The build-up of mass in UV-selected sub-L* galaxies at z~2

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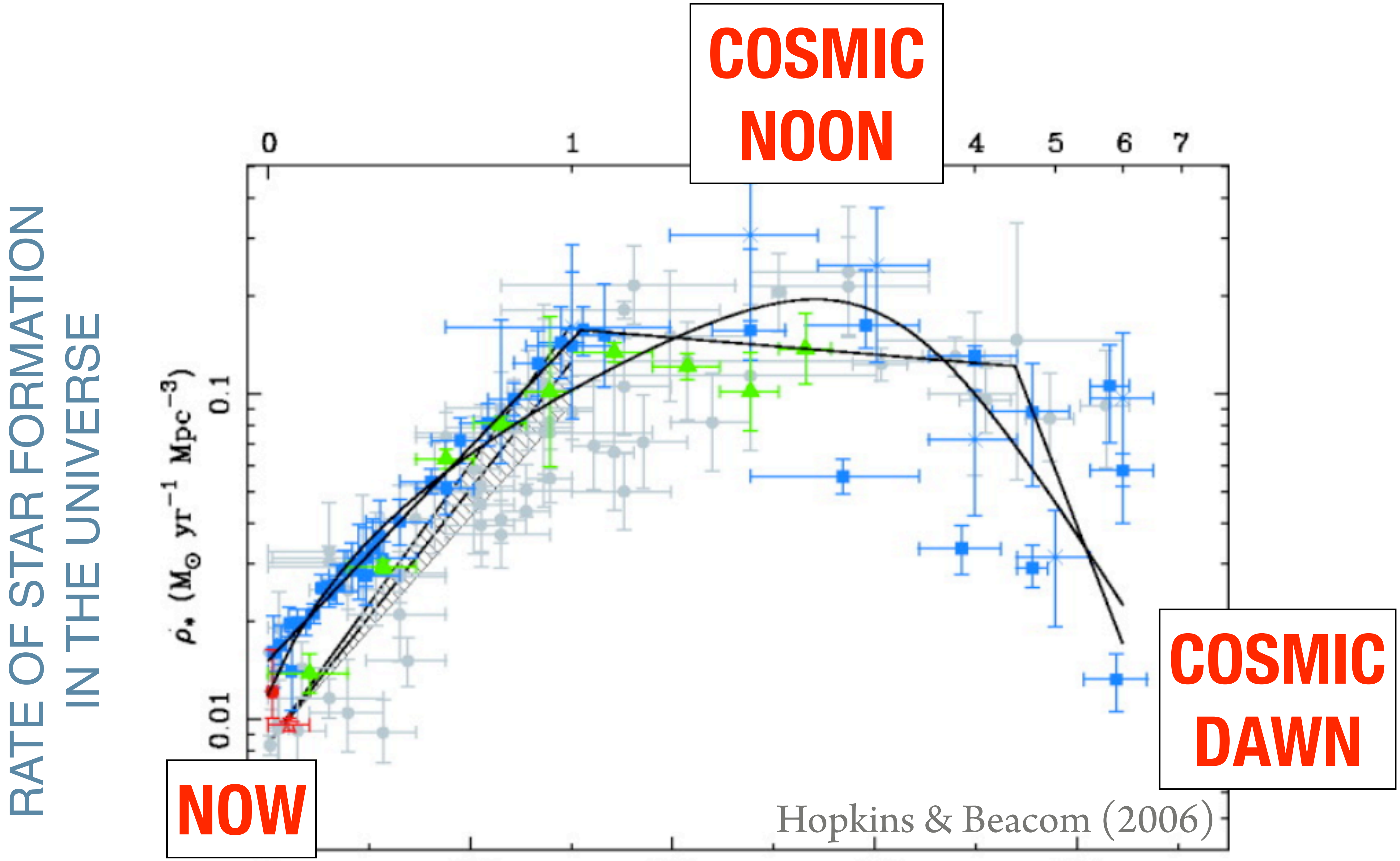
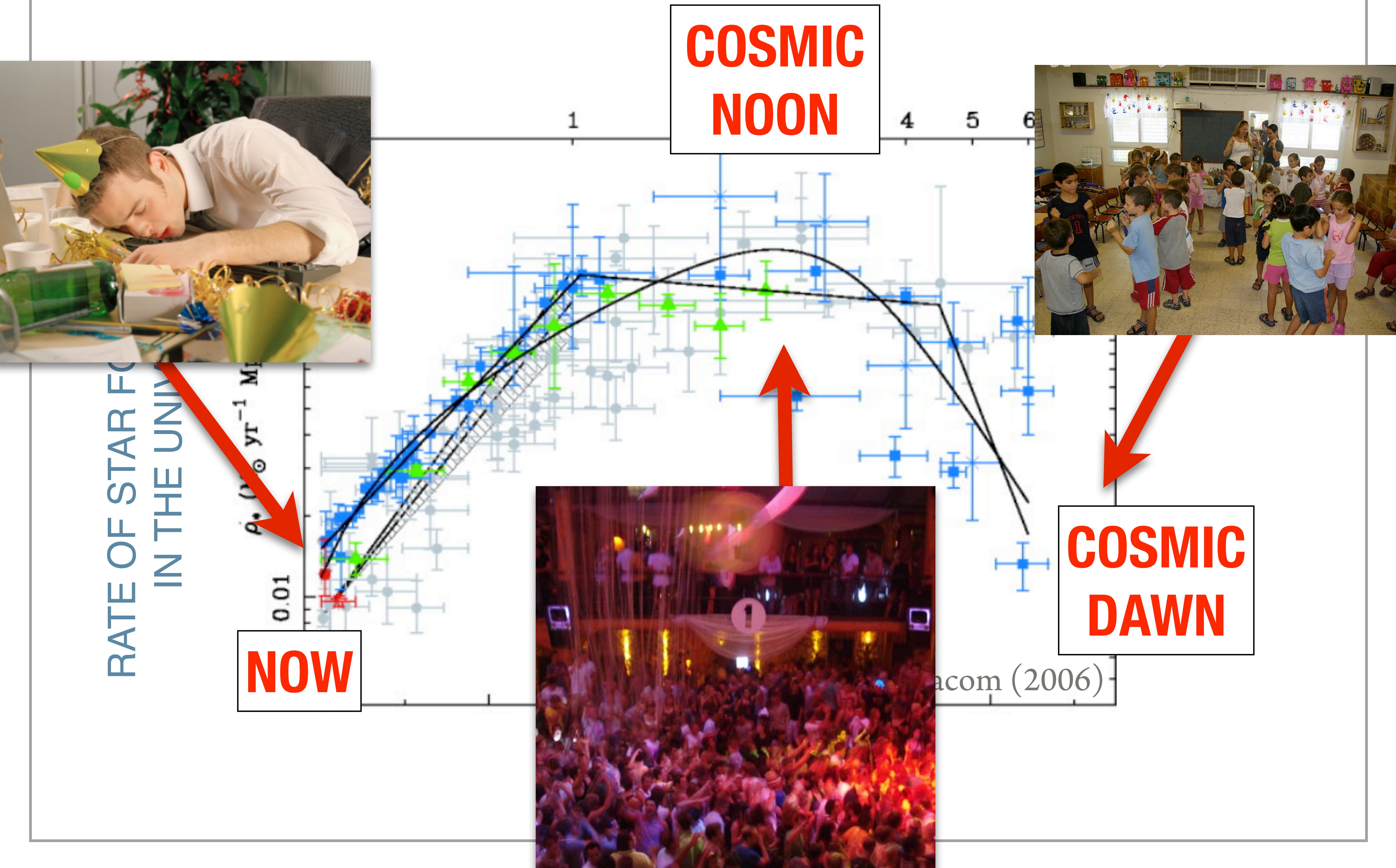
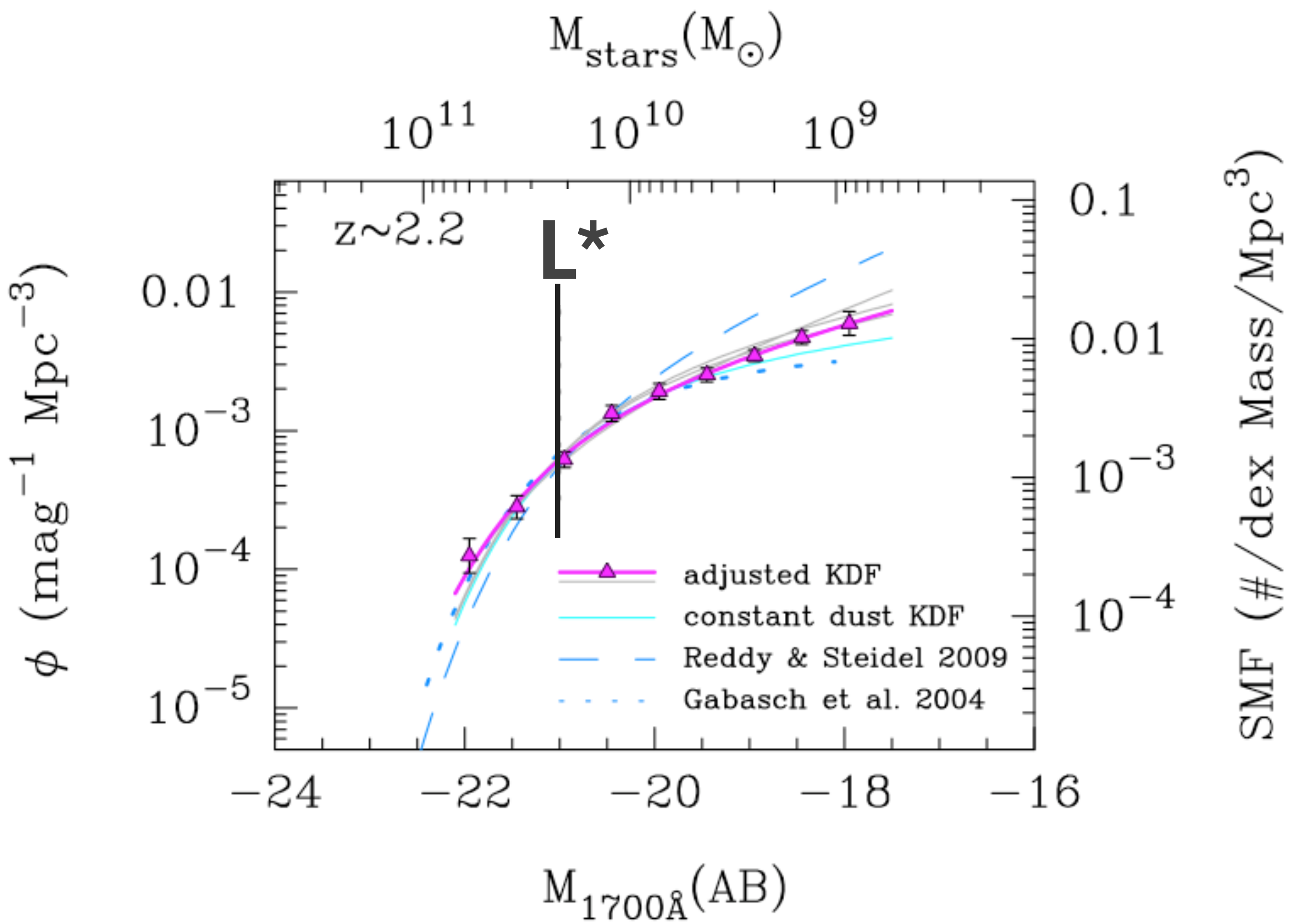
z~2: the most exciting epoch of all time



z~2: the most exciting epoch of all time



Sub-L* galaxies: “the 99%” *

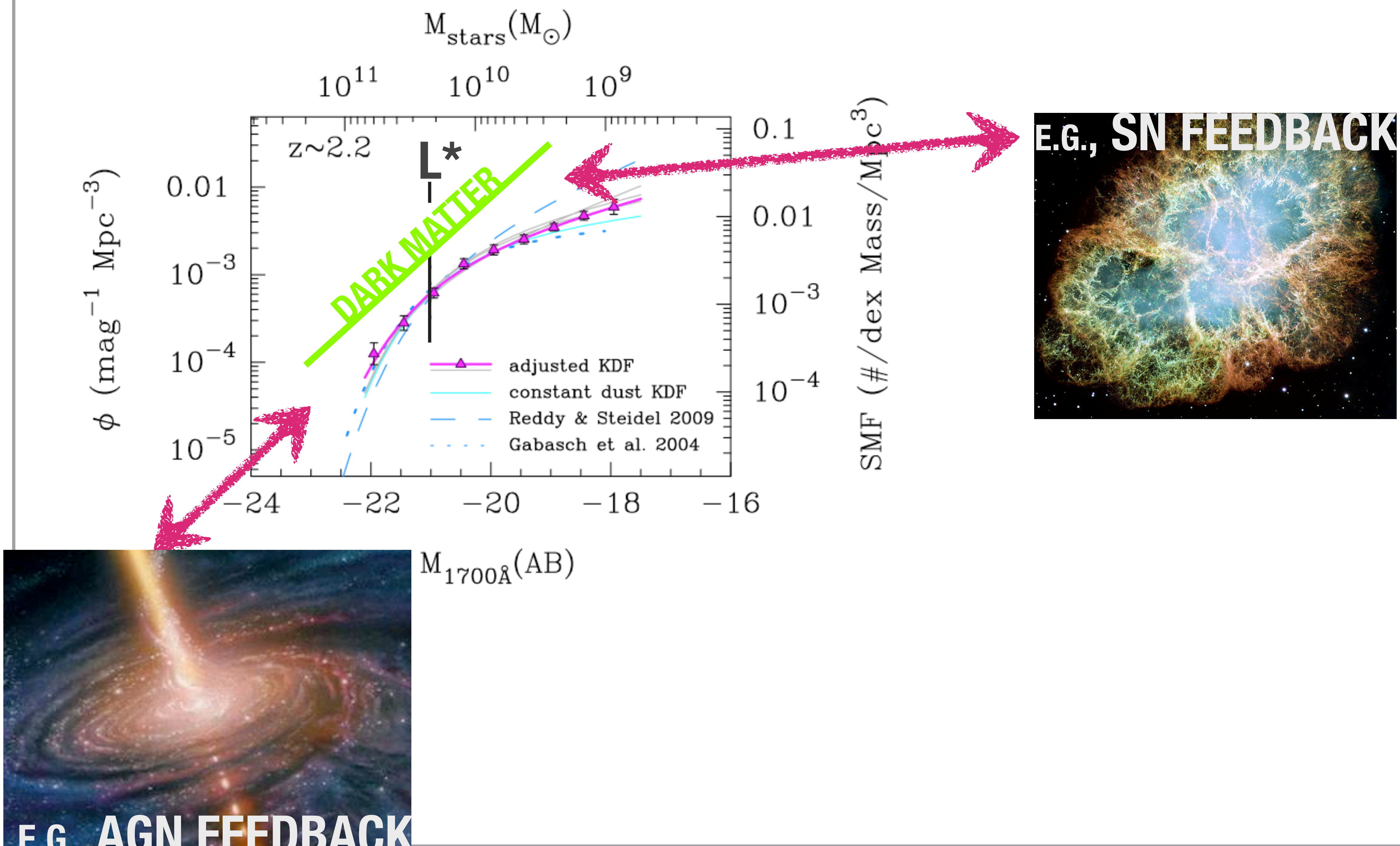


- >99% of galaxies
- ~90% of UV photons
- ~ ⅓ -¼ of star formation

*) with apologies to E. Peng

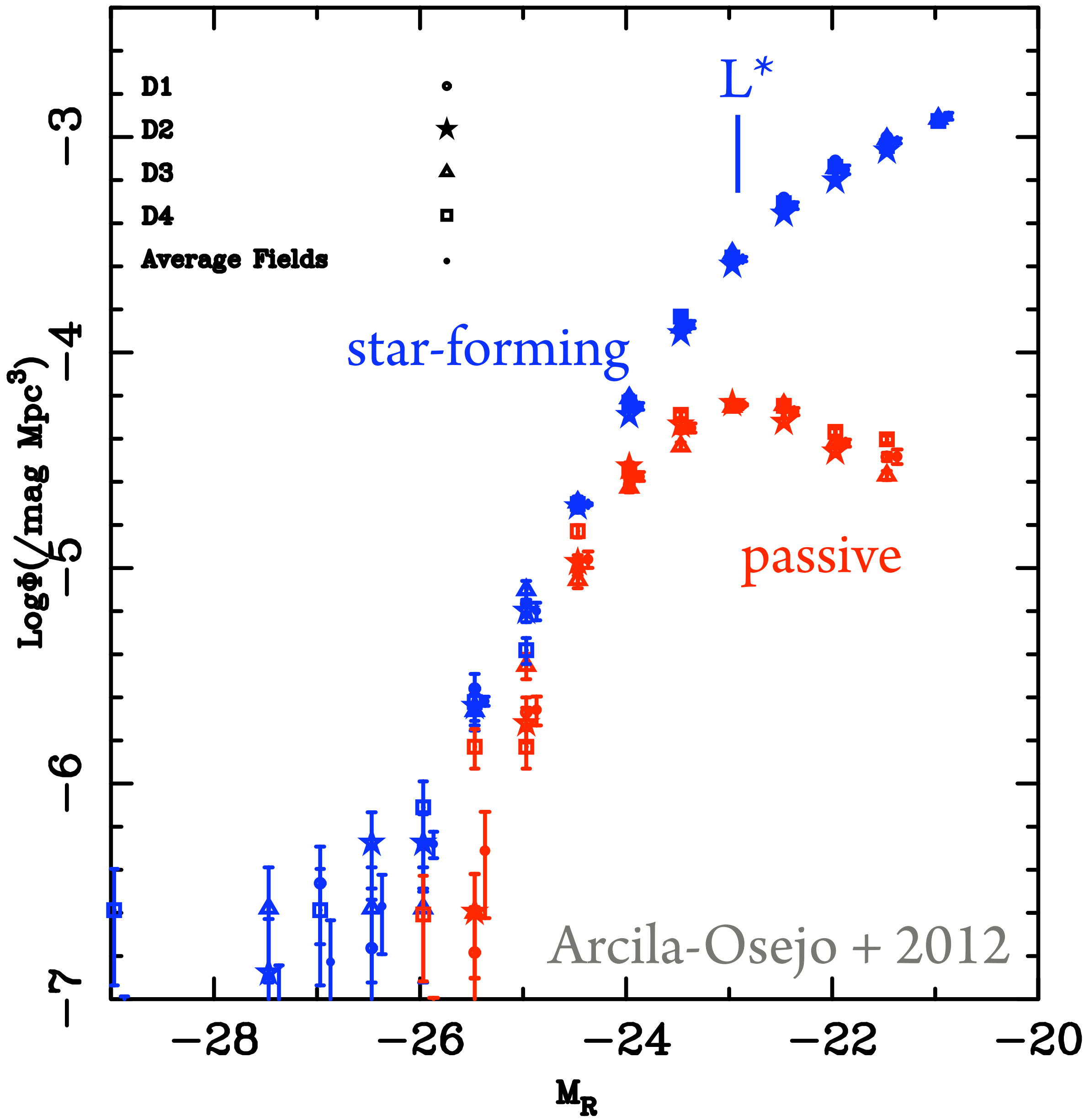
Sub-L* galaxies: “the 99%”

probe different physical regimes of galaxy formation physics



So let's study them

CFHTLS-Deep, 2.5deg², BzK-like selection



- very few passive galaxies at the faint end

➡ let's focus on the star-formers

Three results...

(1) Dust:

z~2 sub-L* star-formers are close to naked (dust-free)

(2) Stellar mass growth:

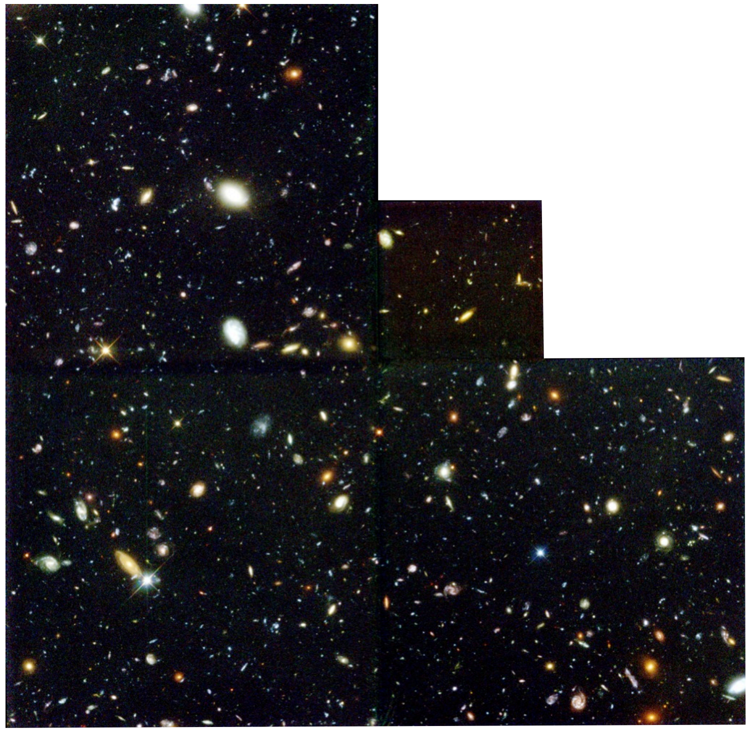
consistent with inefficient star formation that utilizes newly-accreting gas

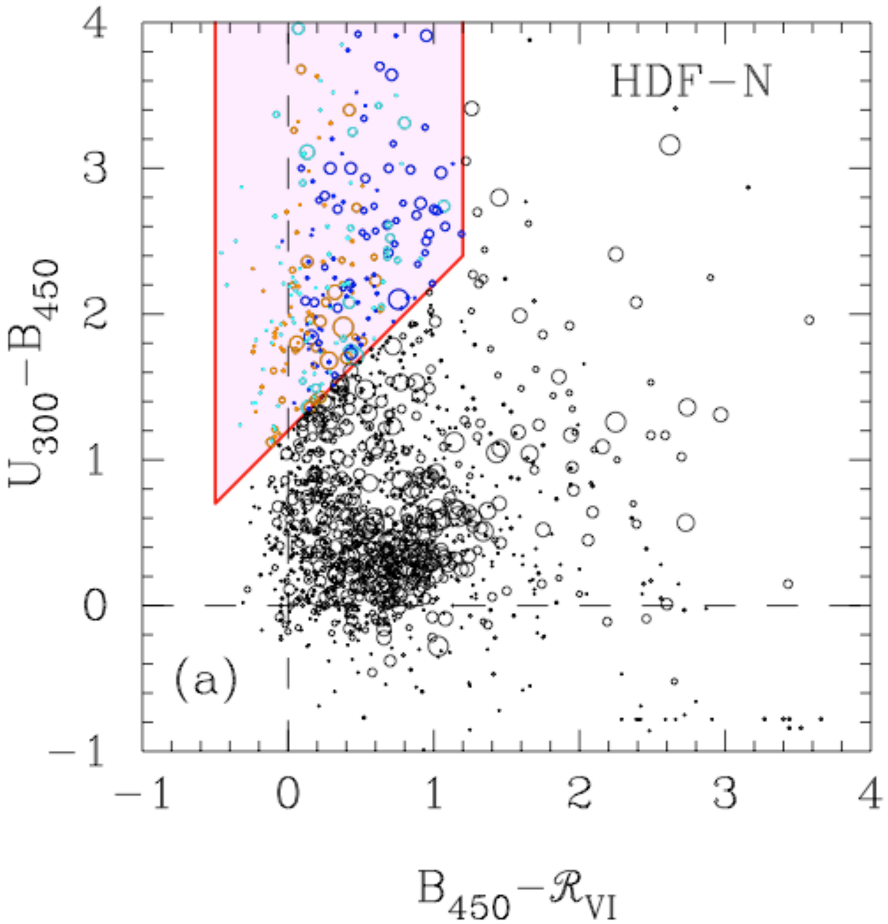
(3) Downsizing in halo mass:

at z~1.7 the most clustered galaxies are no longer the most UV-bright

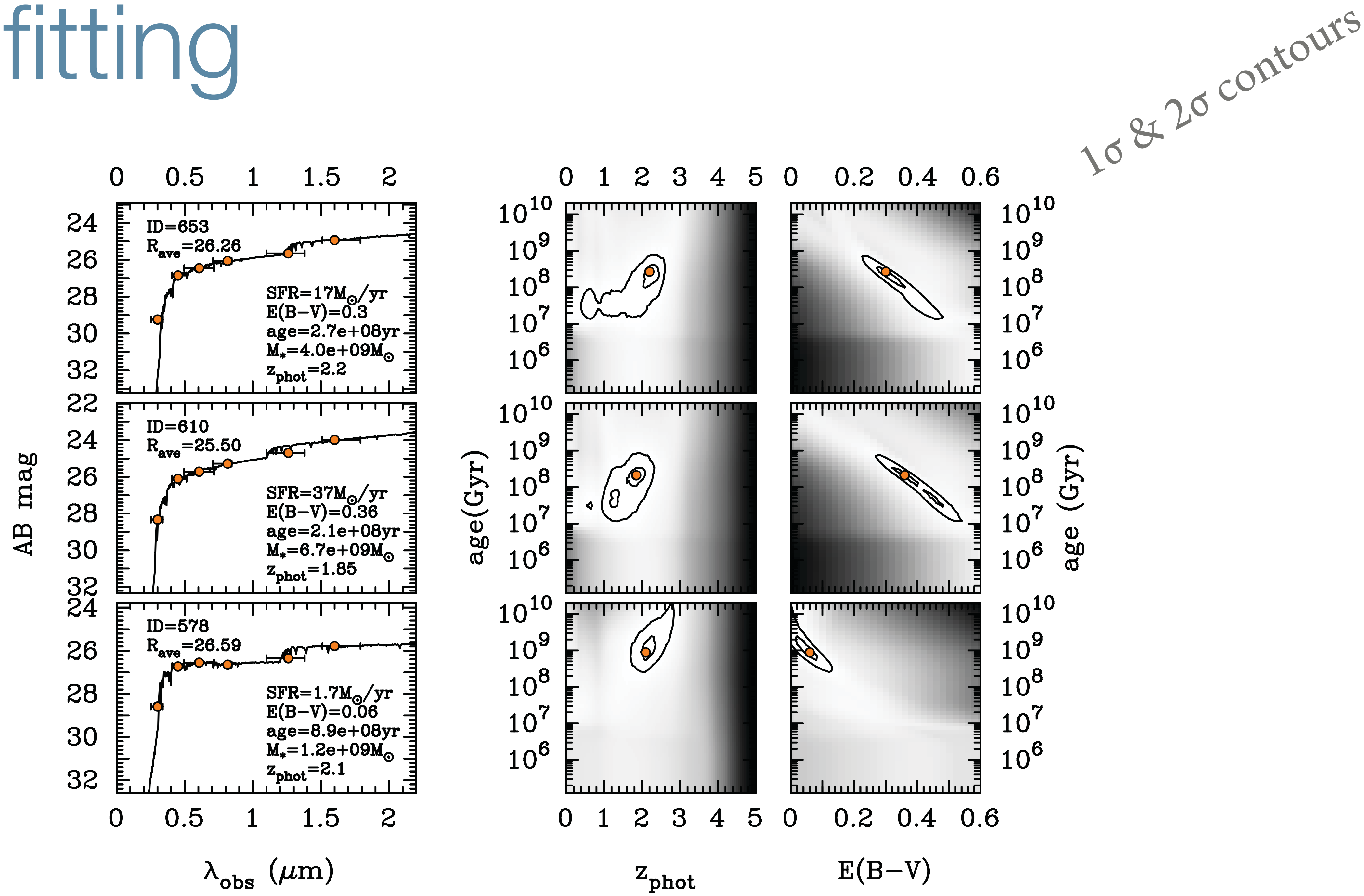
SED fitting: the sample

- color-color BX selection
- Hubble Deep Field (depth and λ coverage)
- $U_{300}\ B_{450}\ V_{606}\ I_{814}$+$J_{110}\ H_{160}$: good for z~2
- ~100 objects with *R*=25-28 (note: L*~24.5)
- $\langle z_{phot} \rangle = 2.3$



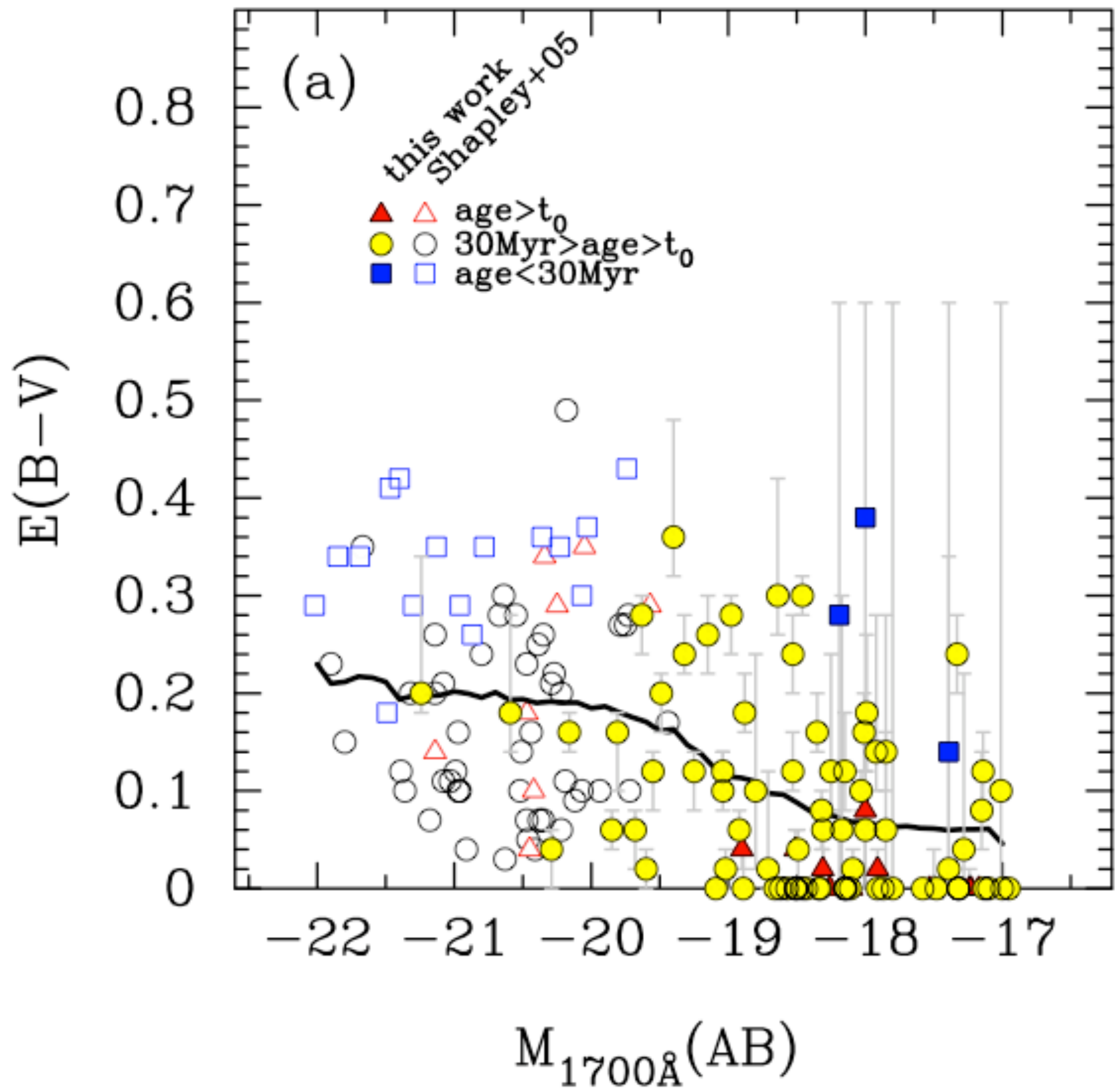


SED fitting



- models: constant SFR B&C (2003) + Calzetti et al. (2000) dust (for consistency with Shapley et al. 2005 ~L* galaxies)
- fitting code: *SEDfit* (Sawicki & Yee 1998; Sawicki 2012)

Dust



- M* galaxy: only ⅕ of UV photons emerge
- M*+3 galaxy: > ½

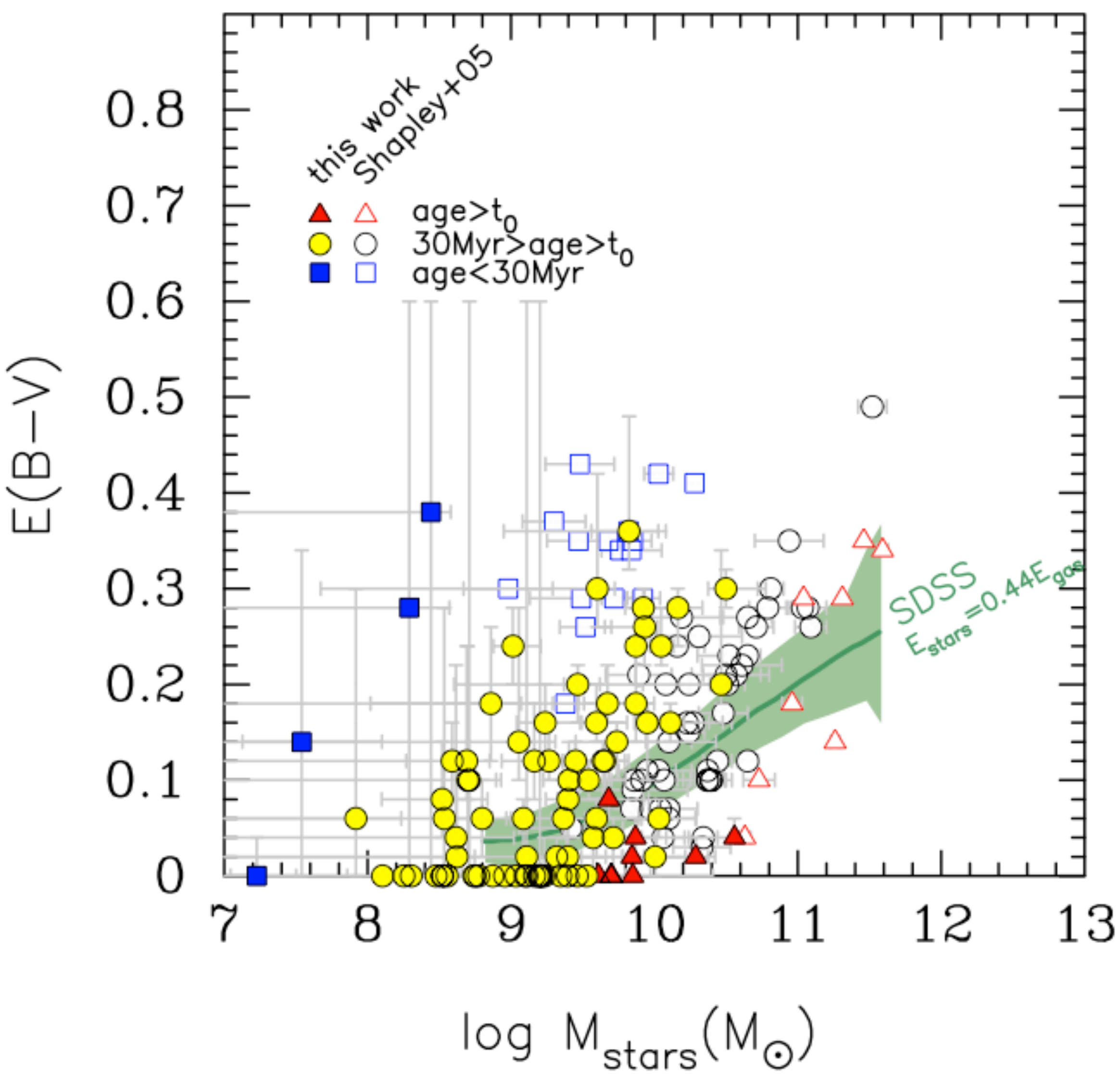
➡ Sub-L* galaxies are far more naked than L* galaxies


Manet (1863)

➡ sub-L*'s easier to study

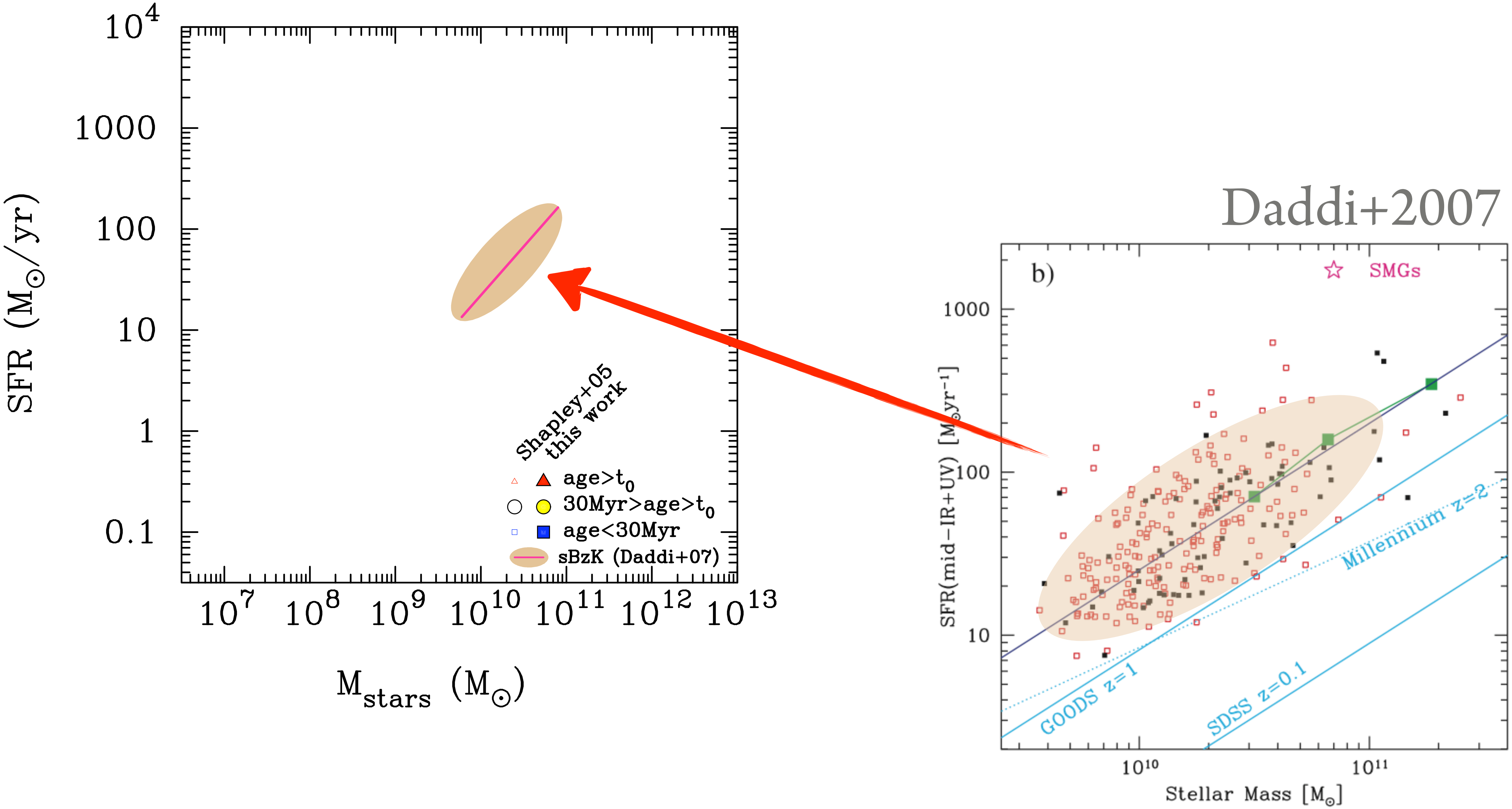
➡ punch "above their weight" in keeping Universe ionized

(1) Dust

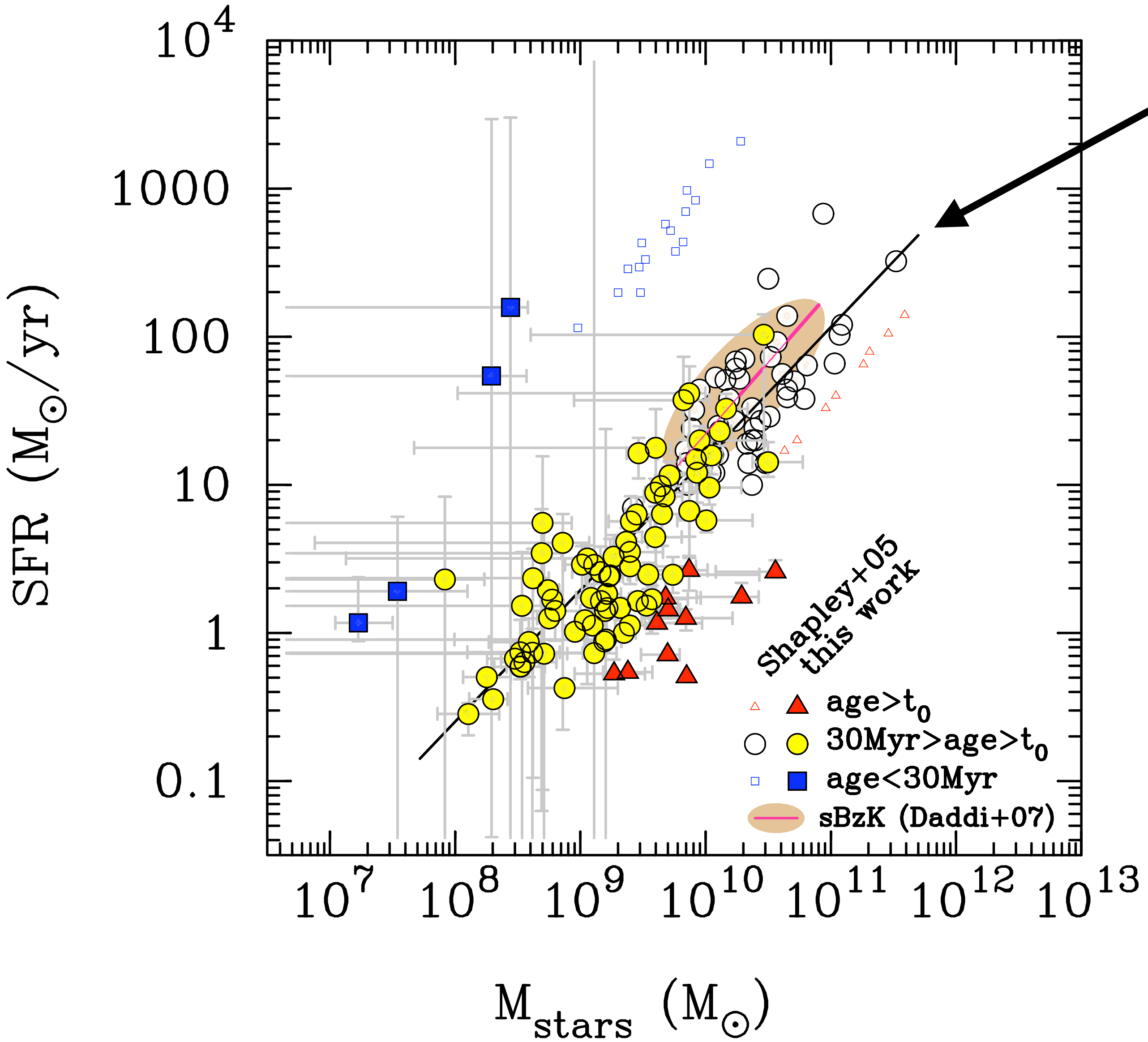


- underlying trend is with stellar mass

SFR-M$_{stars}$ relation



SFR-M$_{stars}$ relation



$$\log\left(\frac{SFR}{M_\odot yr^{-1}}\right) = (0.89\pm0.03)\log\left(\frac{M_{stars}}{M_\odot}\right) - (7.69\pm0.27)$$

- a ~1:1 relation over ~3 orders of magnitude in stellar mass
- why?

Star formation from accreting gas?

N-body simulations give DM accretion rate as function of halo mass:

$$\log \dot{M}_{DM} = (0.8 - 0.9) \log M_{DM} + k$$

e.g.: Tilvi+2009

Add two ingredients:

(1) $$\frac{\dot{M}_b}{\dot{M}_{DM}} = \frac{\Omega_b}{\Omega_{DM}}$$

Baryons & DM accrete together out of the "background"

(2) $$SFR = f_* \dot{M}_b$$

A fraction (f_*) of the baryons turns into stars

This gives:

$$\log SFR = (0.8 - 0.9) \log M_{DM} + k'$$

Star formation from accreting gas?

$$\log SFR = (0.8 - 0.9) \log M_{DM} + k'$$

assume $M_{DM} \propto M_{stars}$ in our galaxies:

$$\log SFR = (0.8 - 0.9) \log M_{stars} + k''$$

compare with observations:

$$\log\left(\frac{SFR}{M_{\odot} yr^{-1}}\right) = (0.89 \pm 0.03) \log\left(\frac{M_{stars}}{M_{\odot}}\right) - (7.69 \pm 0.27)$$

Conclusion:

Observed SFR-M_{stars} relation consistent with a model in which stars form out of gas that co-accretes along with infalling dark matter.

see also Bouche+2010

Star formation from accreting gas?

Combining, while fixing N-body parameters from simulations (e.g., Tilvi et al. 2009), gives:

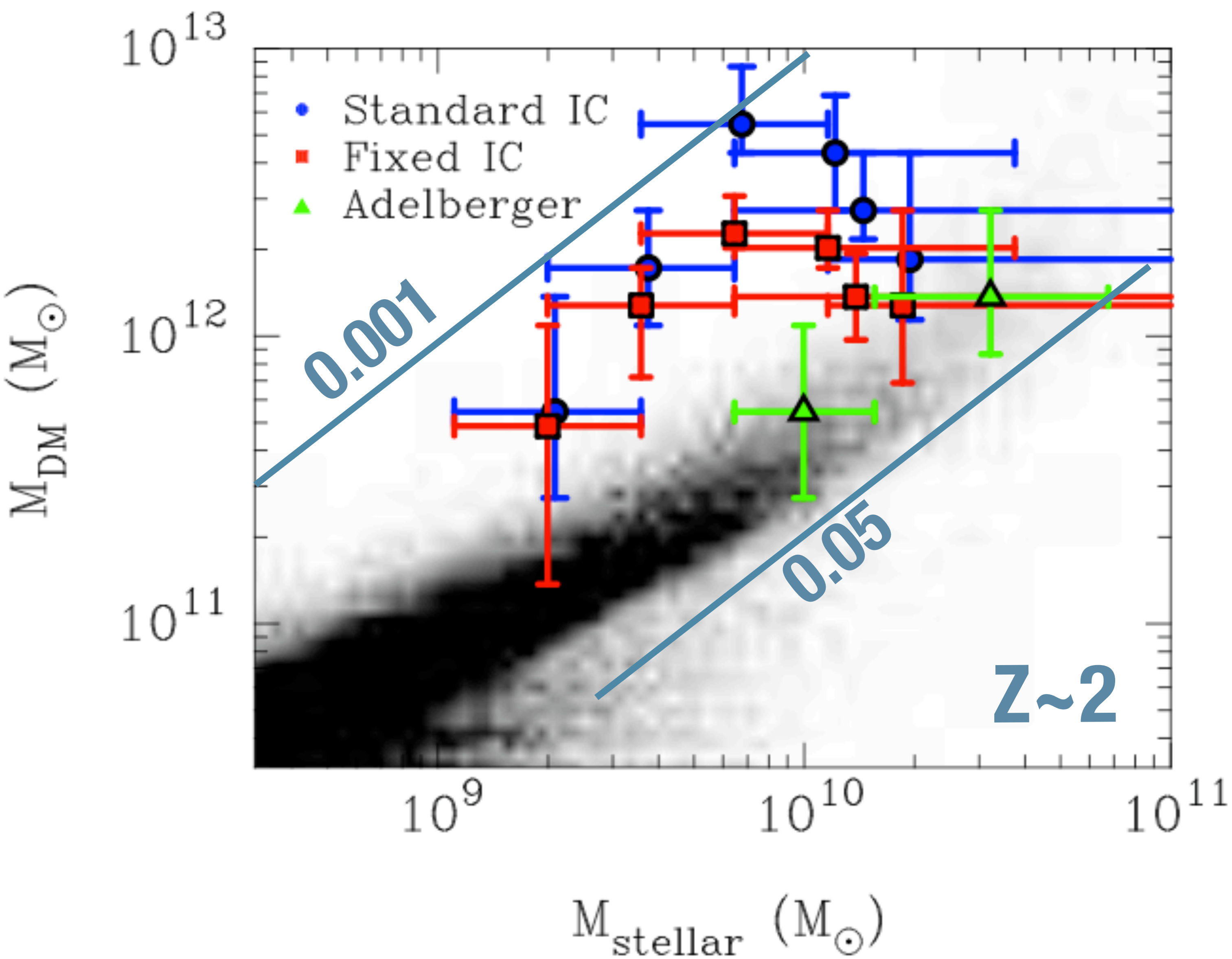
$$0.9 \log\left(\frac{M_{stars}}{M_{DM}}\right) = \log(f_*) + \log\left(\frac{\Omega_b}{\Omega_{DM}}\right) + 1.3$$

stellar mass : halo mass ratio

star formation efficiency

→ if we know M_{stars}/M_{DM}, we can get f_*

Linking stellar and DM masses



Link M_{DM} with M_{stars} via UV luminosities

→ $M_{stars}/M_{DM} = 0.001 - 0.05$

Savoy, Sawicki, Thompson & Sato (2011)

Star formation from accreting gas?

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$$0.9 \log\left(\frac{M_{stars}}{M_{DM}}\right) = \log(f_*) + \log\left(\frac{\Omega_b}{\Omega_{DM}}\right) + 1.3$$

stellar : halo mass ratio

star formation efficiency

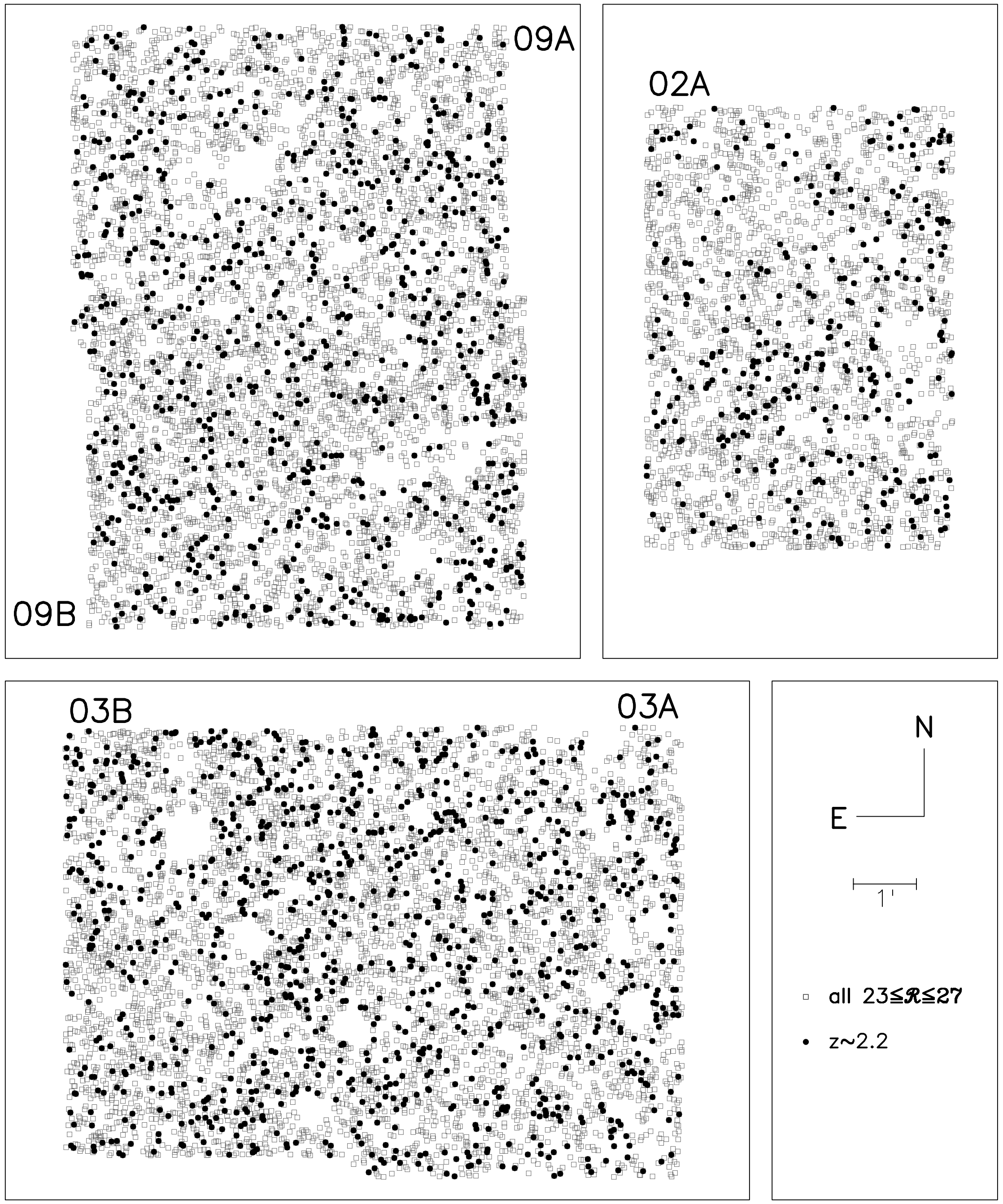
→ **$f_* \sim 1\%$**

Conclusion:

Most of the inflowing gas is prevented from converting into stars.

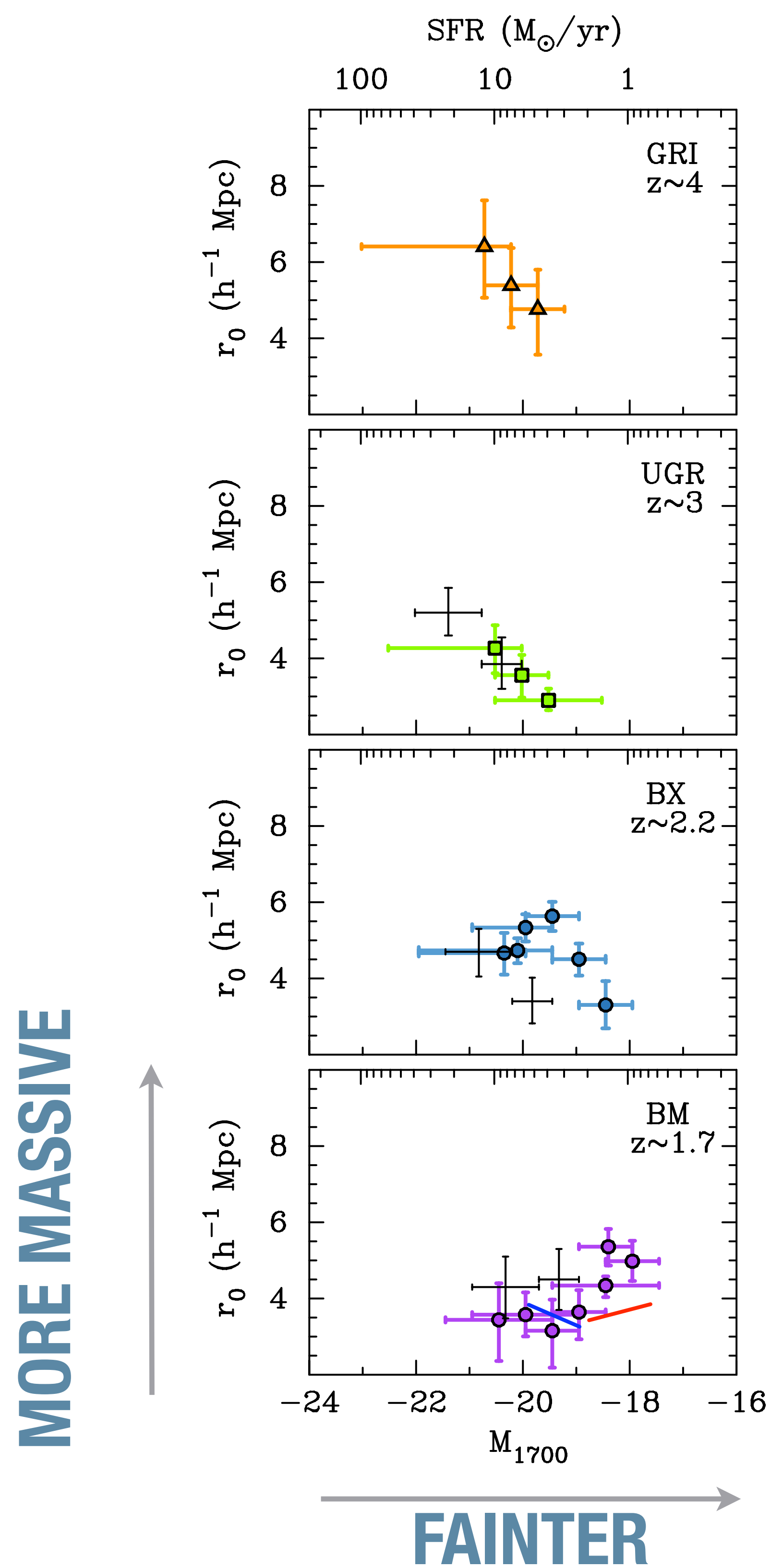
Clustering

LBG/BX/BM-selected galaxies in the Keck Deep Fields (R_{lim}=27.0)

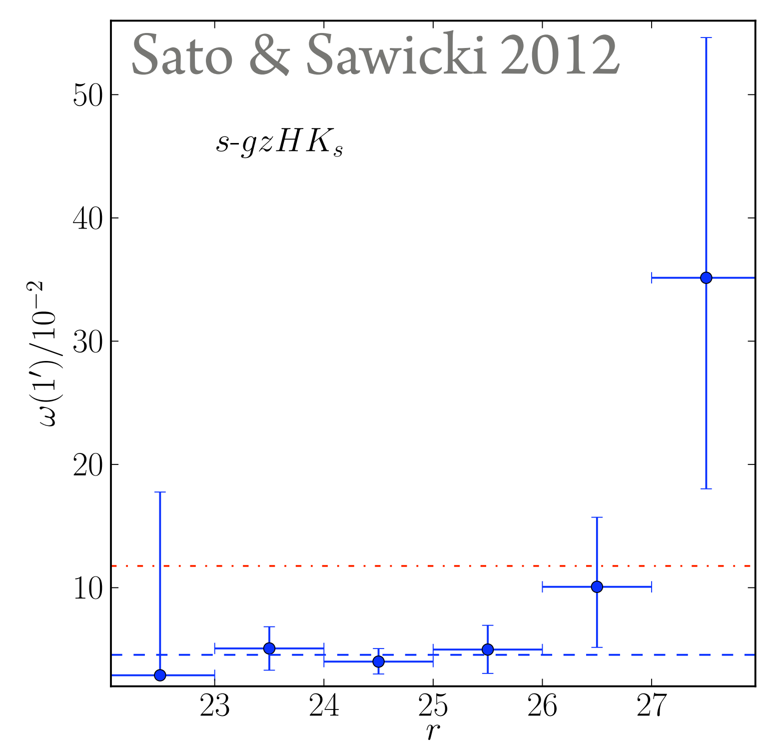


Savoy, Sawicki, Thompon, Sato (2011)

Clustering

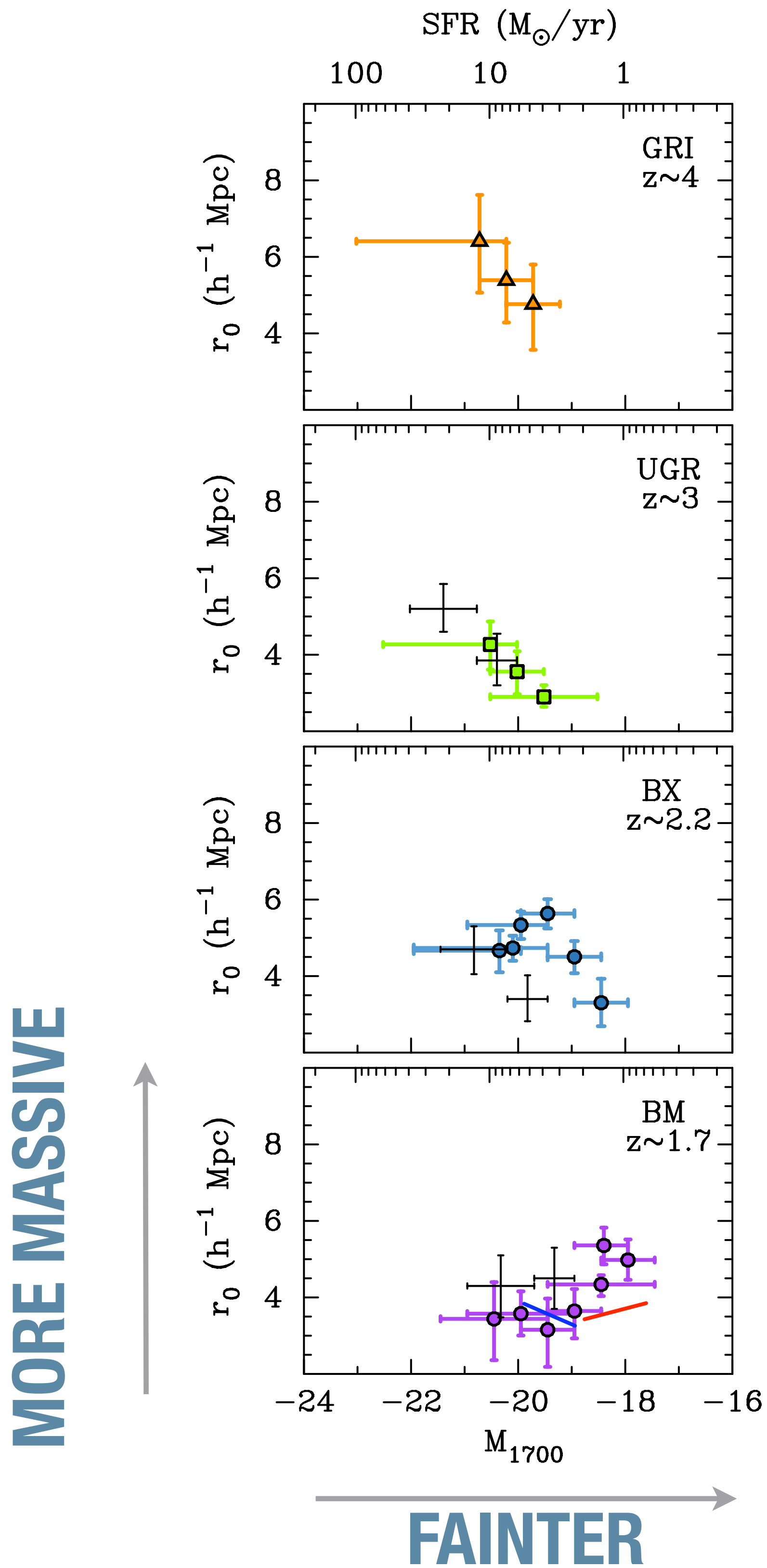


- as expected at z~4, 3
- inverts from z=3 → 1.7
- the most clustered galaxies are not the brightest ones at z=1.7



also seen in K-selected sample by Quadri+2007

Clustering

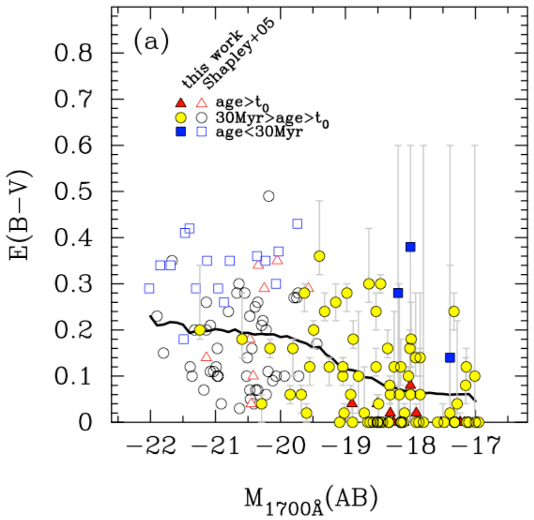


A possible interpretation:

- most massive halos shut down star formation (M_{halo} ~10^{12} - $10^{13}M_\odot$)
- as they fade, their central galaxies (or low-mass satellites) dominate the clustering signal at fainter and fainter magnitudes
- this is "downsizing" in halo mass

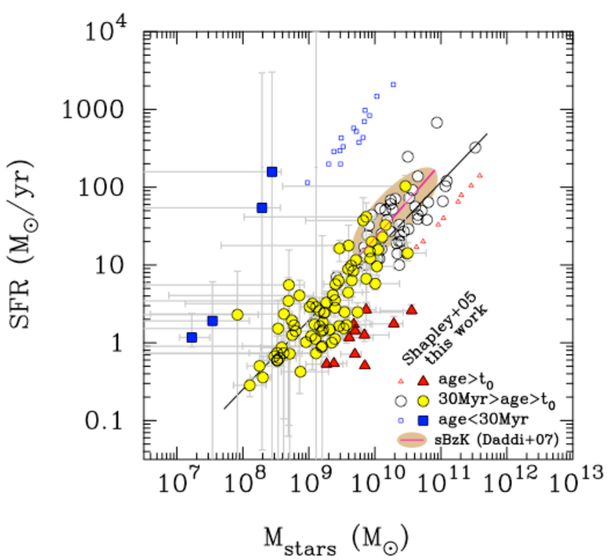
see Savoy+2011, ApJ 737, 92

Summary:



① Sub-L* galaxies are less dusty than L* galaxies

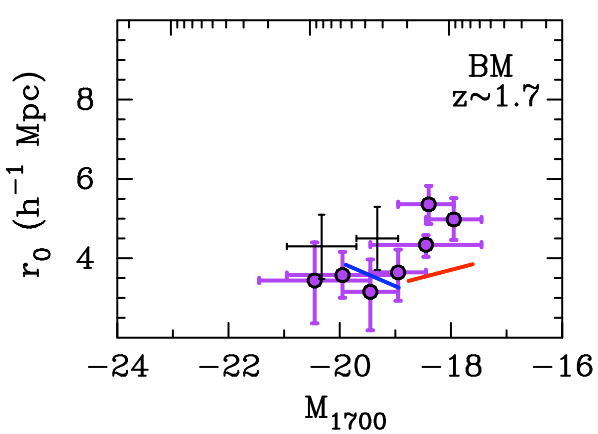
➡ close to naked;
punch above their weight in generating visible UV photons



② SFR-M_{stars} rel'n has ~1:1 slope over long baseline

➡ consistent with low-efficiency star formation from gas co-accreting with DM

Sawicki 2012, MN 421, 2187



③ by z~1.7 luminosity-DM mass relation disappears

➡ shut-down of SF in most massive halos,
downsizing in DM mass

Savoy+2011, ApJ 737, 92

thank you

merci

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