

# The SFMS and starbursts in *Illustris*

Time Since Big Bang: 4 Billion Years

A simulation of the universe at 4 billion years after the Big Bang. The image shows a complex web of green filaments, representing the cosmic web, with numerous clusters of blue and red star-forming regions. The background is black, and the overall structure is highly interconnected and branching.

Vogelsberger+14

Chris Hayward (Caltech)

Star Formation Across Space and Time, 13 November 2014

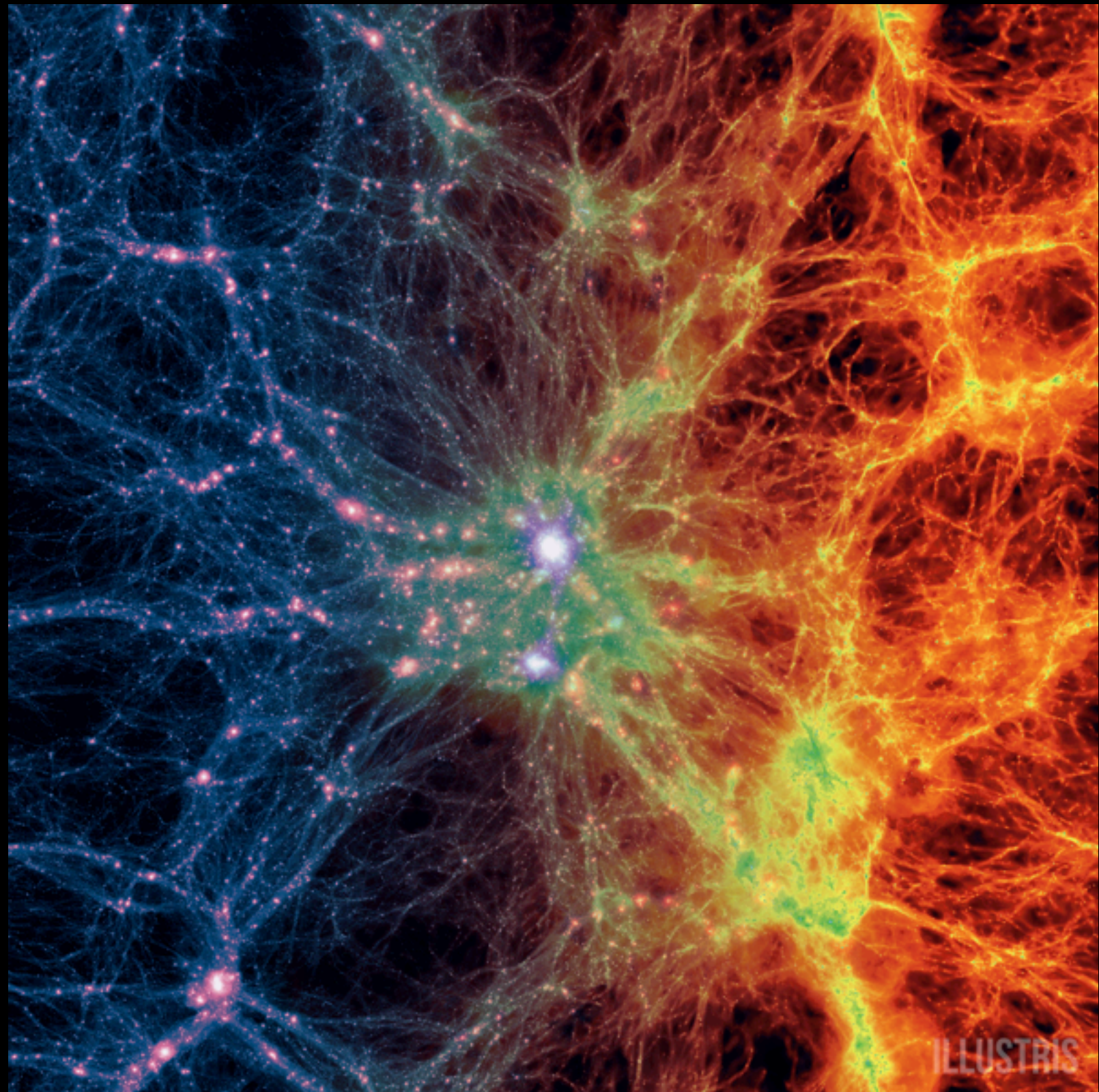
# Outline

- The *Illustris* simulation
- The star formation ‘main sequence’ in *Illustris*
- Starbursts in *Illustris*
- Is the main sequence a red herring?



# The *Illustris* simulation

- Cosmological hydro sim w/  $(106.5 \text{ Mpc})^3$  volume
- $1820^3$  DM particles &  $1820^3$  gas cells
- Softening  $\sim 0.7 \text{ kpc}$
- See Vogelsberger + 14a,b, Genel + 14...



# Included 'physics'

- Cooling (primordial & metal-line)
- Effective equation-of-state ISM treatment
- Stochastic star (cluster) formation
- Stellar evolution, gas recycling, & chemical enrichment
- Kinetic feedback from SNe
- SMBH seeding, accretion, & merging
- AGN feedback (quasar-mode, radio-mode, & photoionization)

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# The star formation main sequence and stellar mass assembly of galaxies in the Illustris simulation

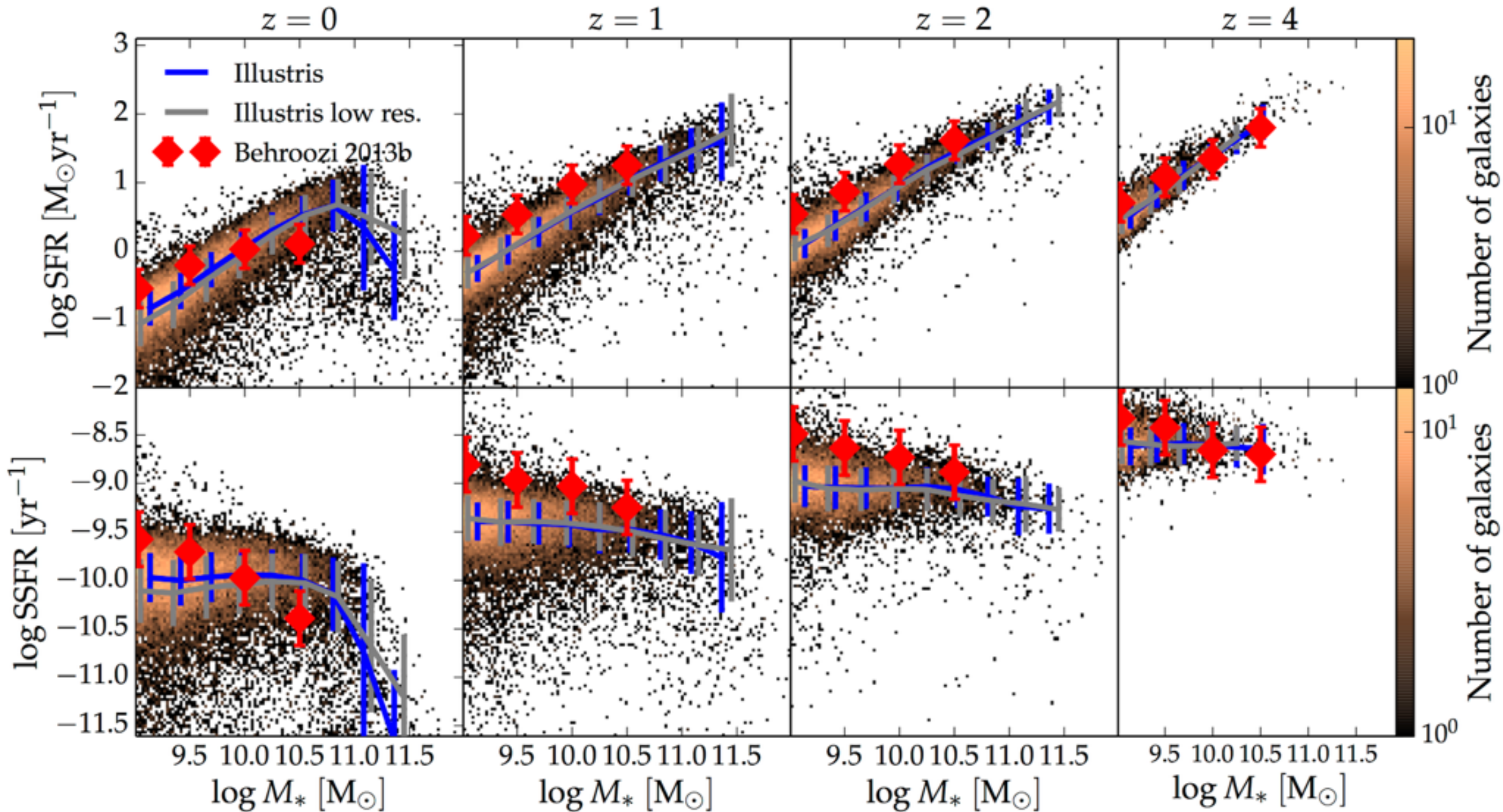
Martin Sparre<sup>1\*</sup>, Christopher C. Hayward<sup>2,3†</sup>, Volker Springel<sup>3,4</sup>, Mark Vogelsberger<sup>5</sup>, Shy Genel<sup>6</sup>, Paul Torrey<sup>2,5,6</sup>, Dylan Nelson<sup>6</sup>, Debora Sijacki<sup>7</sup>, Lars Hernquist<sup>6</sup>



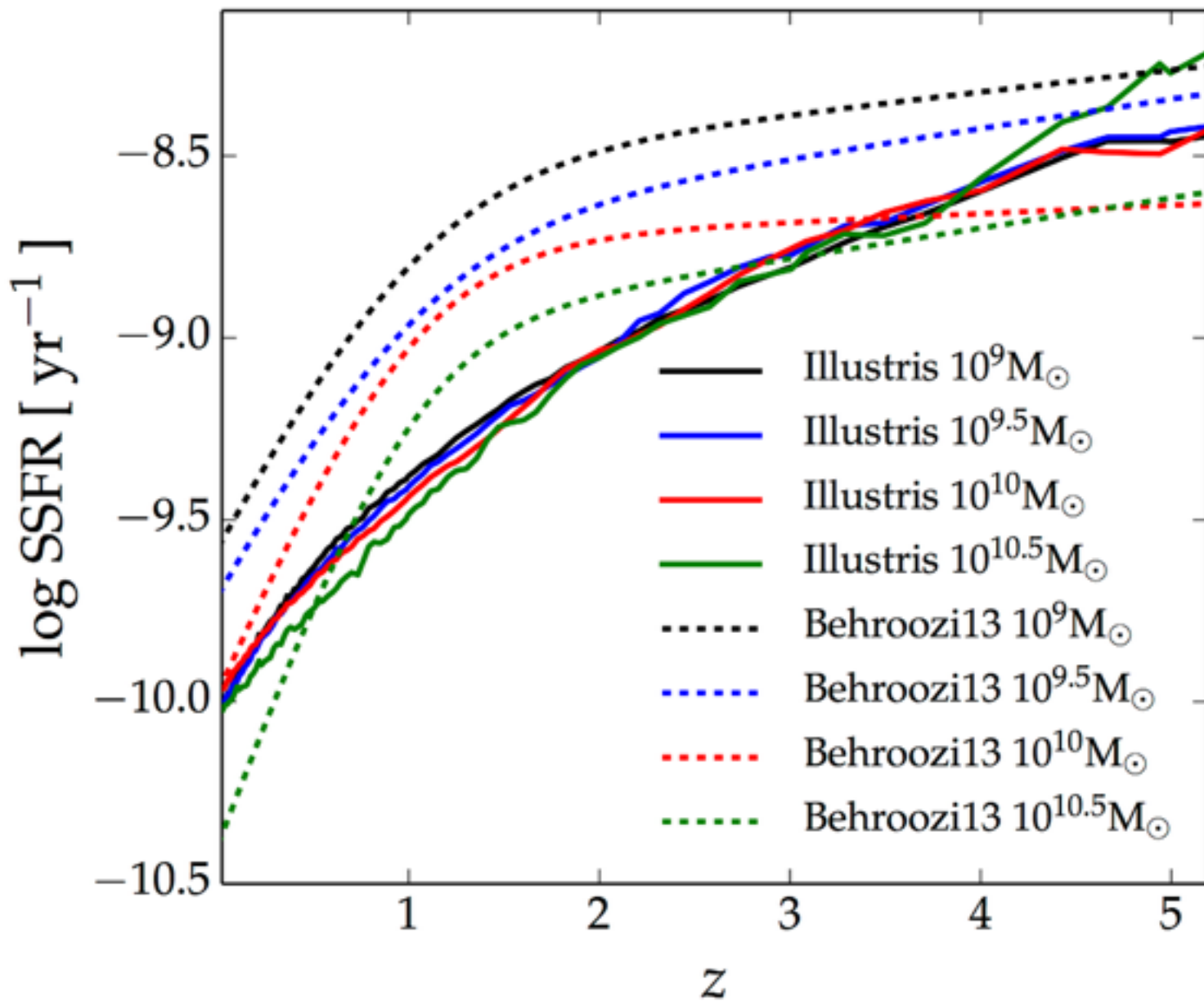
Please hire me!



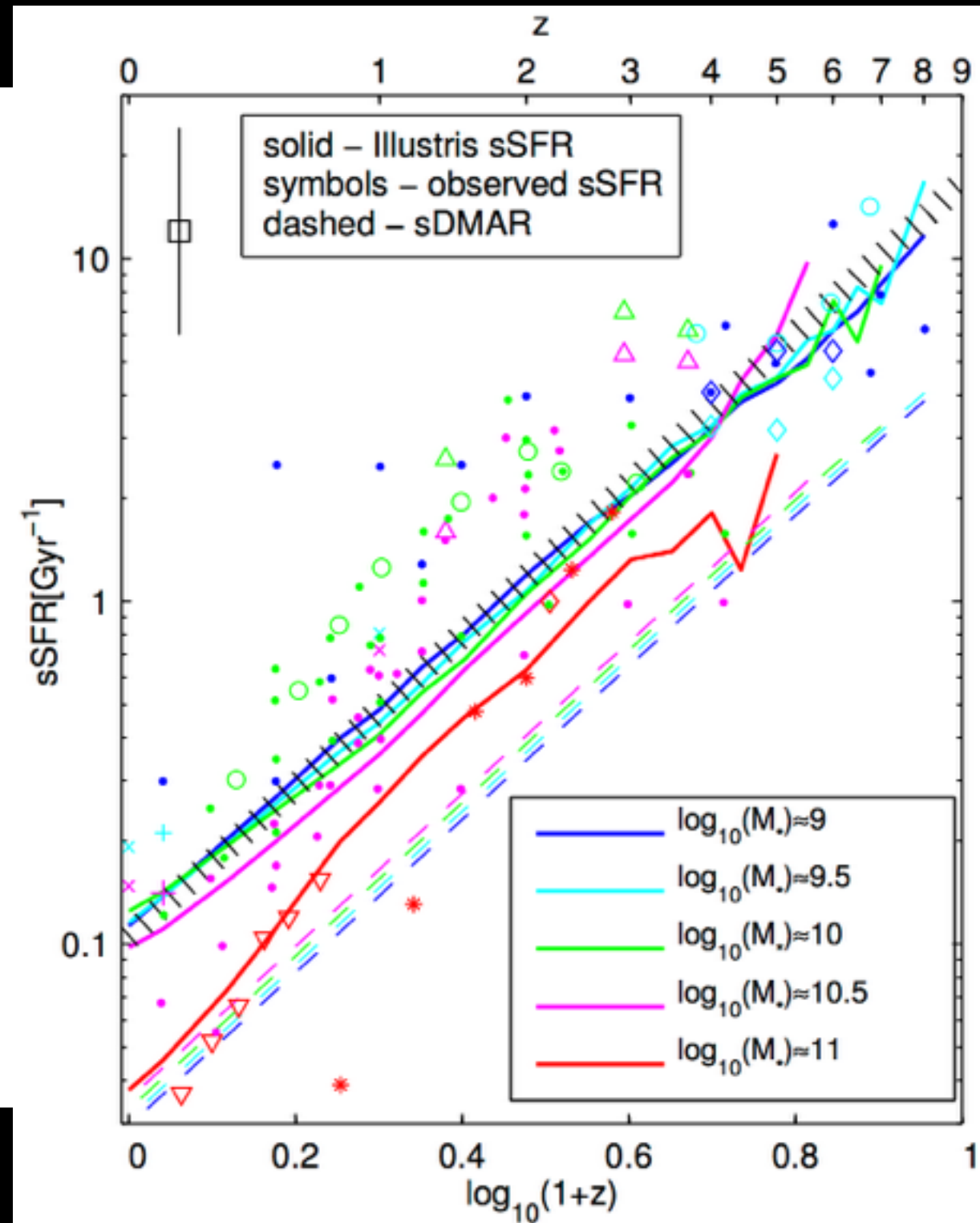
# The star formation main sequence



# SSFR evolution



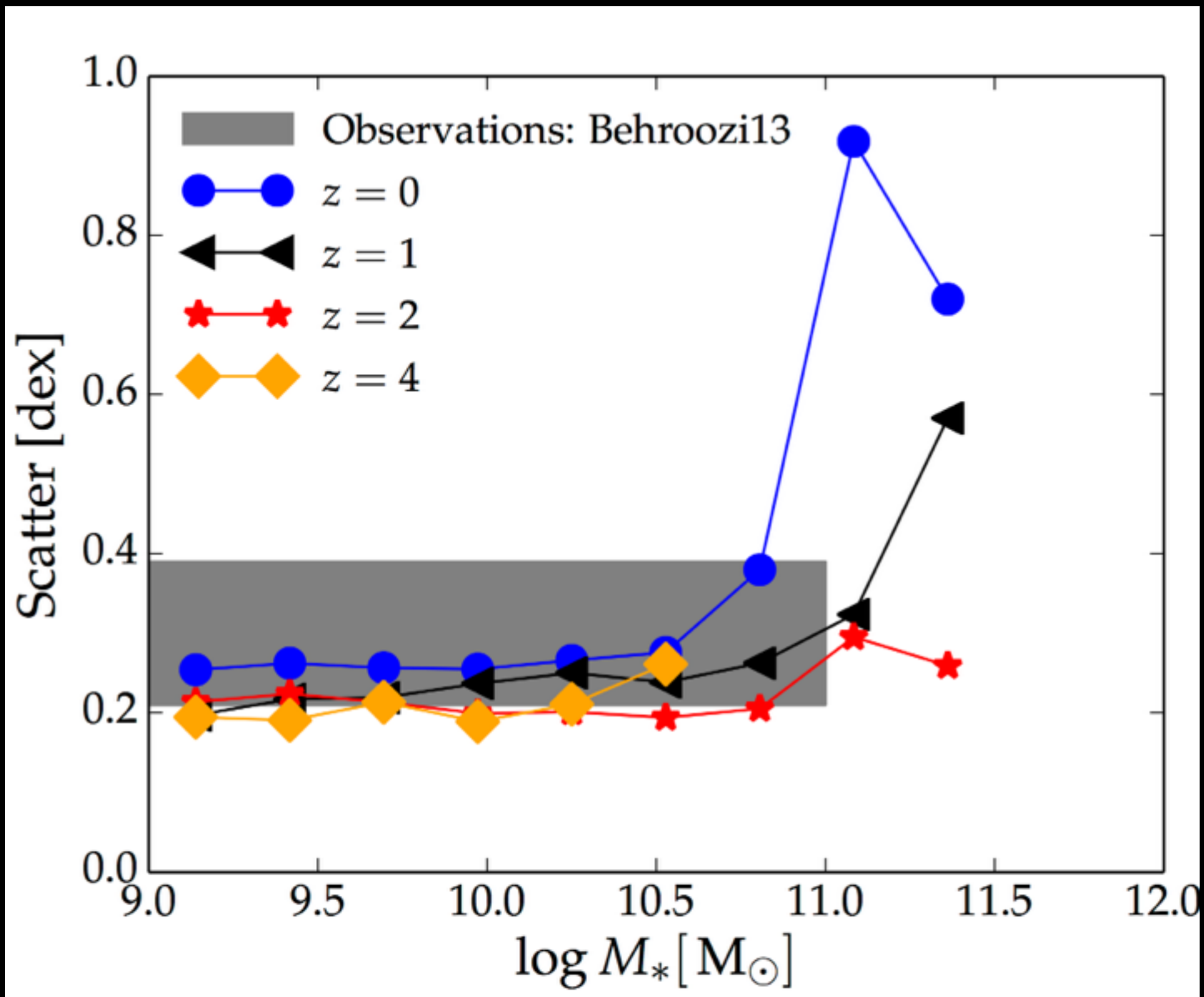
Sparre, CCH+14



Genel+14



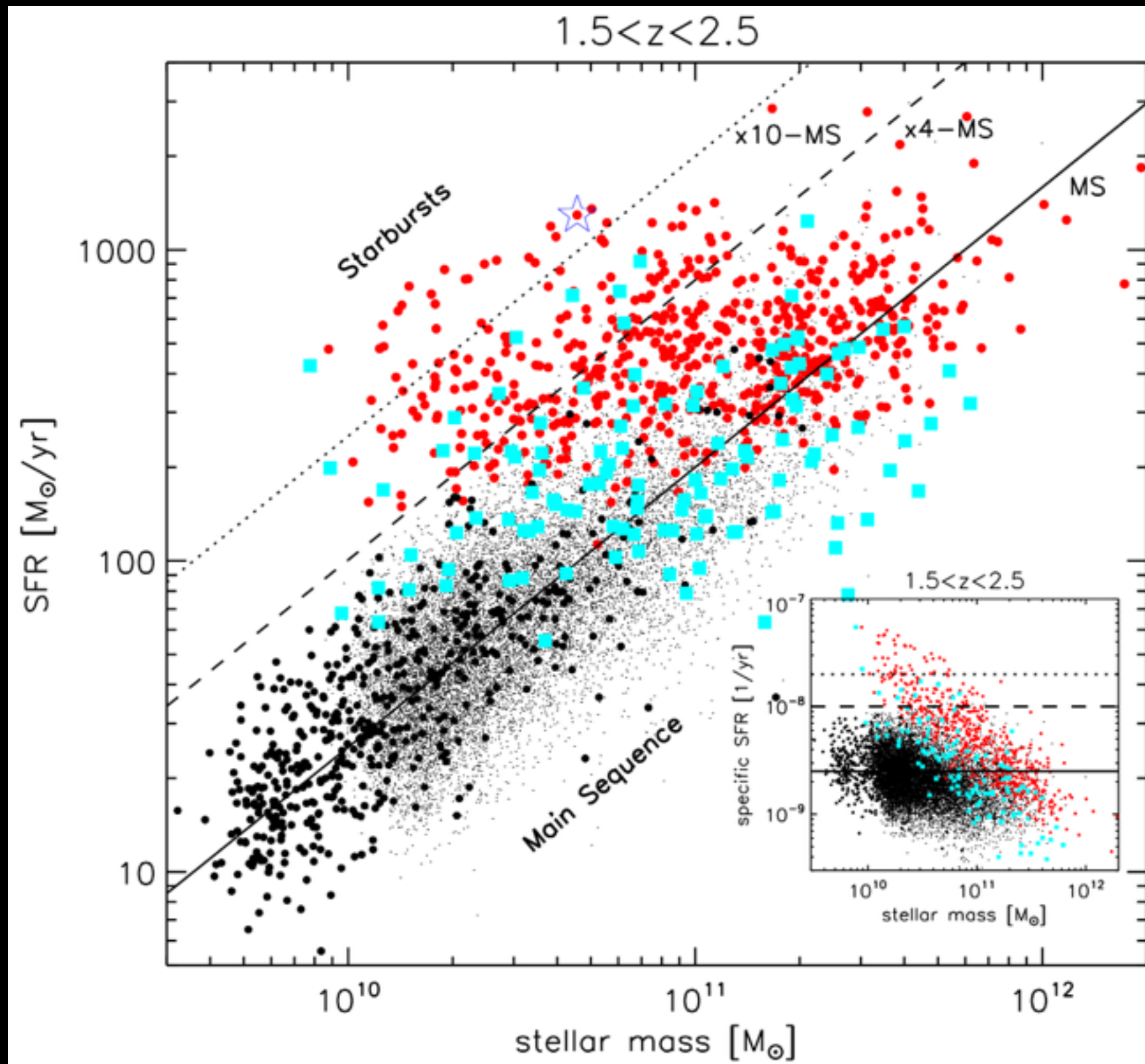
# Scatter in the SFMS



# Outline

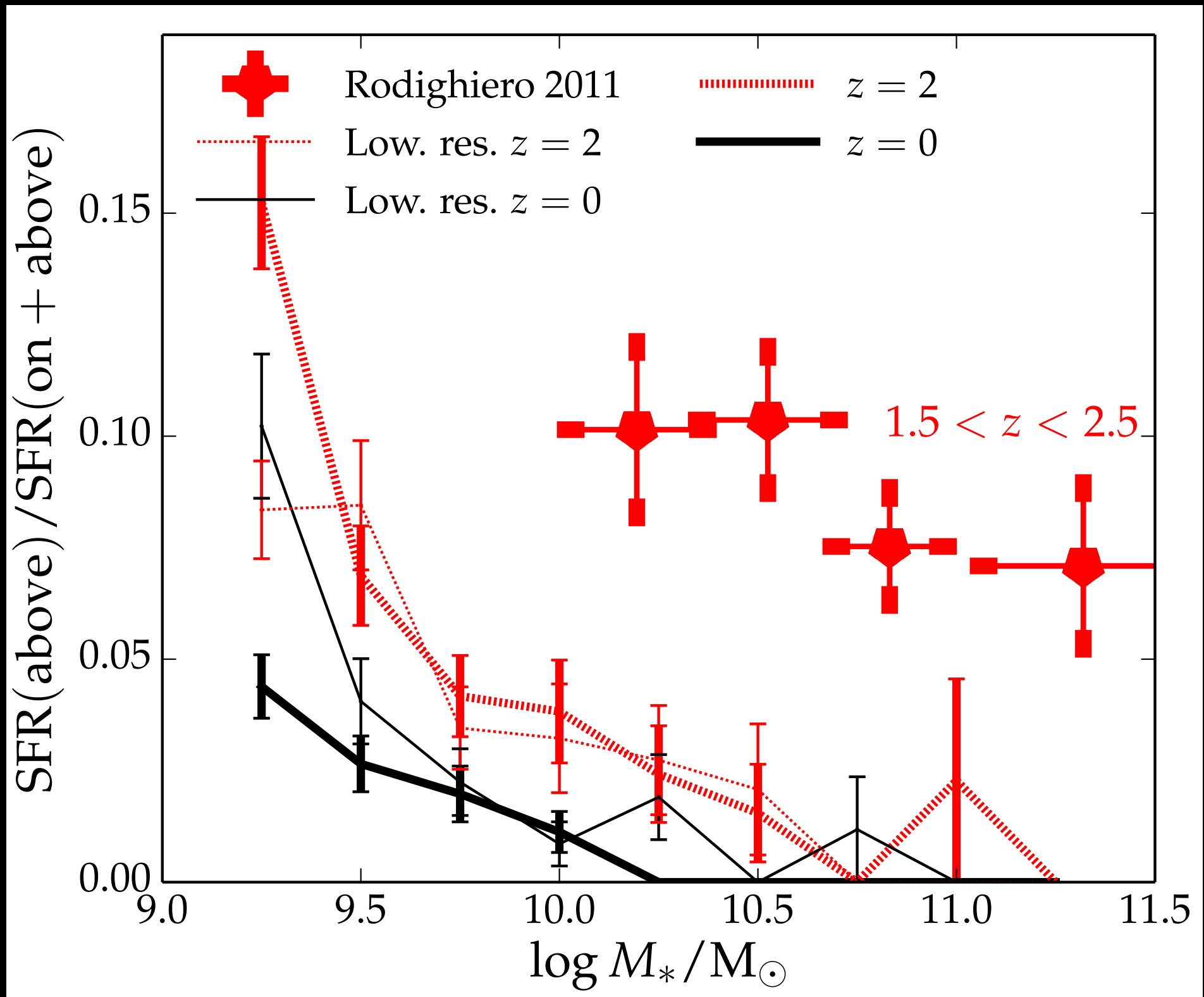
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# Definition of starbursts

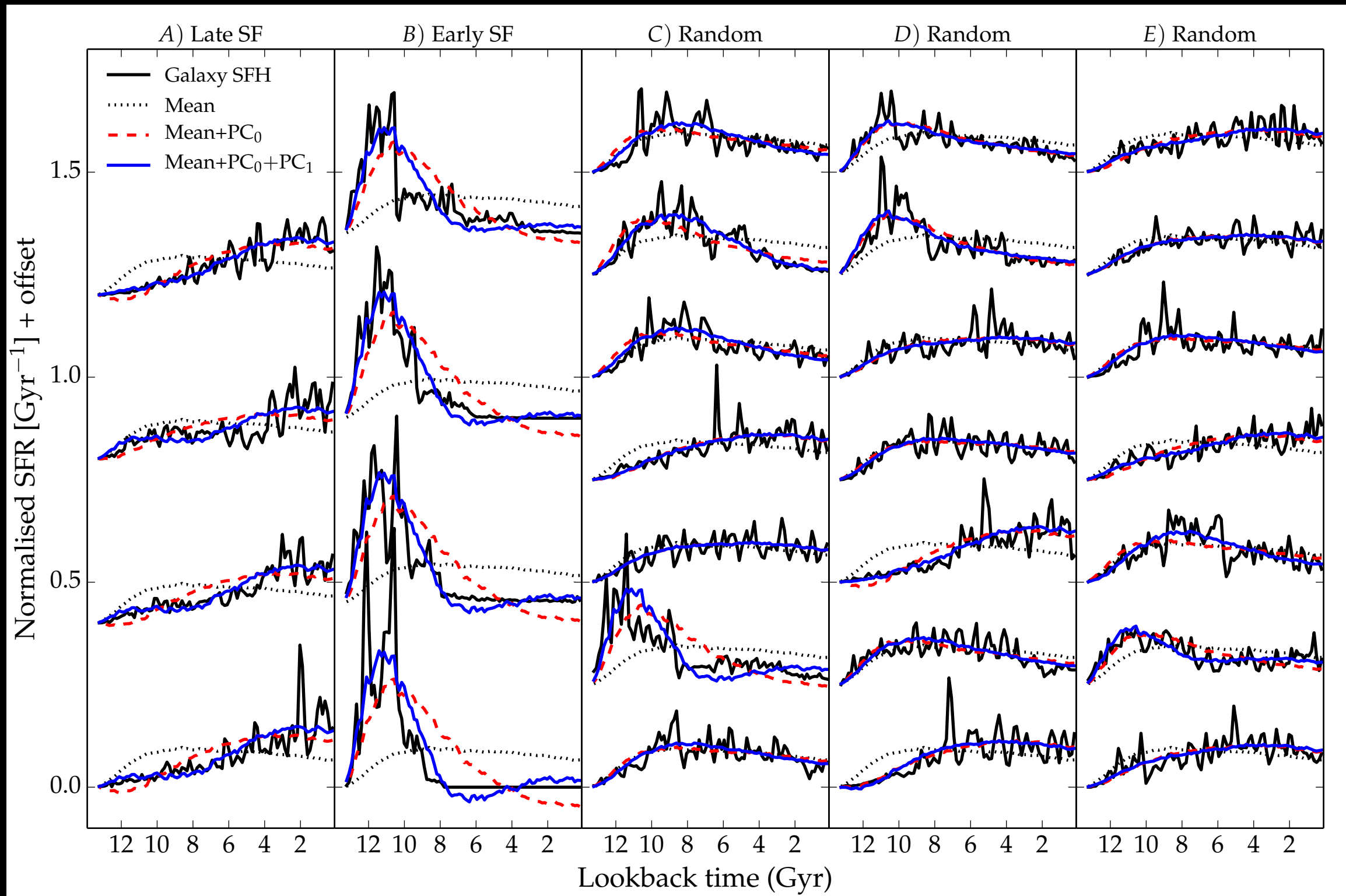




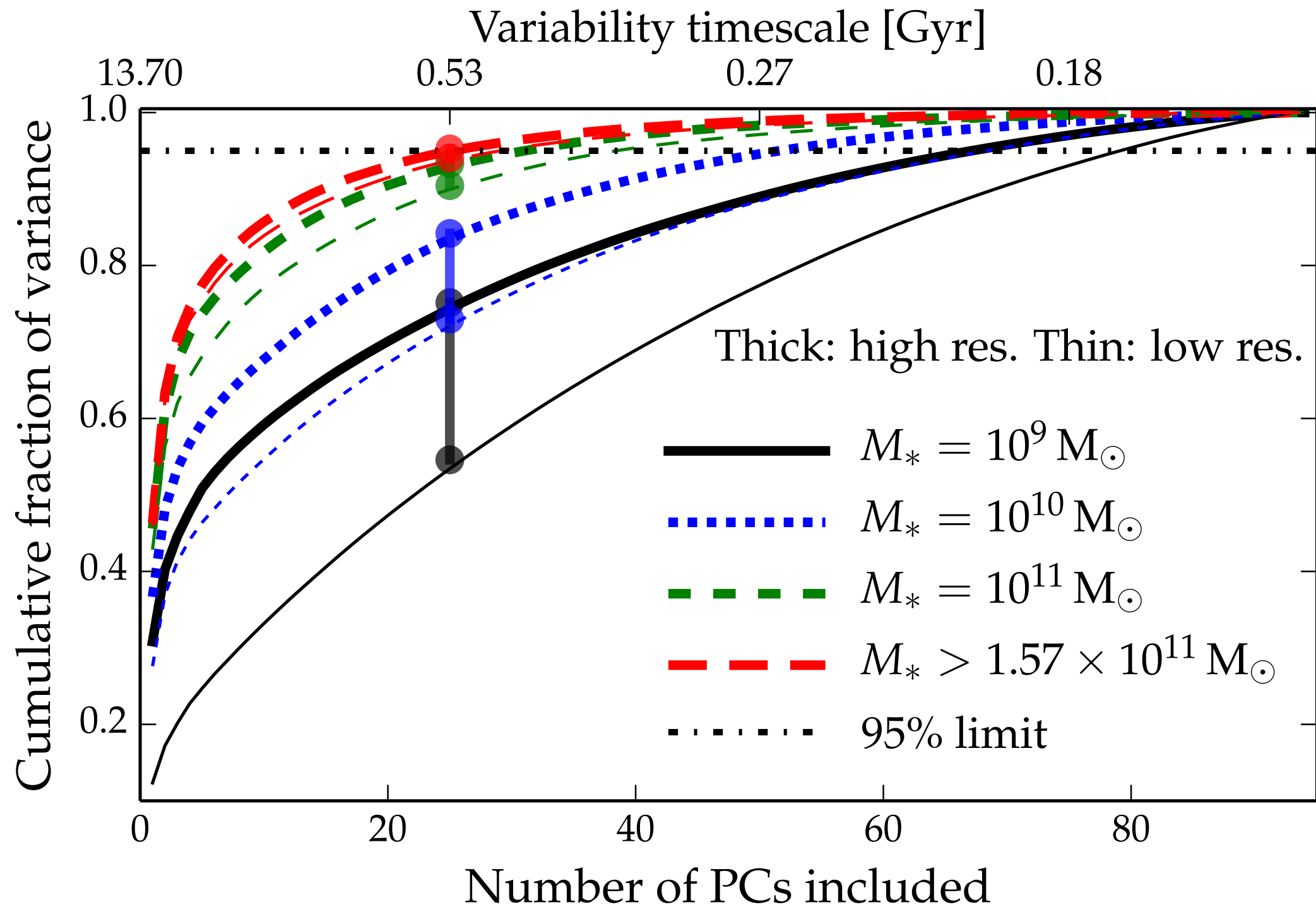
# A paucity of starbursts



# Burstiness of SFHs



# Variability timescale



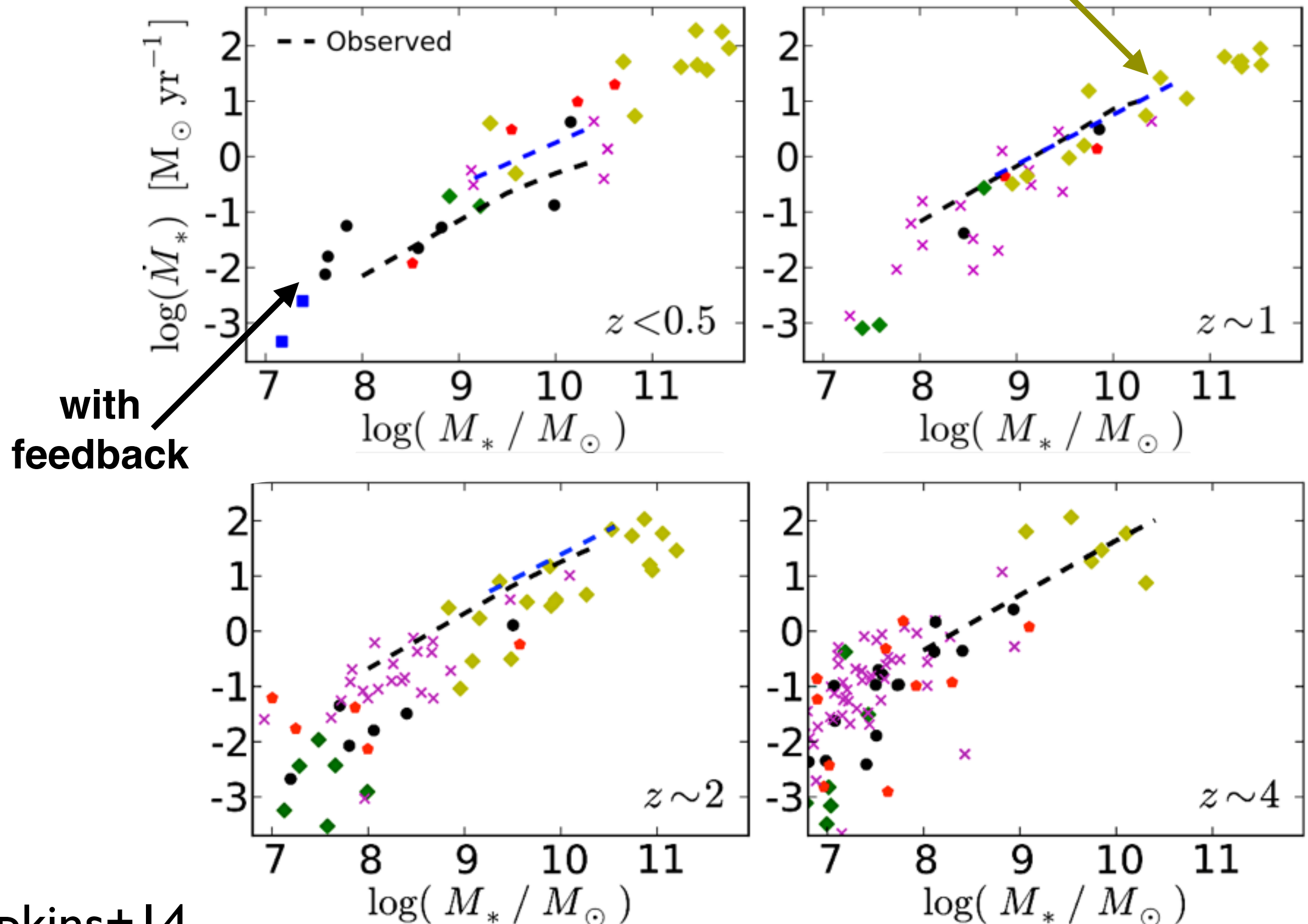


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# Red Herrings

THE “MAIN SEQUENCE” IS NOT A USEFUL CONSTRAINT



# Summary



- Redshift evolution of SFMS normalization is qualitatively recovered in *Illustris*, but normalization too low at  $z \sim 2$
- However, **the existence of an SFMS is not a useful constraint**
- Starburst fraction is less than that inferred from observations
- **Problem:** SFR is closely coupled to DM accretion rate
- **(Potential) solution:** better feedback models and higher res

