on the star formation histories of distant galaxies

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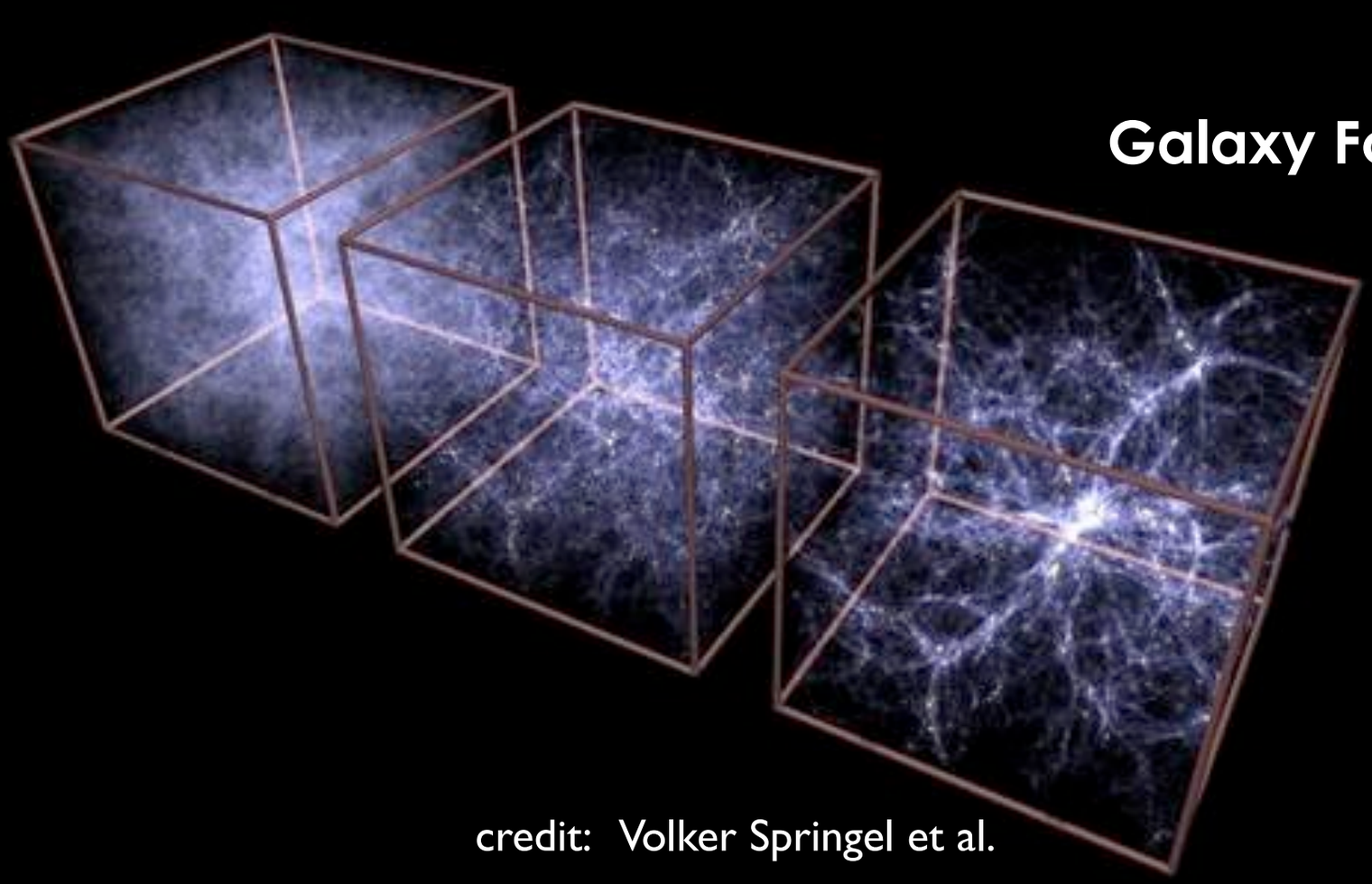
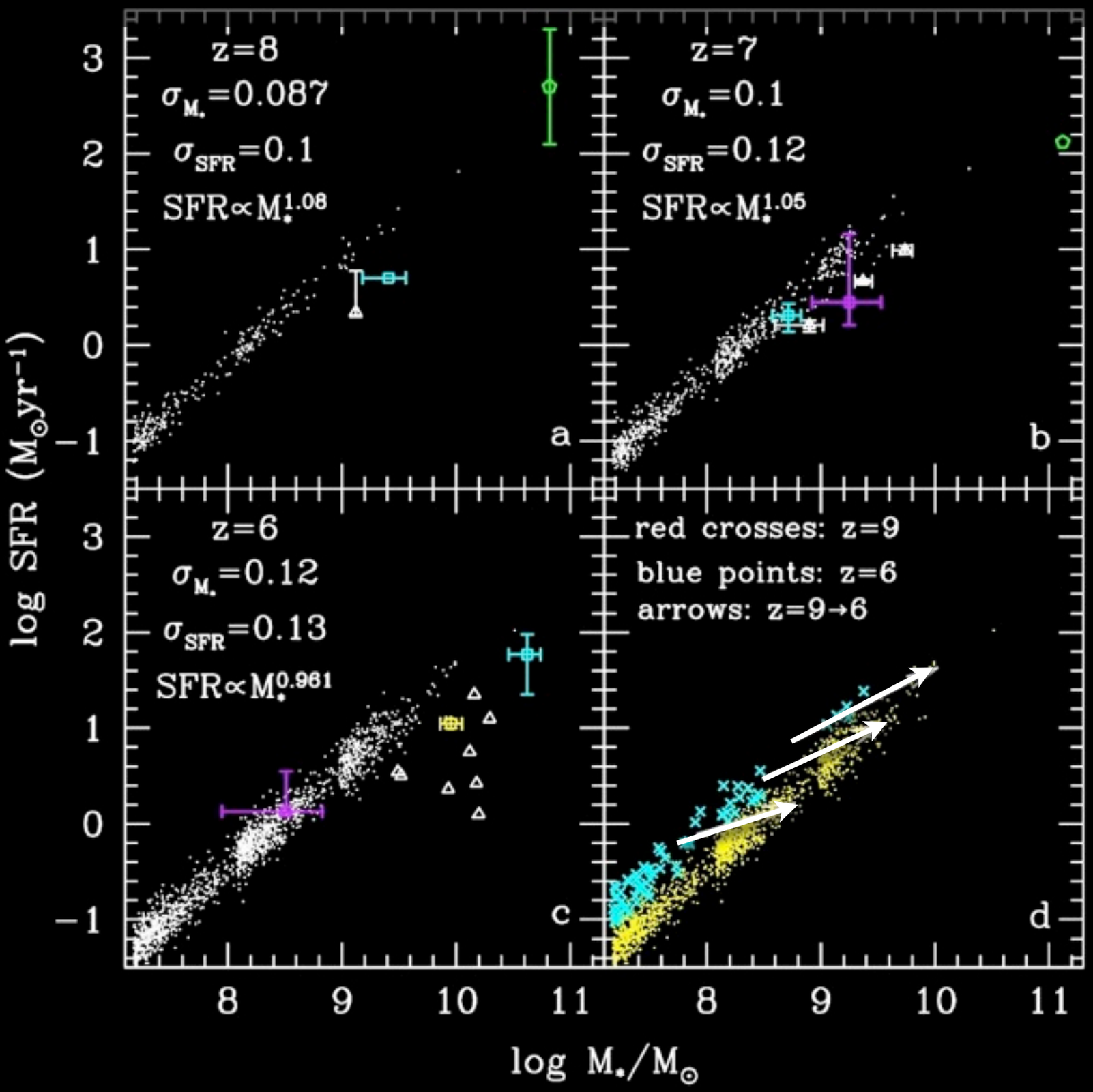
Galaxy Formation, Durham University
2011 July 22



credit: Volker Springel et al.

what are the star formation histories of galaxies ?

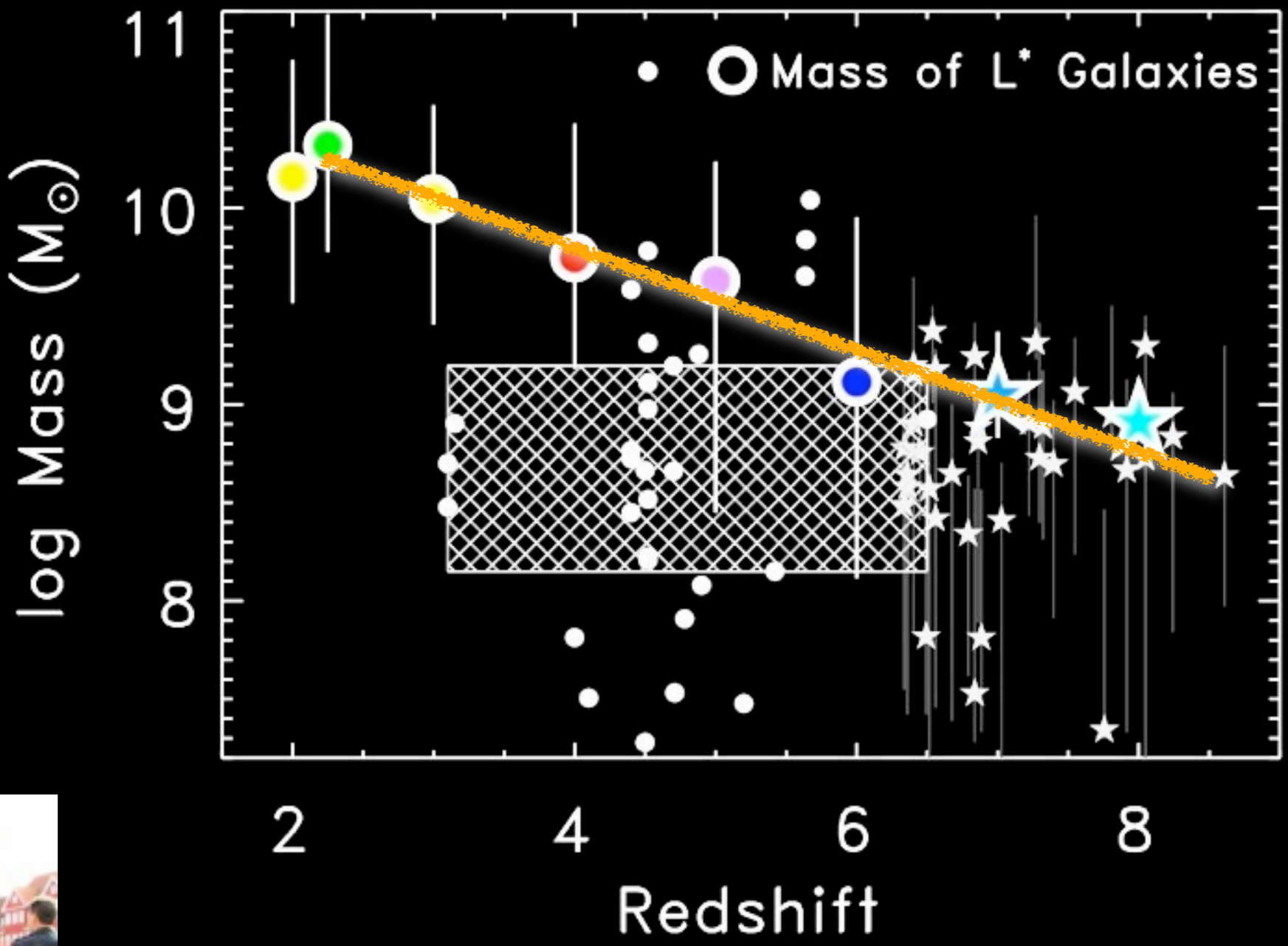


SFR ~ M_*
high duty cycle

$$\frac{d(SFR)}{dt} > 0$$

Finlator, Davé, & Oppenheimer (2010, arXiv:1005.4066)

star formation and mass growth in distant galaxies



Finkelstein, Papovich et al. (2010), ApJ, 719, 1250

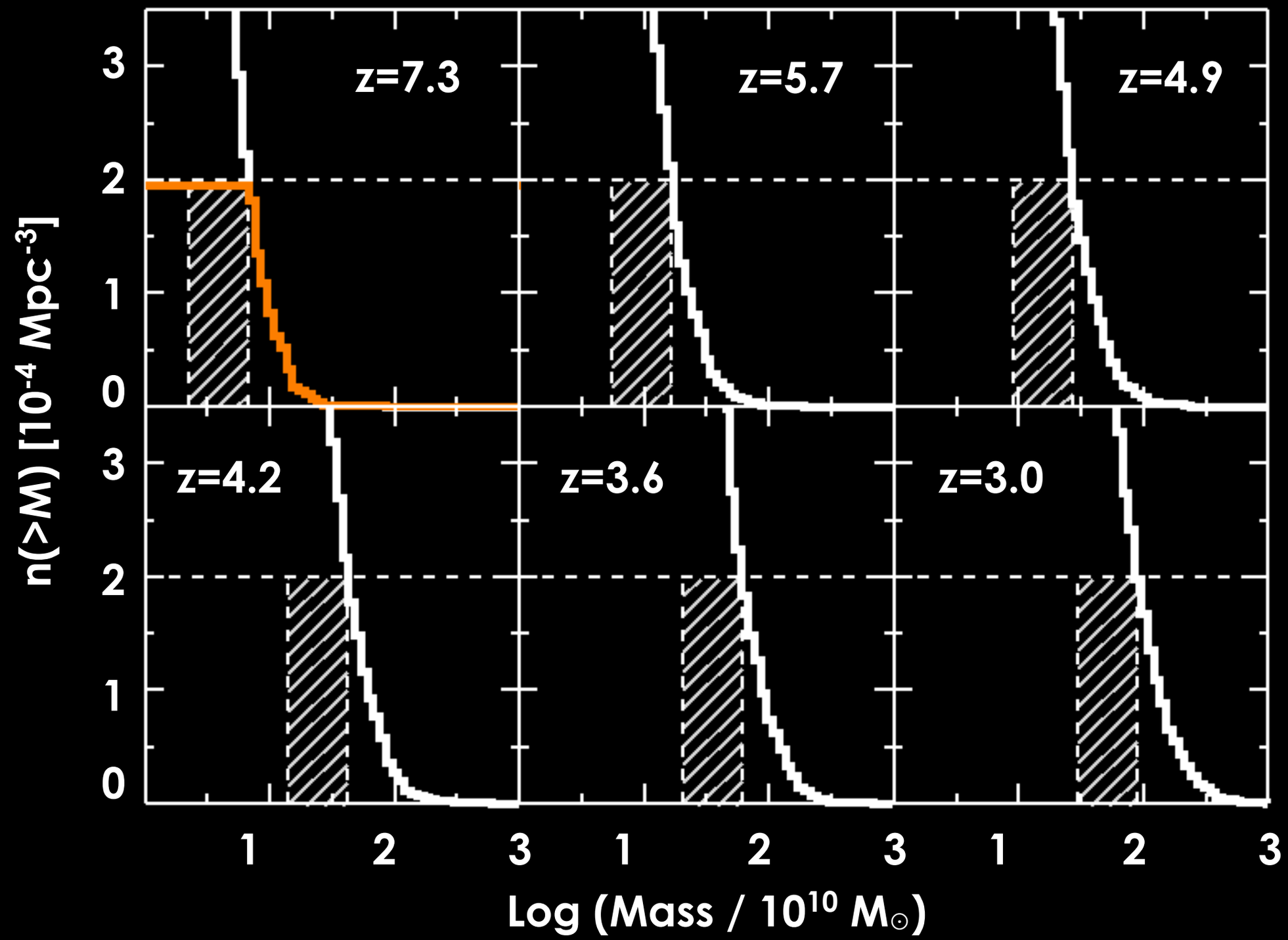
do high redshift galaxies have
star formation rates that rise with time ?

empirical constraints on star-formation histories

- Trace mass growth by comparing massive high-z galaxies at constant number density:
  - track descendants and progenitors in galaxies in a relatively robust way (van Dokkum et al. 2010; similar to abundance matching Conroy & Weschler 2009)
  - SFRs of galaxies with $n=2 \times 10^{-4}$ Mpc^{-3} increase from z=8 to z=3.
  - galaxies with this number density have $M=1.5 \times 10^{11}$ $M_\odot$ at z=0,
  - star formation history of these galaxies matches stellar mass growth.

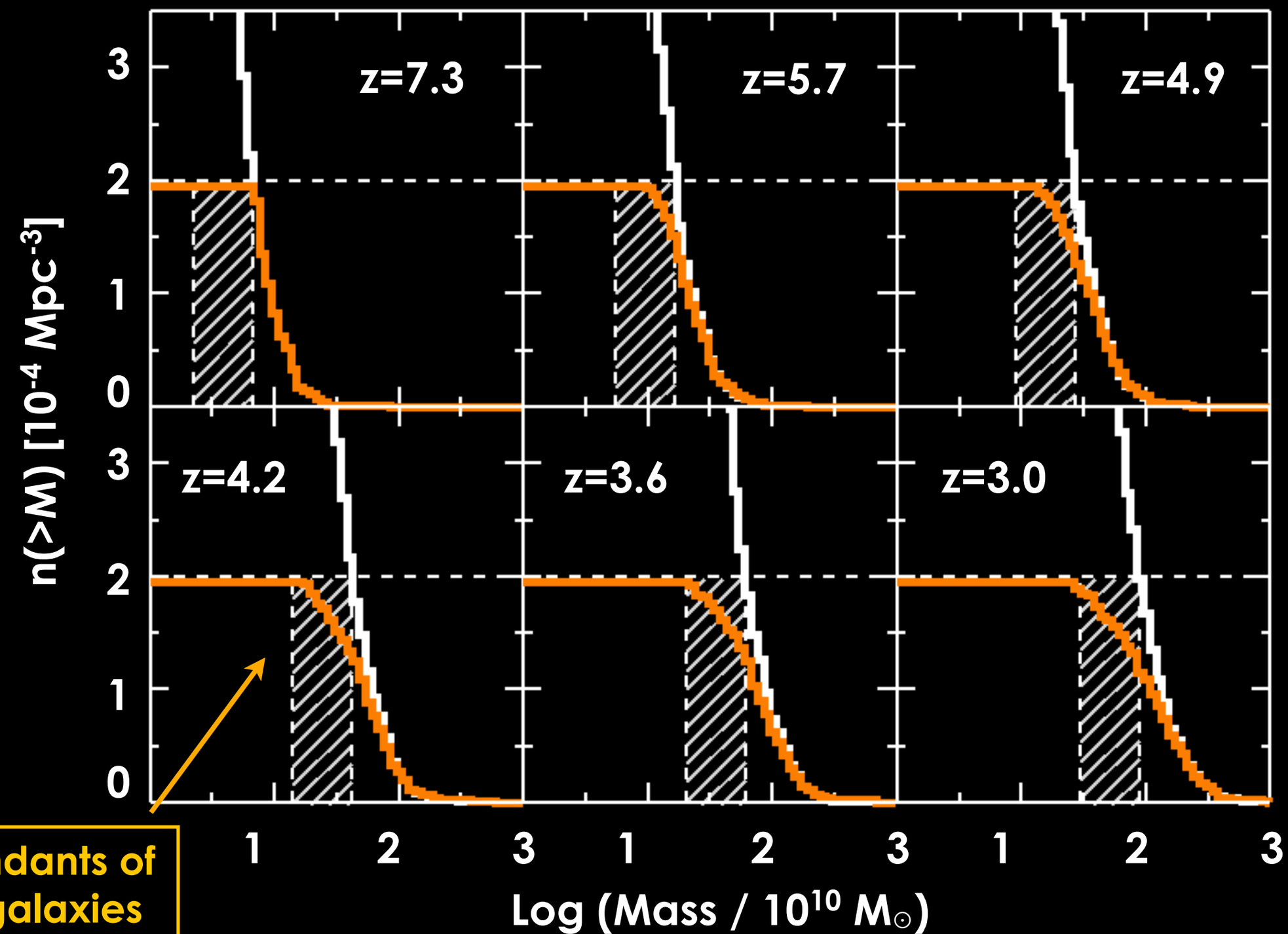
track the descendants of distant galaxies by comparing at constant number density

Mass Functions and Halo Merger Trees from Millennium (Springel+05)

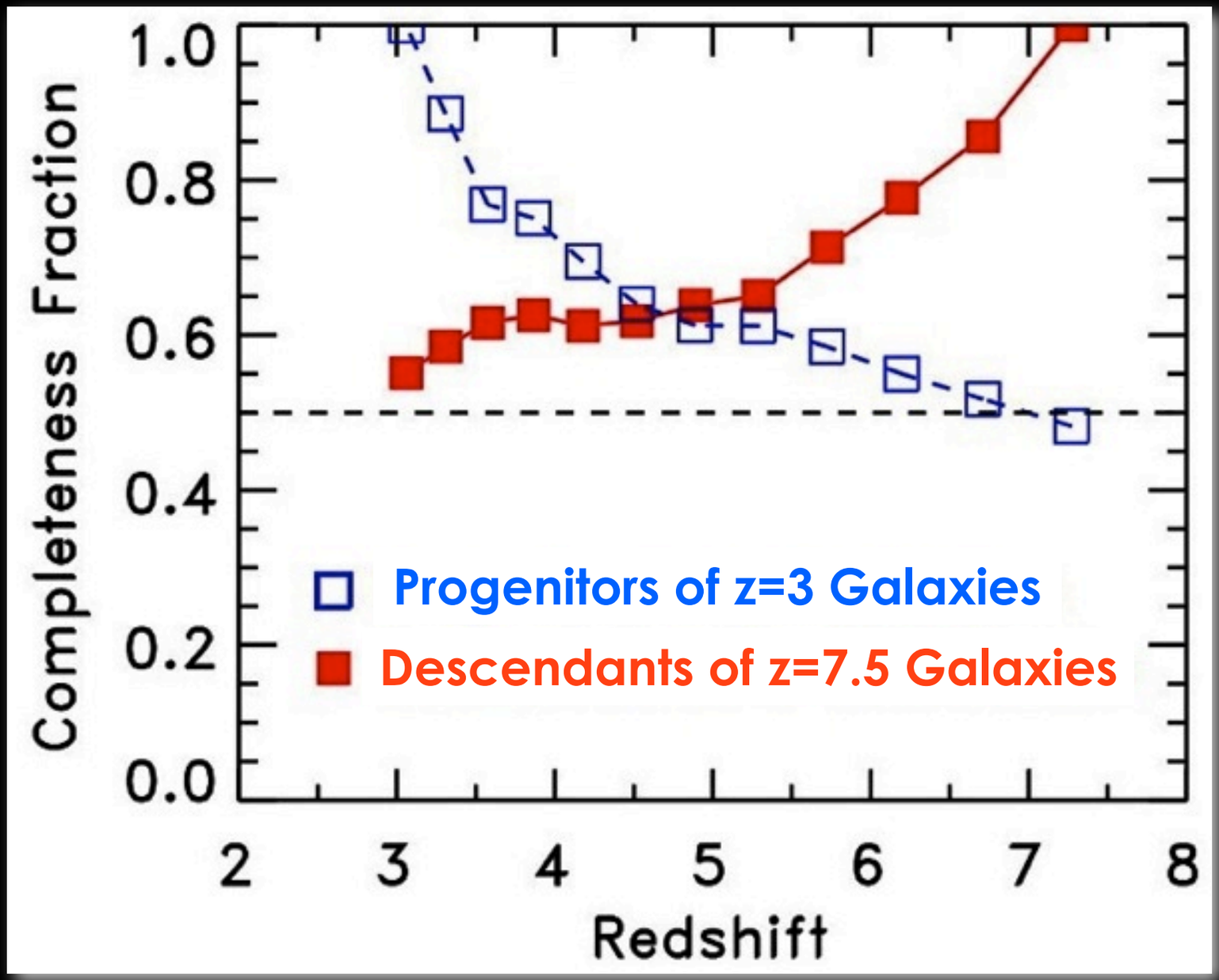


track the descendants of distant galaxies by comparing at constant number density

Mass Functions and Halo Merger Trees from Millennium (Springel+05)



track the descendants of distant galaxies by comparing at constant number density

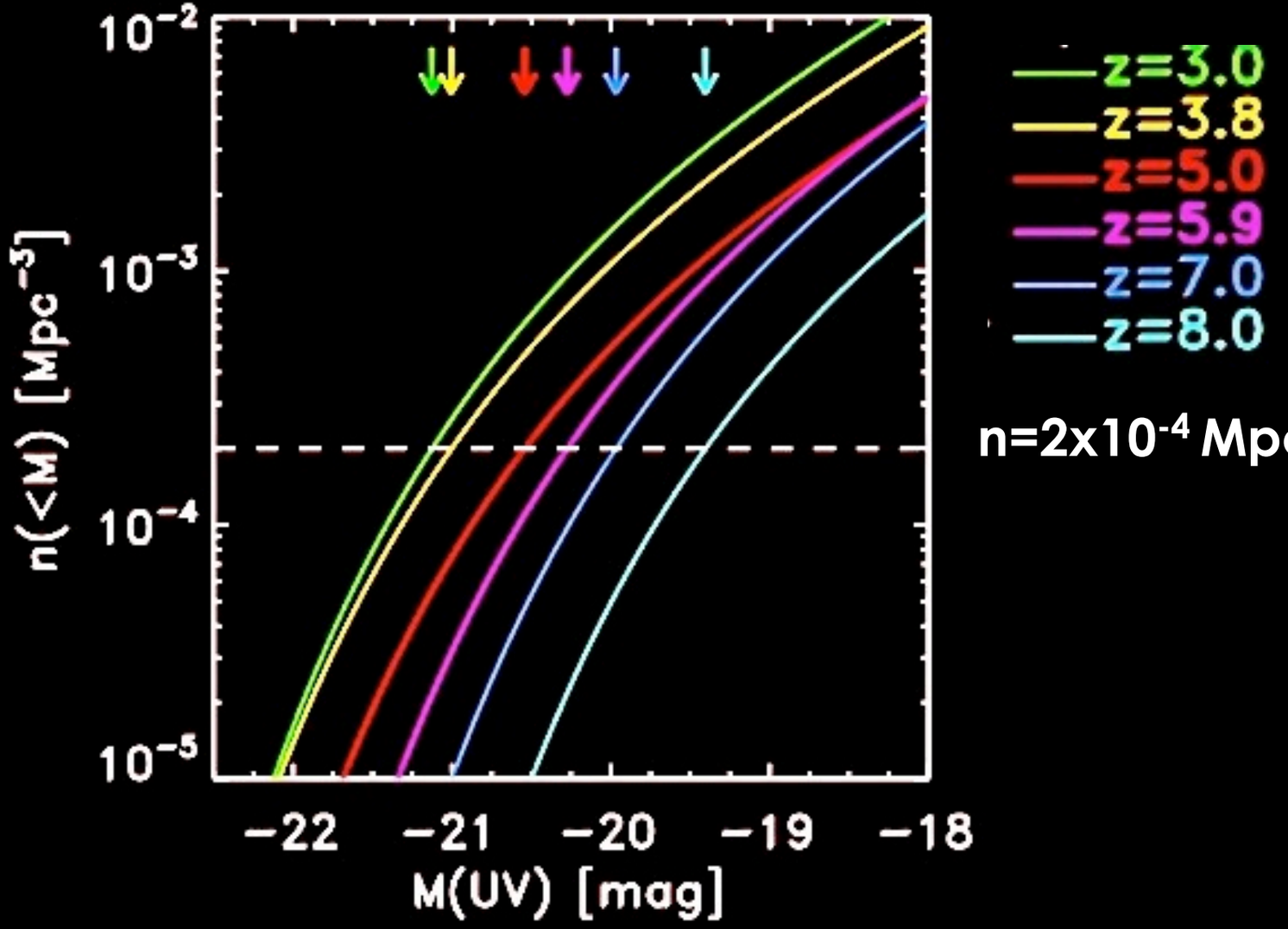


Completeness = Fraction of selected galaxies with a progenitor selected at z=7.5 (descendant selected at z=3.0).

Similar results from simulations of the effects of mergers on mass functions (van Dokkum et al. 2010).

Papovich et al (2011), MNRAS 412, 1123

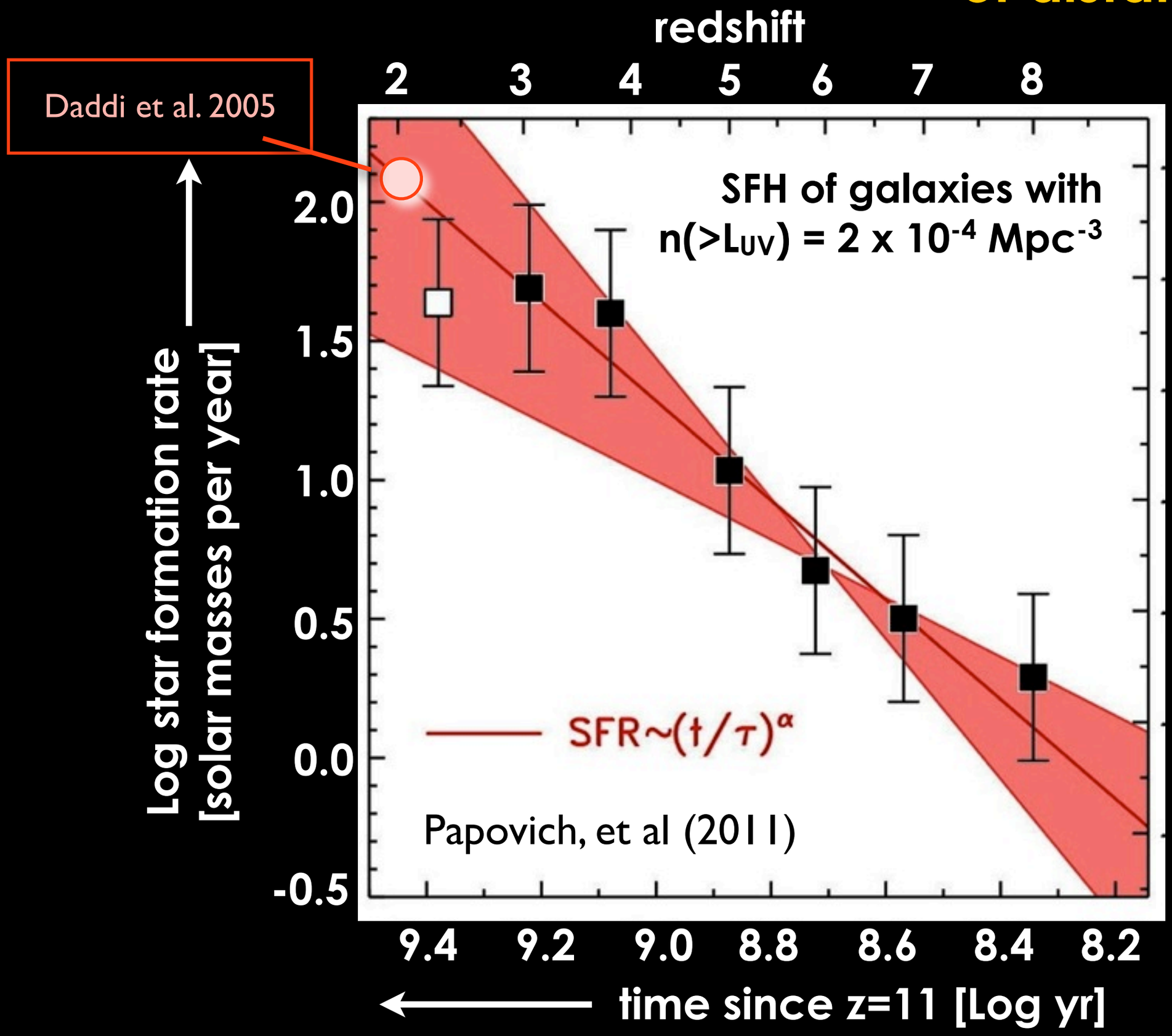
track the descendants of distant galaxies by comparing at constant number density



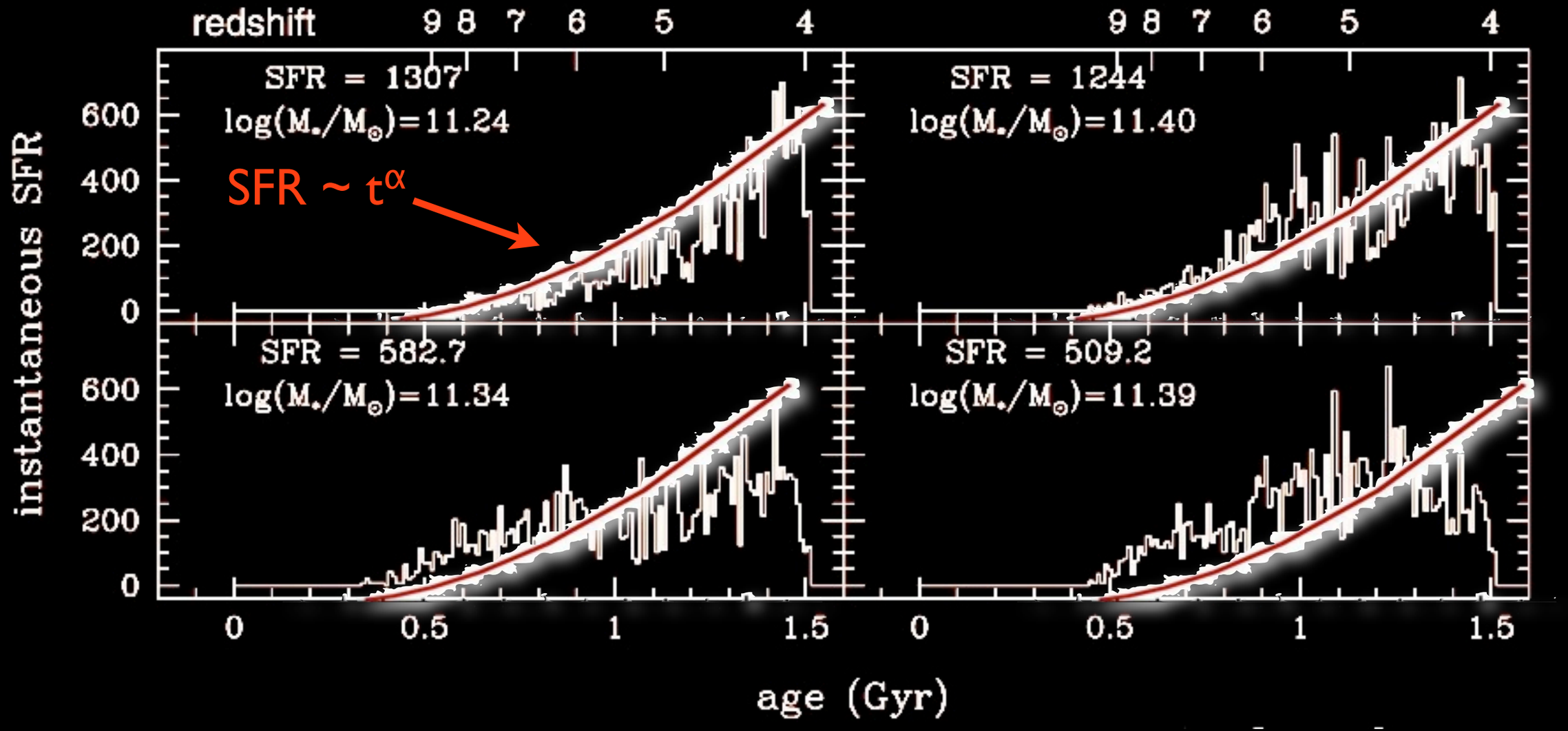
Integrated UV Luminosity Functions
(Reddy & Steidel 2008; Bouwens et al. 2007, 2010).

Galaxy Populations selected at constant luminosity (or mass) correspond to very different number densities at different redshifts.

star formation histories of distant galaxies

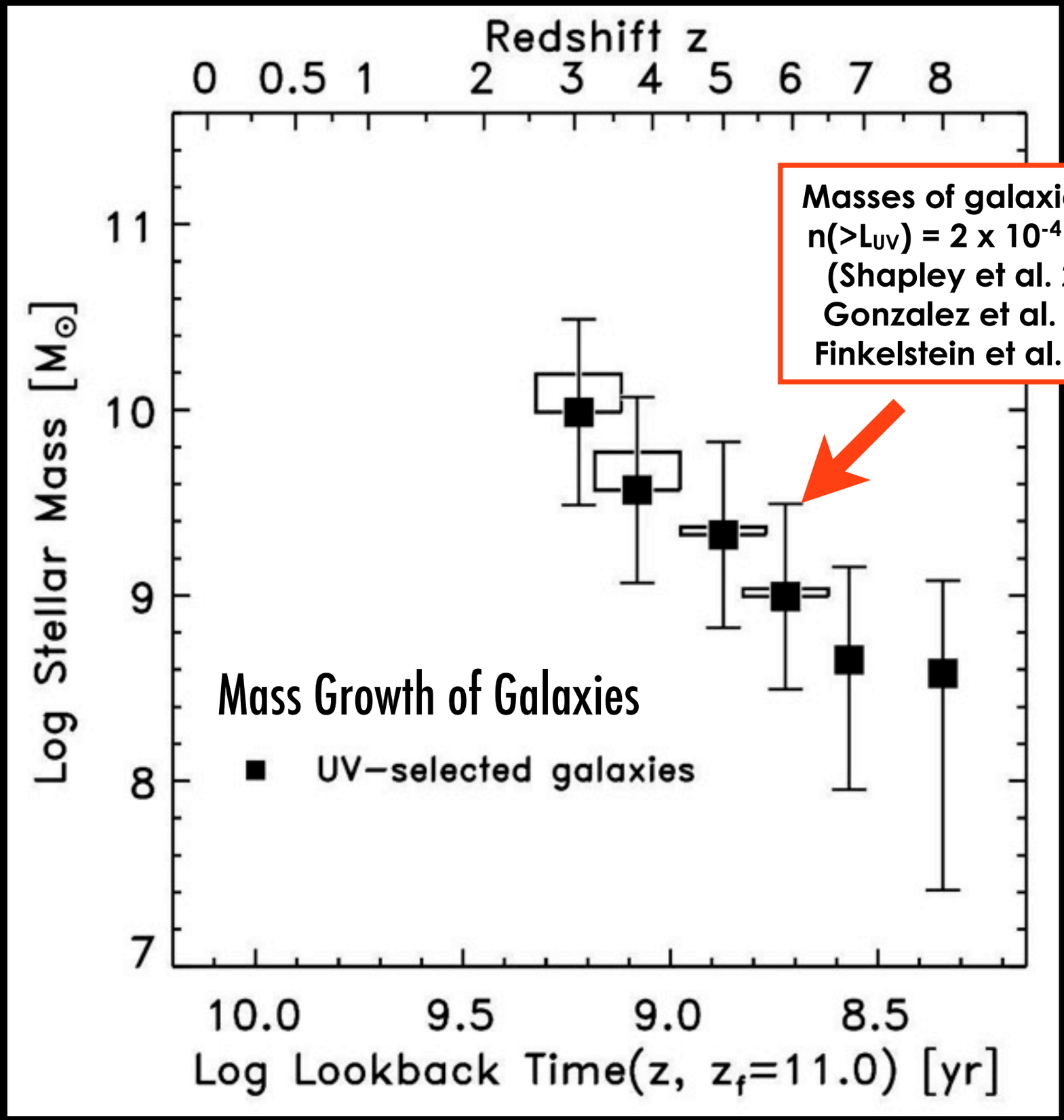


star formation histories of distant galaxies



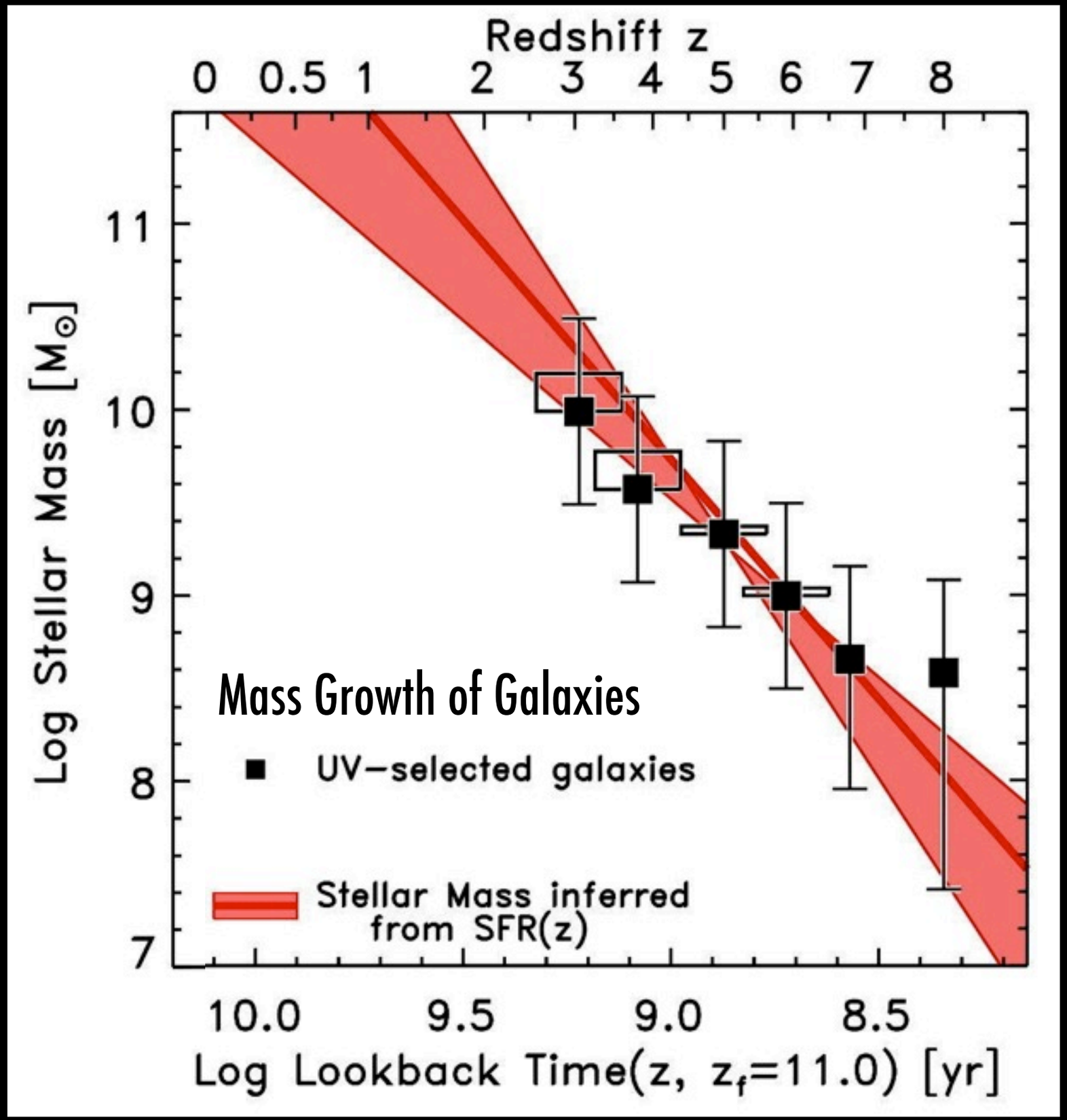
galaxies in cosmological simulations show rising star formation rates
(Finlator, Davé, Papovich & Hernquist 2006)

stellar mass growth of distant galaxies



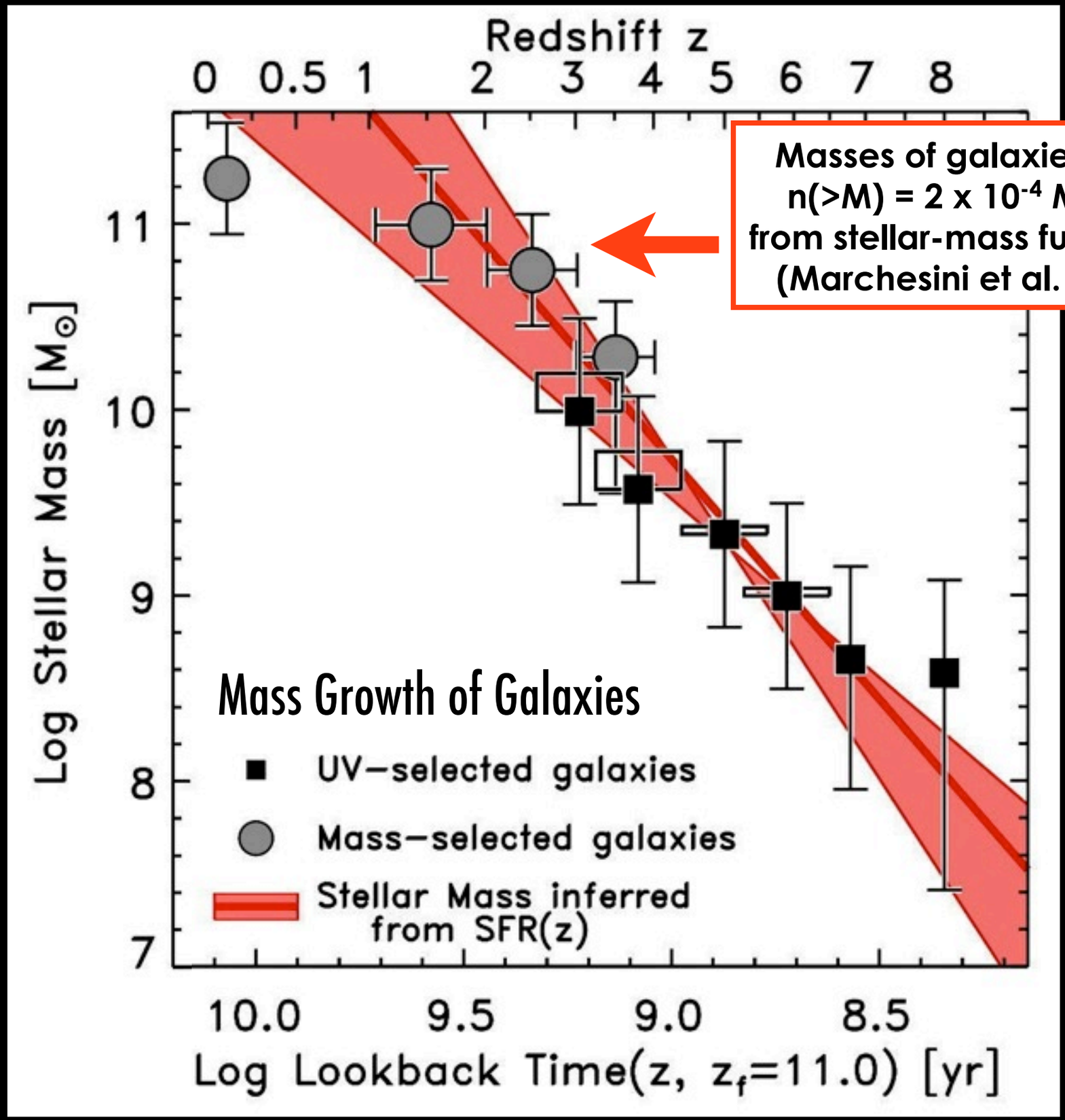
Papovich et al. 2011

stellar mass growth of distant galaxies



Papovich et al. 2011

stellar mass growth of distant galaxies

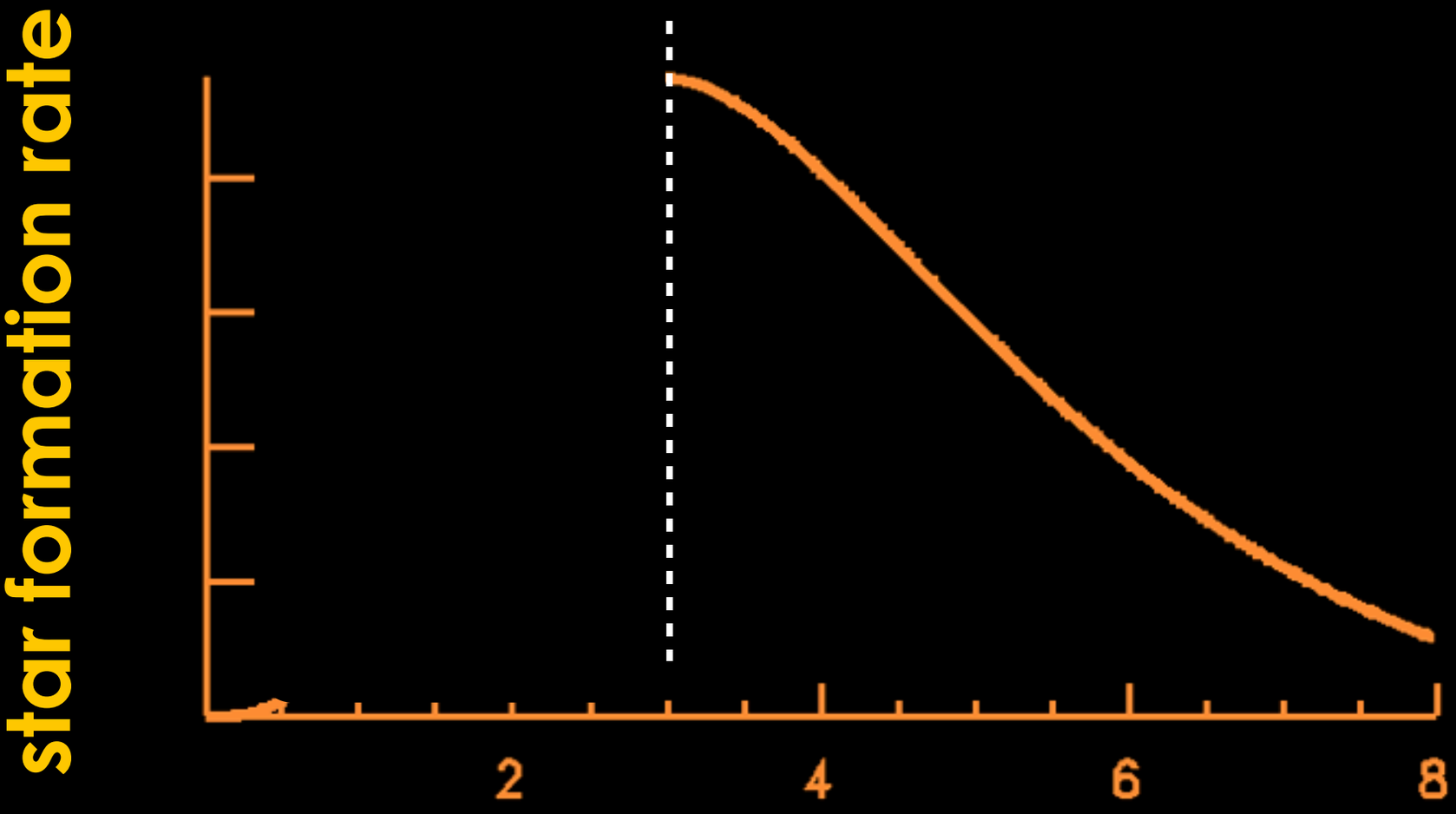


Papovich et al. 2011

empirical constraints on star-formation histories

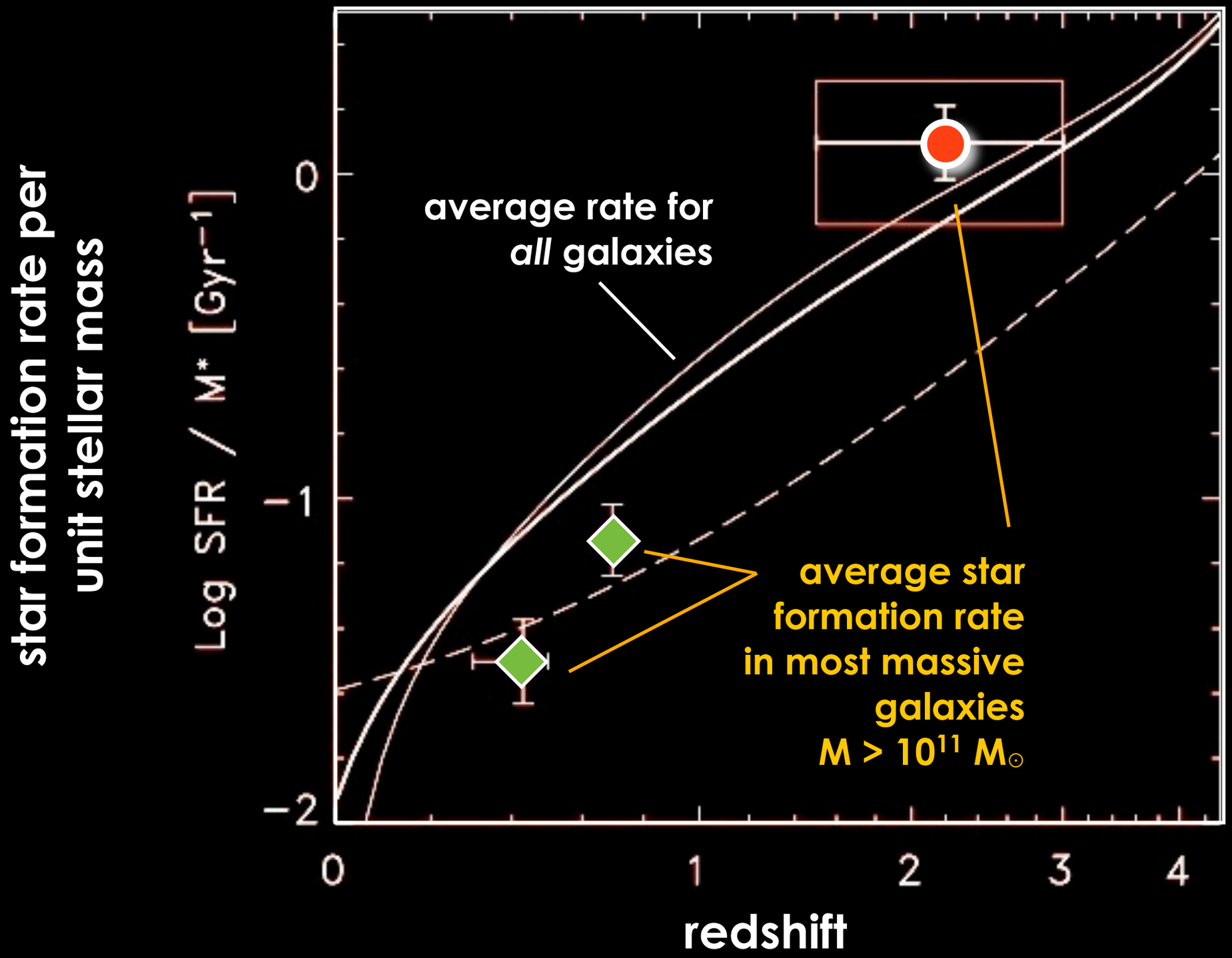
- Trace mass growth by comparing galaxies at constant number density:
  - empirically, galaxies have *average* star-formation rates that increase from z=8 to z=3.
  - Basic agreement between empirical and theoretical SFHs.
  - Star formation History of these galaxies matches stellar mass growth:
    - if near unity "Duty cycle" of Star-formation, then high-mass end of IMF approximately Salpeter/ Chabrier-like.

star formation histories of distant galaxies



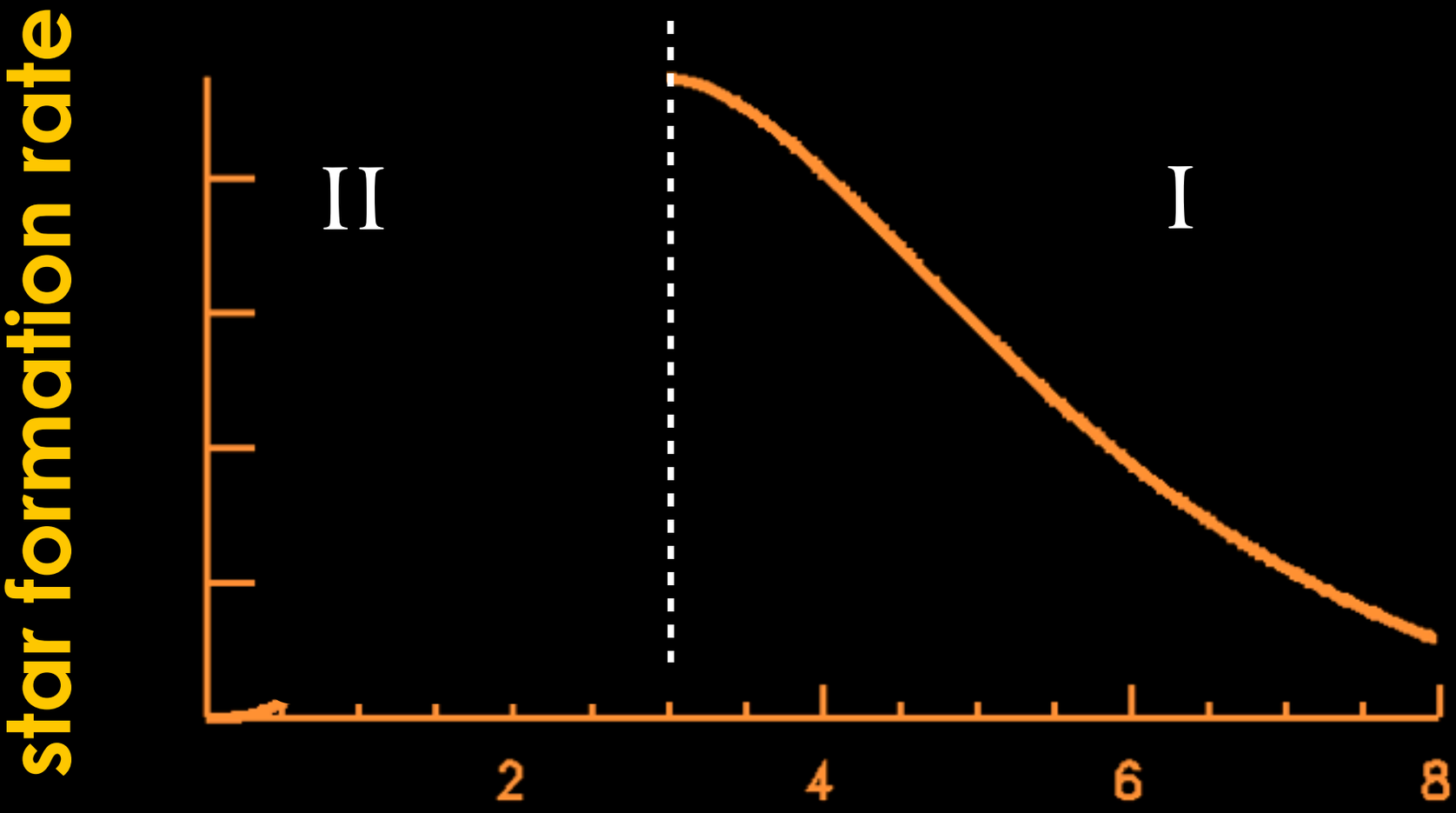
I. Period from z ~ 8 to 3 characterized by increasing SFRs.

star formation histories of distant galaxies



Papovich et al. 2006

star formation histories of distant galaxies



I. Period from z ~ 8 to 3 characterized by increasing SFRs.

Summary

- Trace star formation histories and mass growth in galaxies empirically by comparing galaxies at constant number density:
  - empirically, galaxies have average star-formation rates that increase from z=8 to z=3. Basic agreement between empirical and theoretical SFHs.
  - Star formation History of these galaxies matches stellar mass growth:
    - if near unity "Duty cycle" of Star-formation, then high-mass end of IMF approximately Salpeter/Chabrier-like.
  - Distinct Periods of Star Formation for Galaxies:
    - empirically rising SFRs from z=8 to 3; declining SFRs from z=3 to 0.

- Prediction: Star-formation and Mass growth predict Gas masses must *Increase* and that the Gas Accretion Rate tracks SFR.

- Questions: How and when do galaxies acquire their gas ?
  - How well do we know the duty cycles of distant star-forming galaxies?
  - What causes galaxies to stop forming stars ?