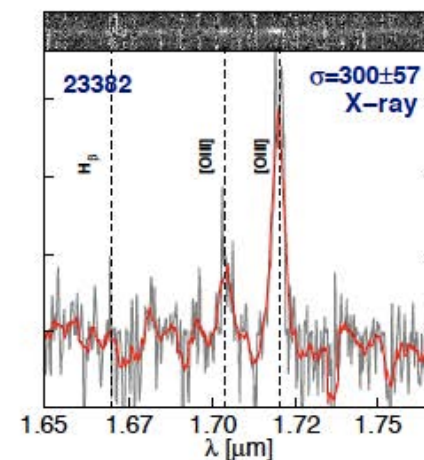
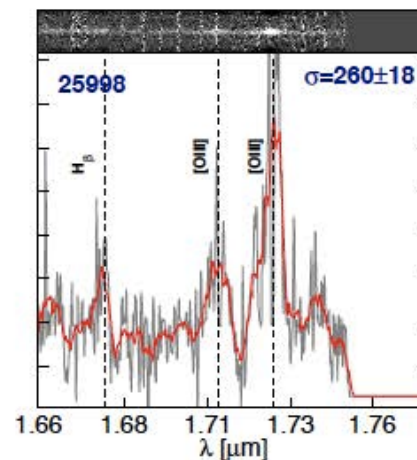
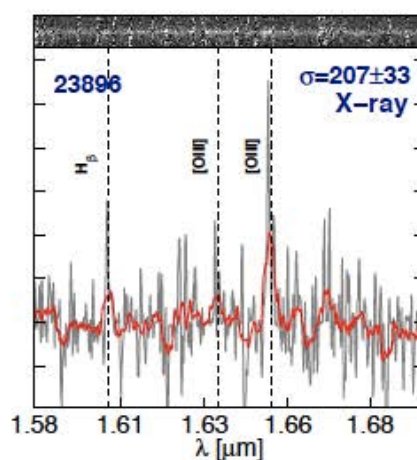
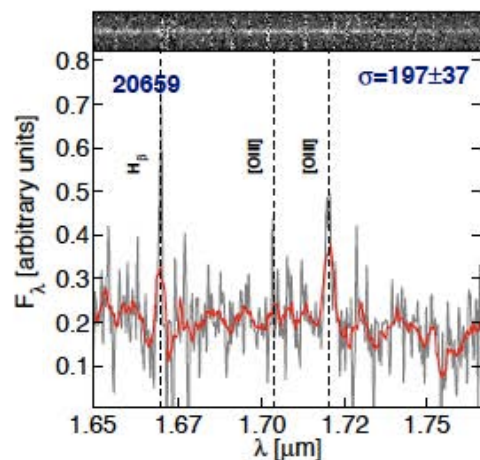
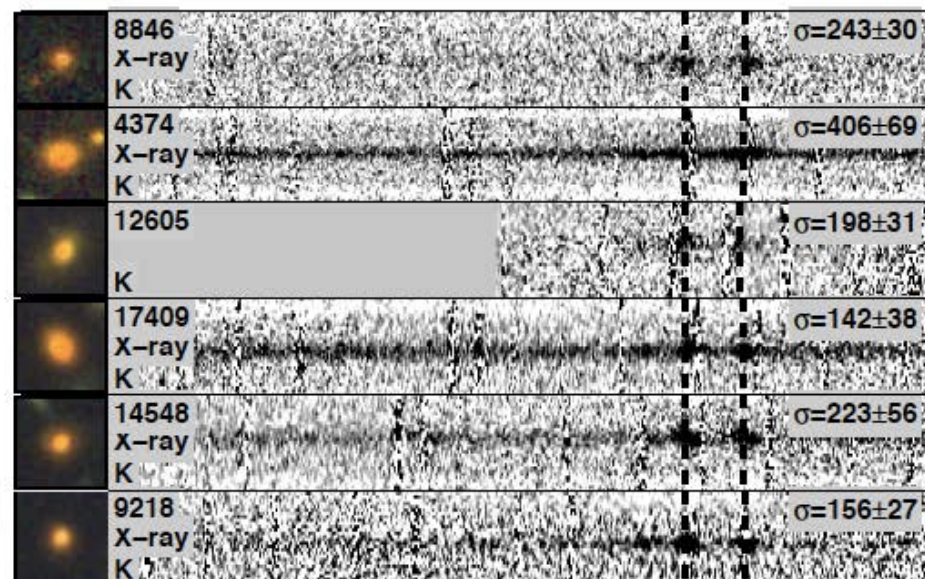
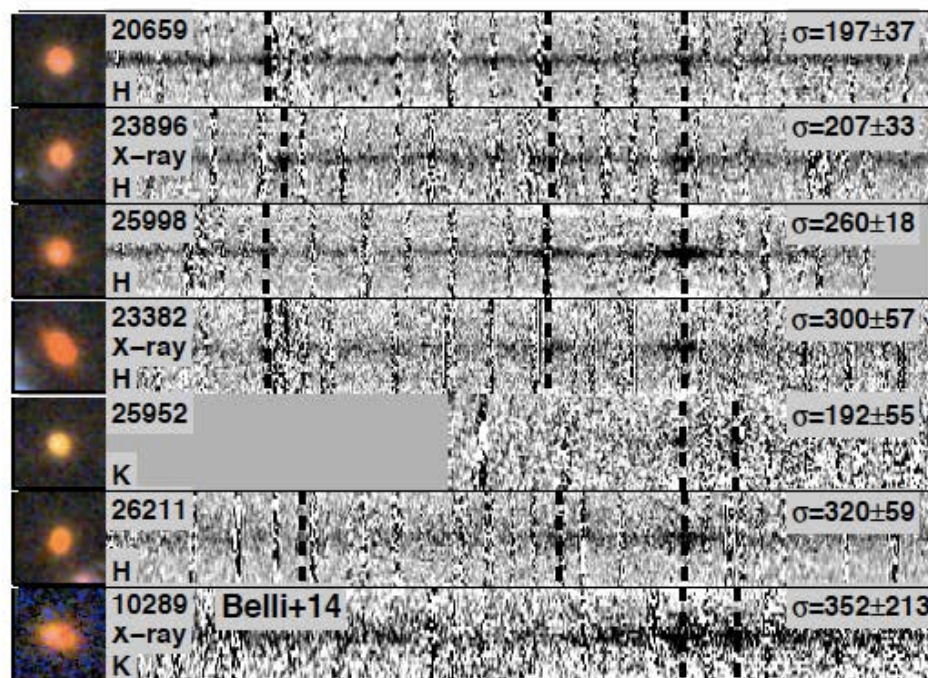
Barro+14b



- Compact SFGs are notoriously missing in NIR surveys (but see Nelson+14)

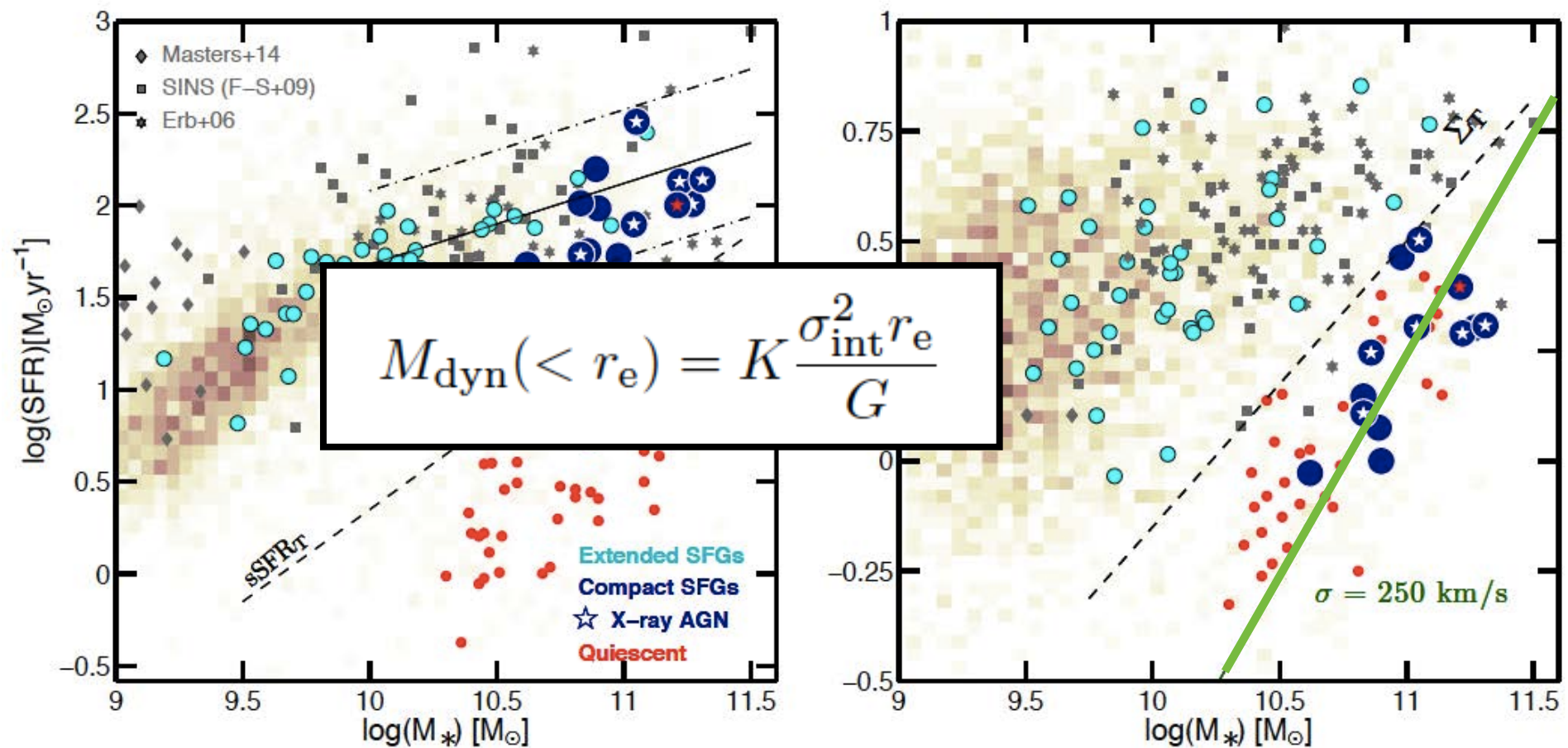
Large gas-phase velocity dispersions $\sigma \approx 230$ km/s

Barro+14b



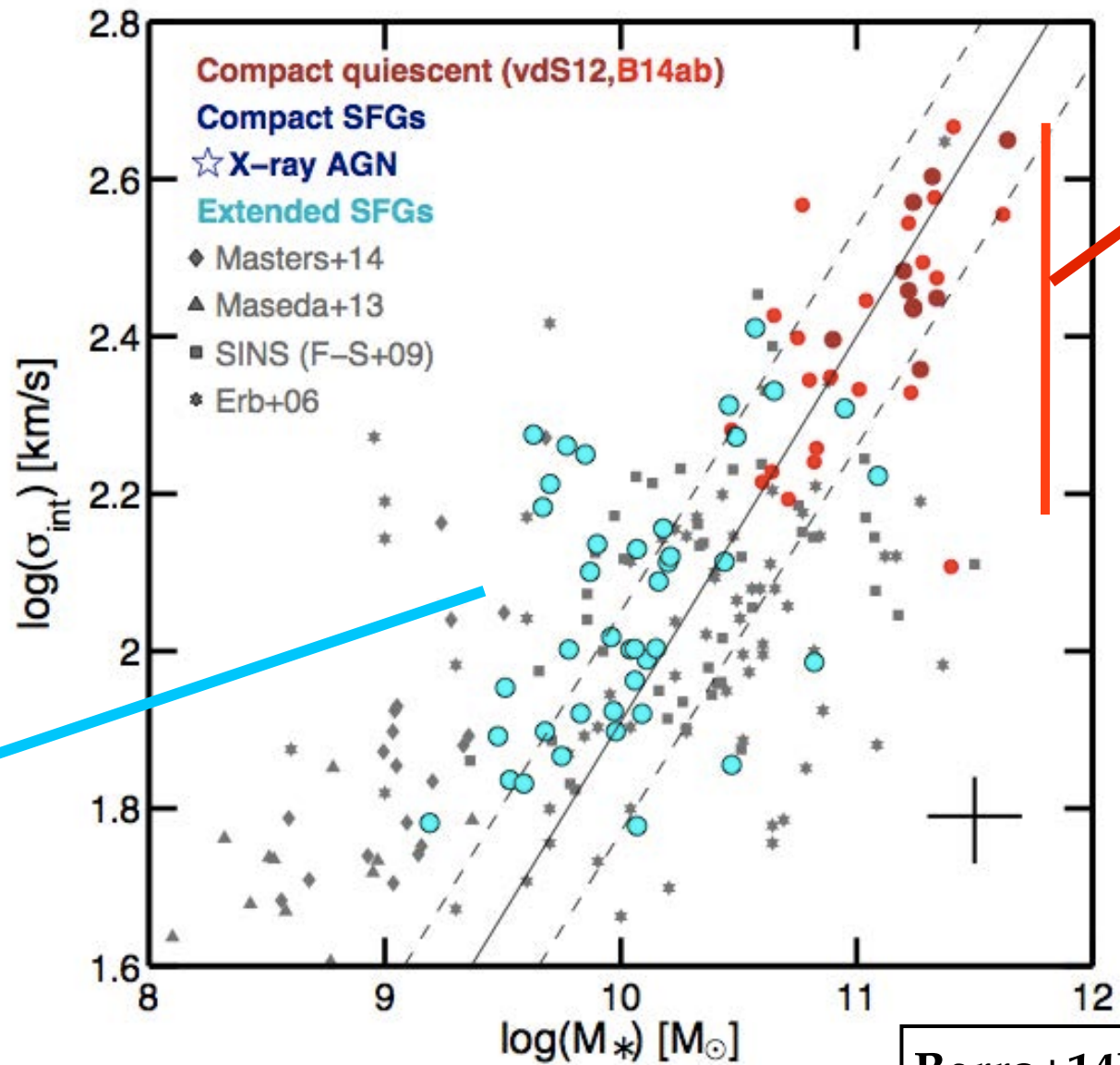
Large gas-phase velocity dispersions $\sigma \approx 230$ km/s

Barro+14b



$M_{\text{star}} - \sigma$ relation

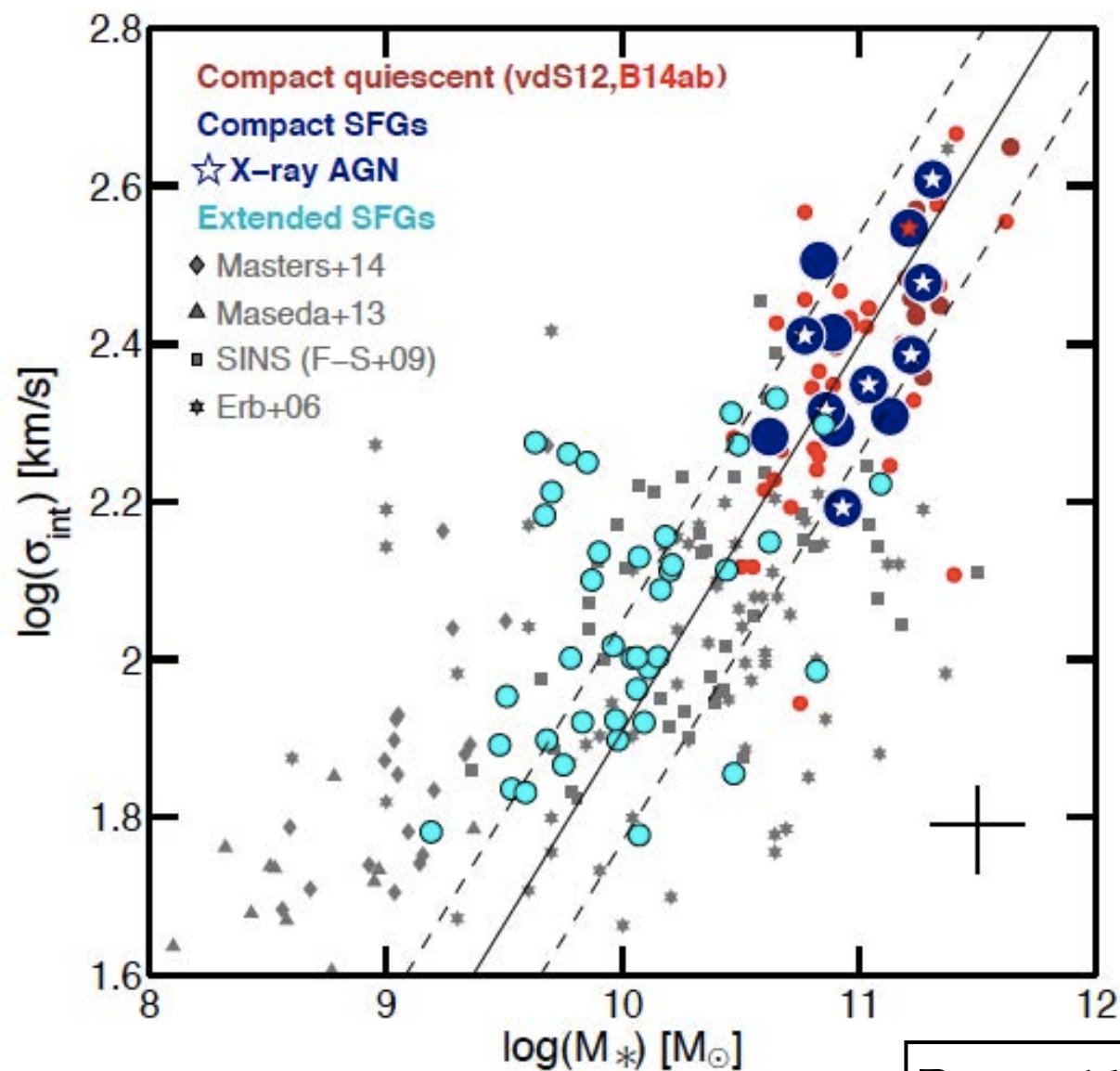
Ionized gas velocity dispersion



Stellar velocity dispersion

Barro+14b

Consistent kinematics in compact SFGs/Quiescent

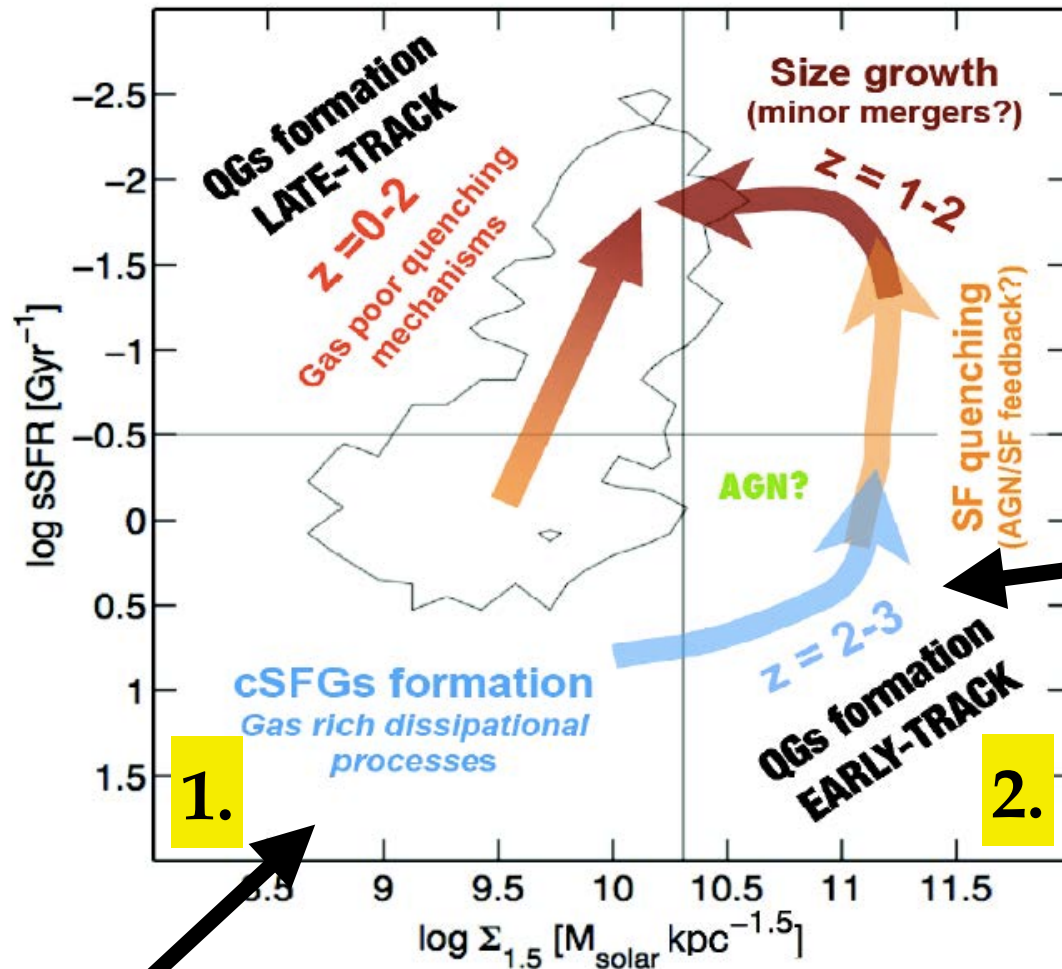


Barro+14b

Summary

Galaxies become compact cores before quenching star-formation

Barro et al., ApJ 2013



Barro et al., ApJ (arXiv 1311.5559)

1. Compact SFGs formation

- ❖ SAMs - DI (60%) , wet mergers (40%)
- ❖ SAMs - Shrinkage by a factor of $\sim x2$
- ❖ ART-hydro - VDI time-scale 300 - 500 Myrs.

2. Compact SFGs properties

- ❖ 70% dusty (IR-) star-formation.
- ❖ high-sersic, undisturbed sph.
- ❖ 50% AGN det. fraction.
- ❖ Consistent with quiescent pop.
- ❖ Age $\sim 1-2$ Gyr.
- ❖ 0.3 -1 Gyr quenching time.

