



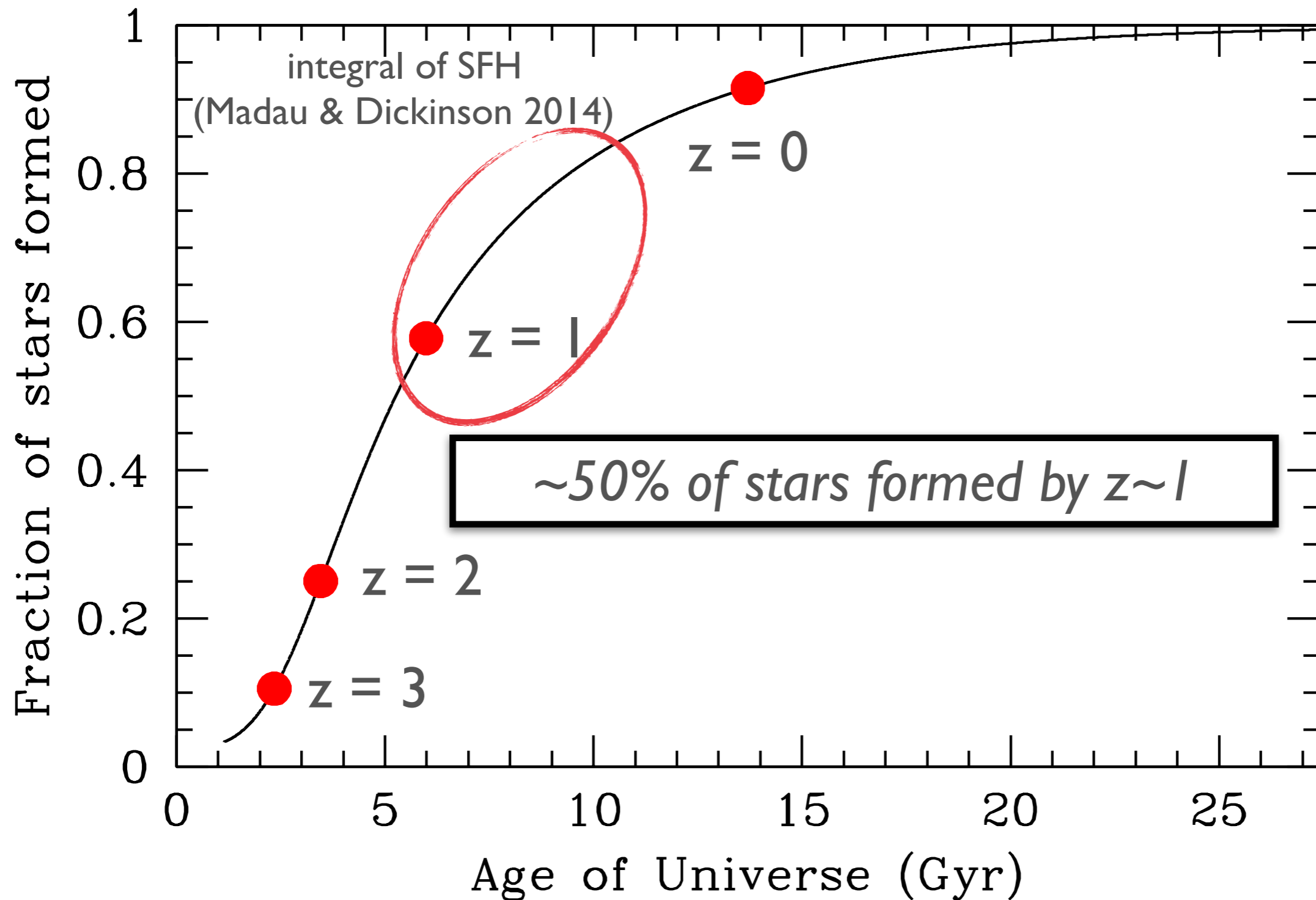
Tracing galaxy formation with deep spectroscopic survey

Multiple paths from star-forming to quiescence

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East Asian Core Observatory Association Fellow
@ National Astronomical Observatory of Japan

14 Gyr of Galaxy Evolution



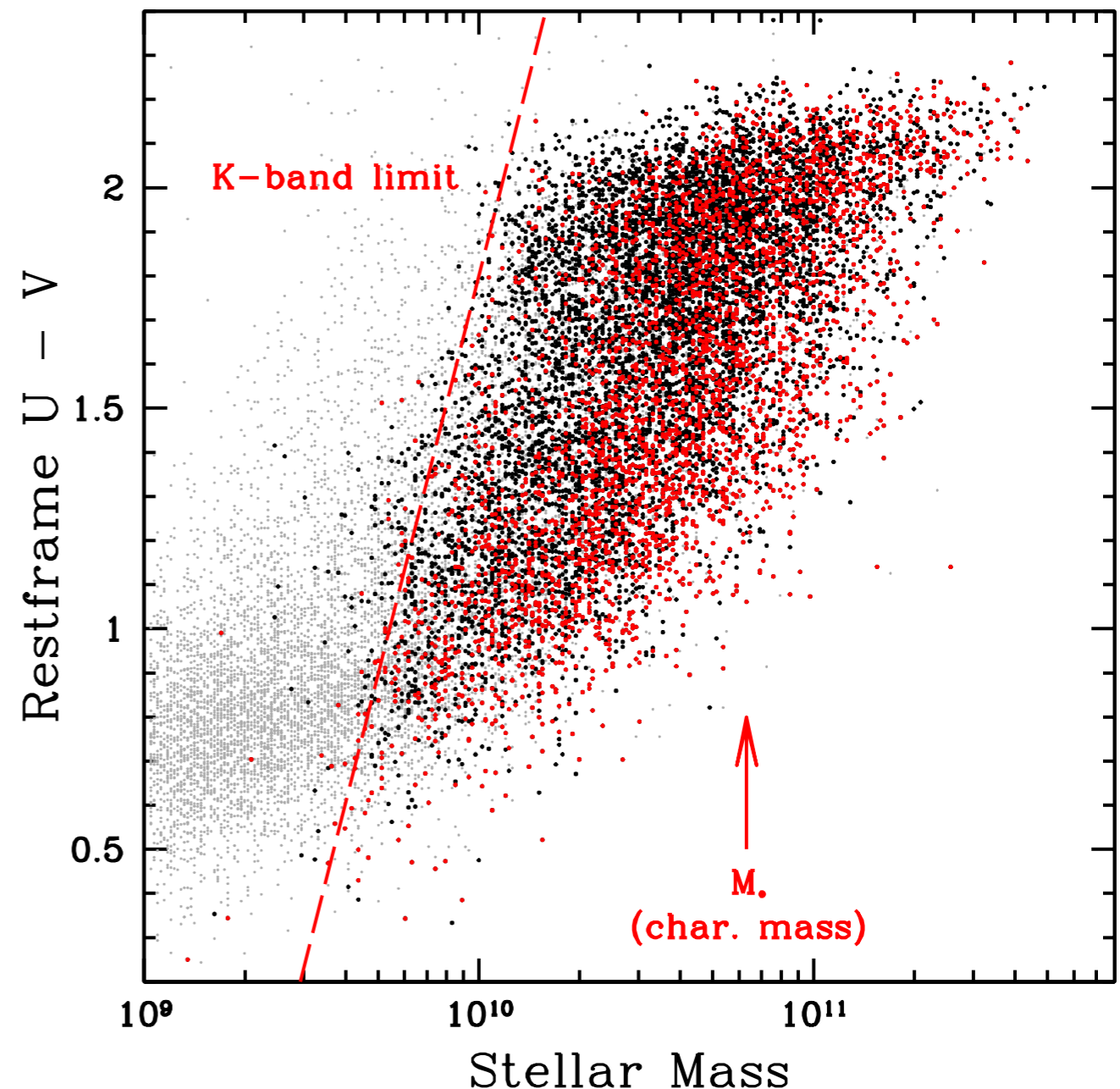
LEGA-C: a VLT / VIMOS Public Survey

Large **E**arly **G**alaxy **A**strophysics **C**ensus (*van der Wel et al. 2016*)

- >1000hr allocation
- >3000 galaxies at $0.6 < z < 1.0$
- 20h integrations.
- typical $S/N=20/\text{\AA}$
- **DR2**

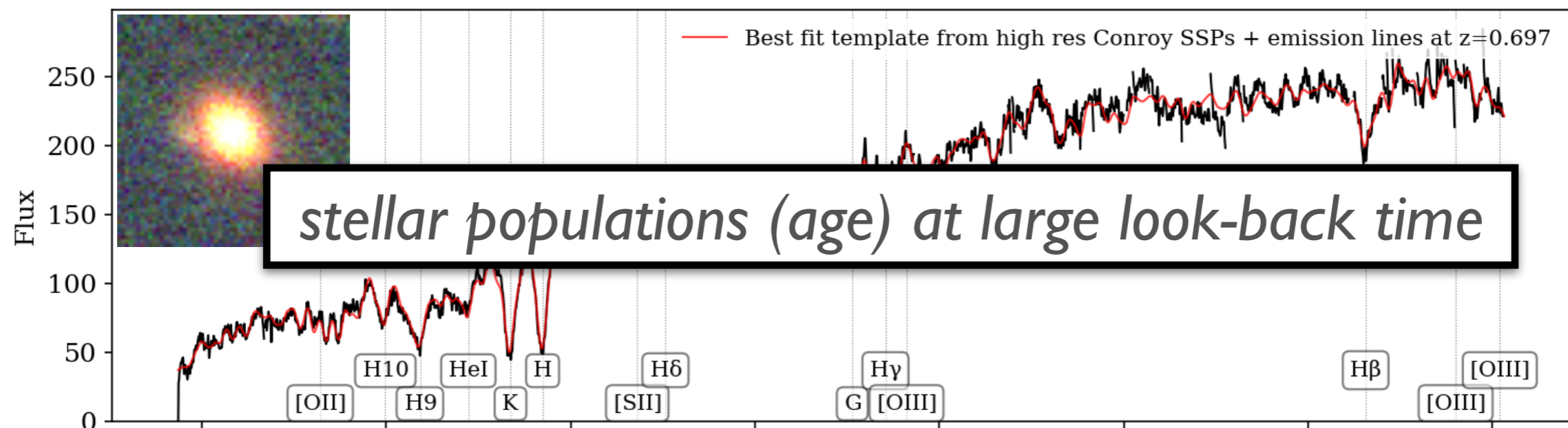


COSMOS/Ultra-VISTA field



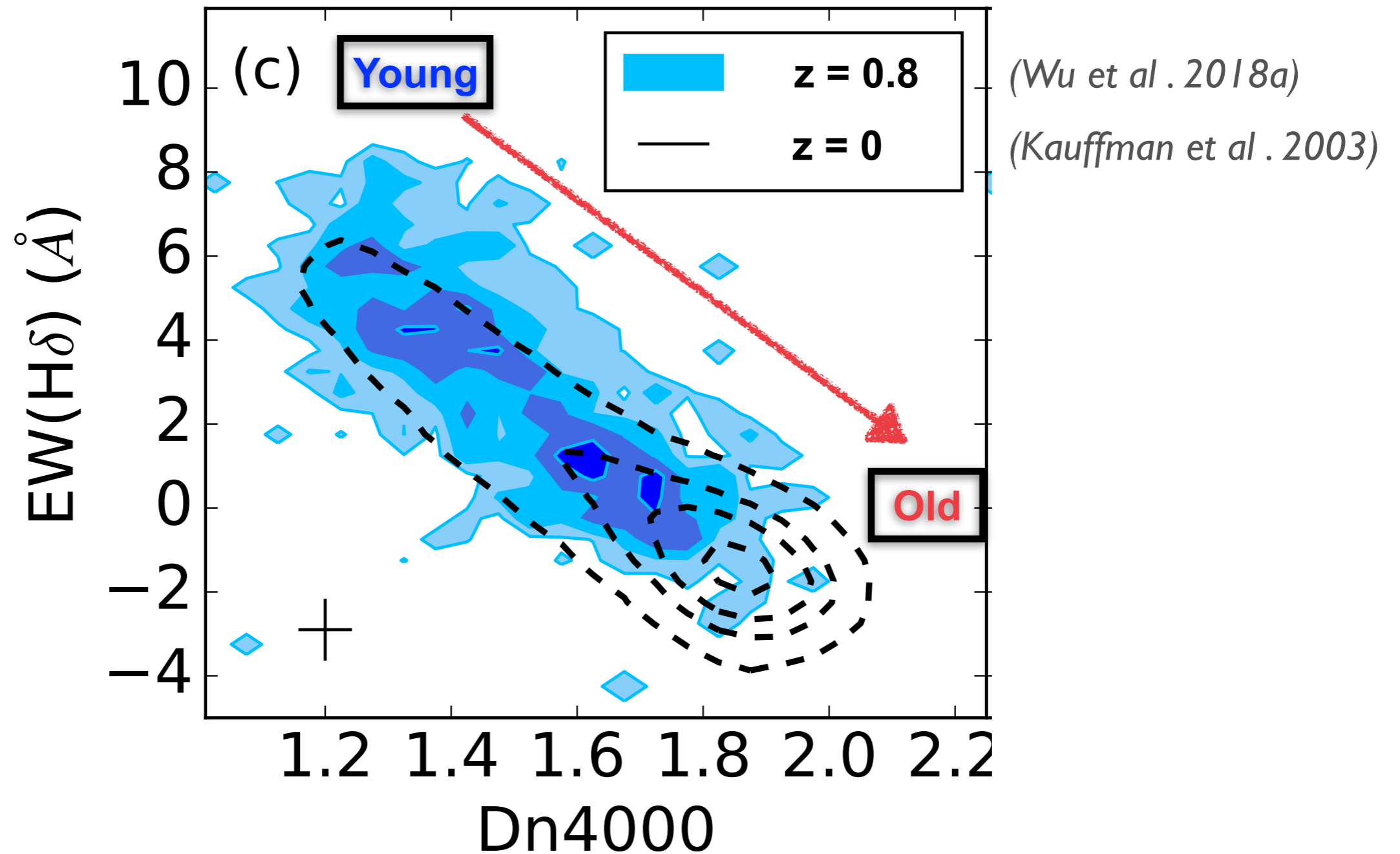
Stellar population

$$z=0.7, \log(M_s/M_{\text{sun}}) = 11.1$$



Stellar population

> 1000 galaxies @ $z \sim 0.8$

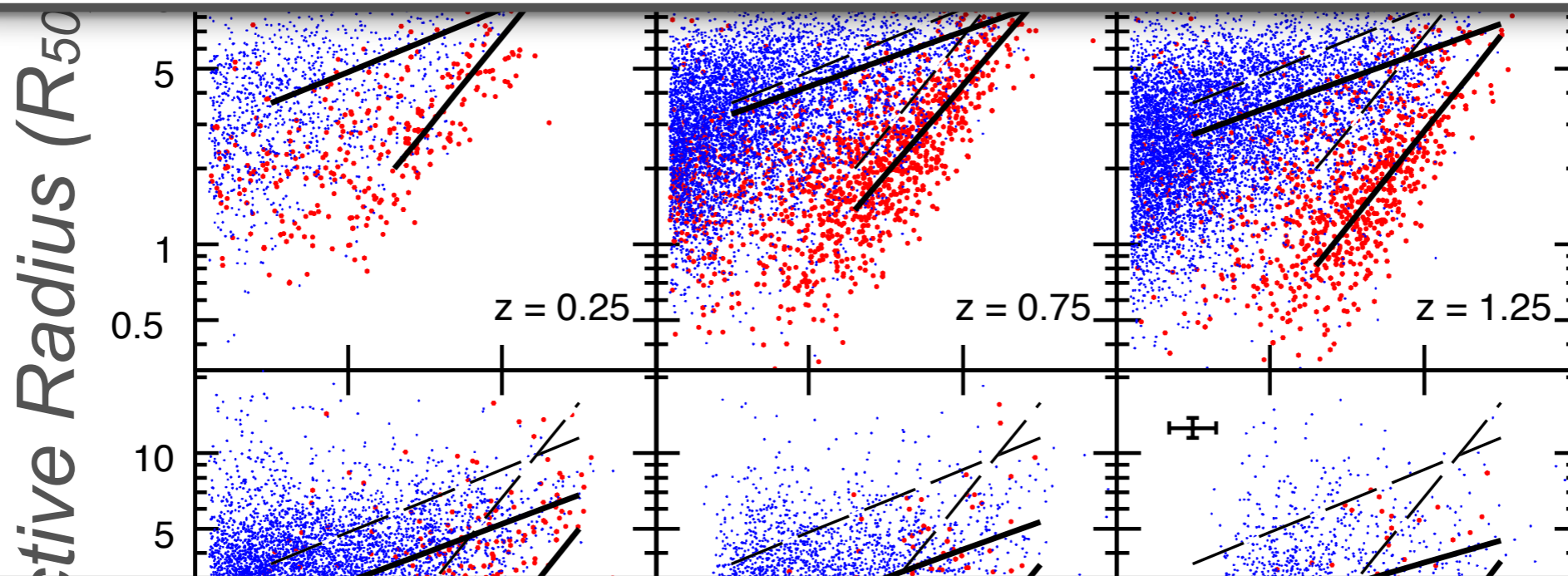


Question



Mass-size relation

Scenario 1: SFR and size decrease at the same time



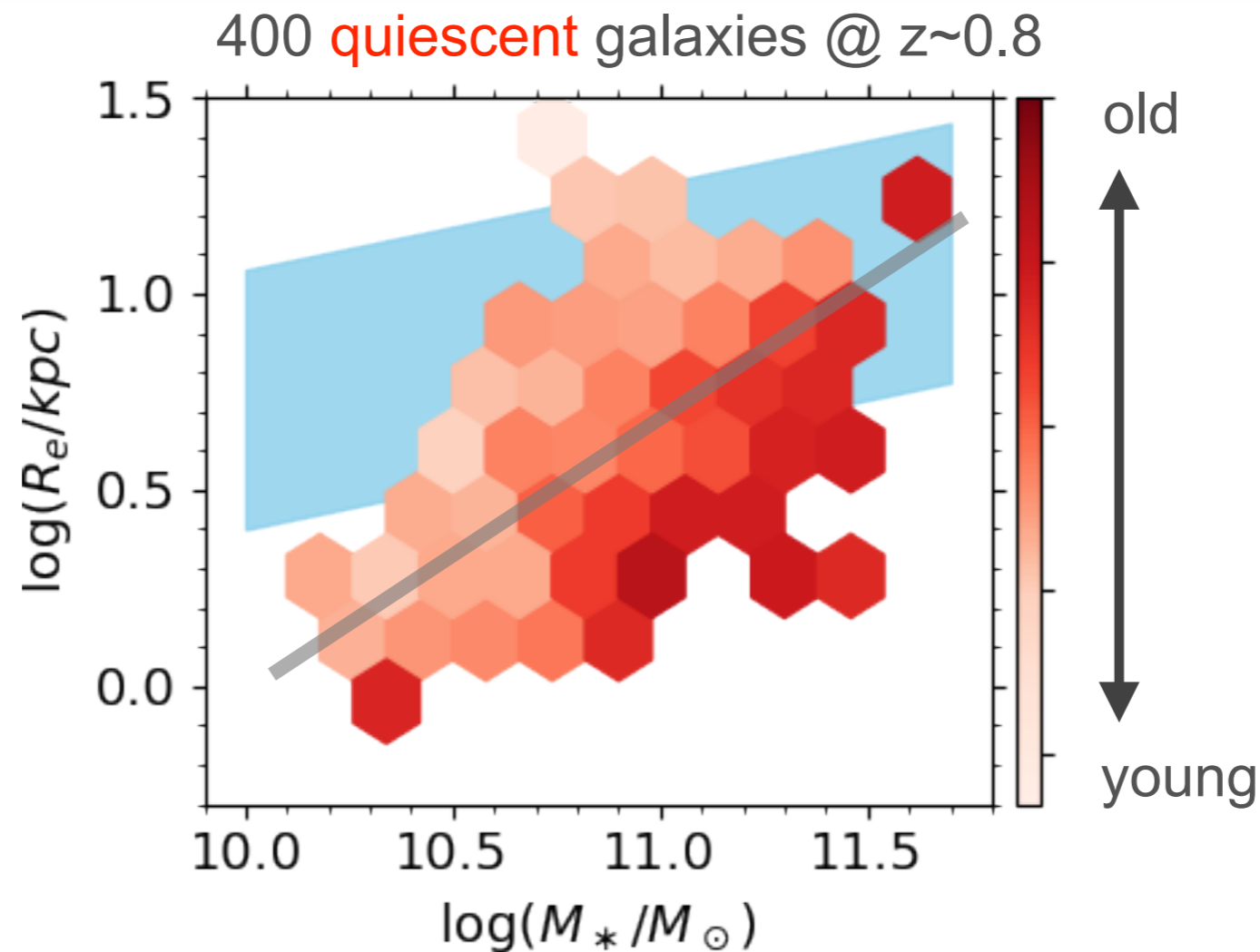
Scenario 2: Smaller galaxies evolve faster
— *Smaller quiescent galaxies*
should be older

Stellar Mass (M_{\odot})

(van der Wel et al. 2014)

Stellar ages of quiescent galaxies

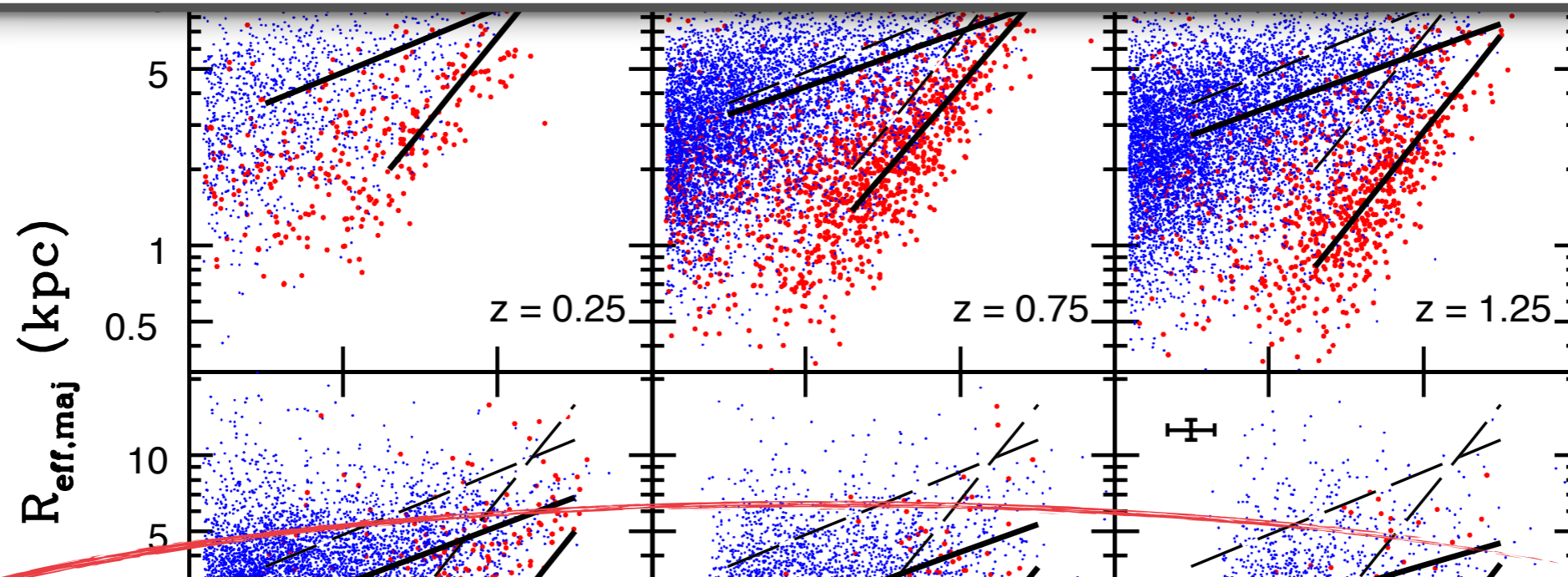
Small quiescent galaxies are on average older



(Wu et al. 2018b)

Mass-size relation

Scenario 1: SFR and size decrease at the same time



Scenario 2: Smaller galaxies evolve faster
— Smaller quiescent galaxies
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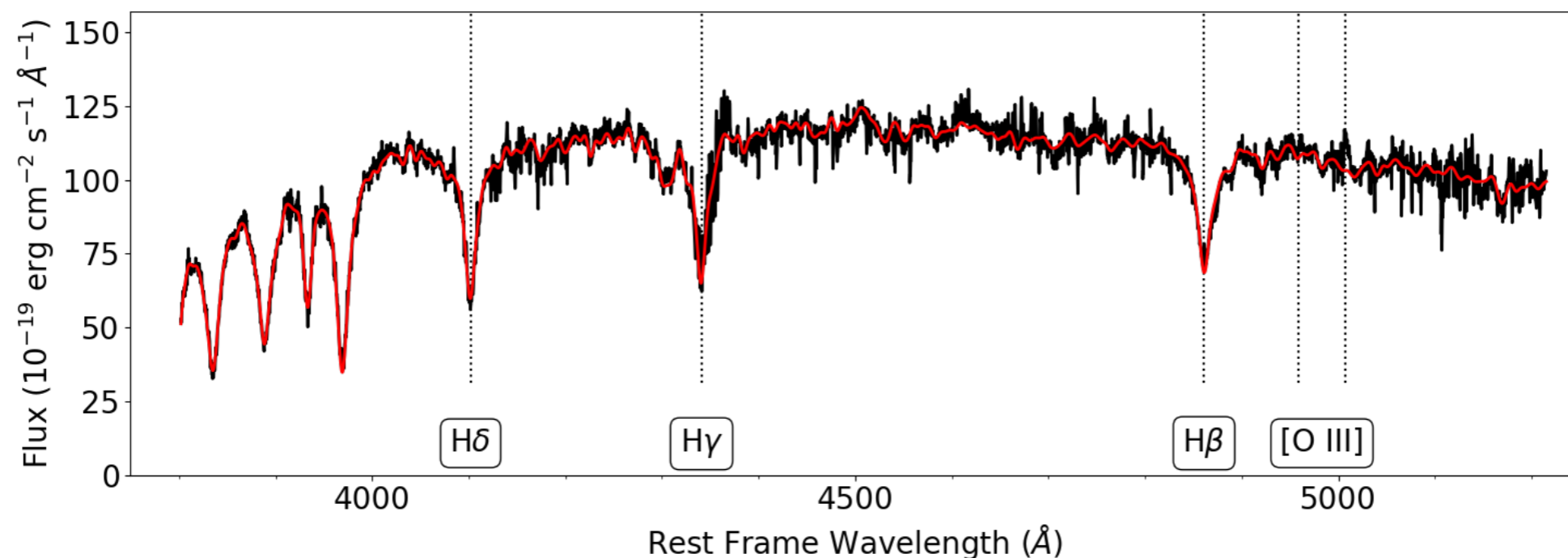
Stellar Mass (M_{\odot})

(van der Wel et al. 2014)

A different view from “*Young*” galaxies

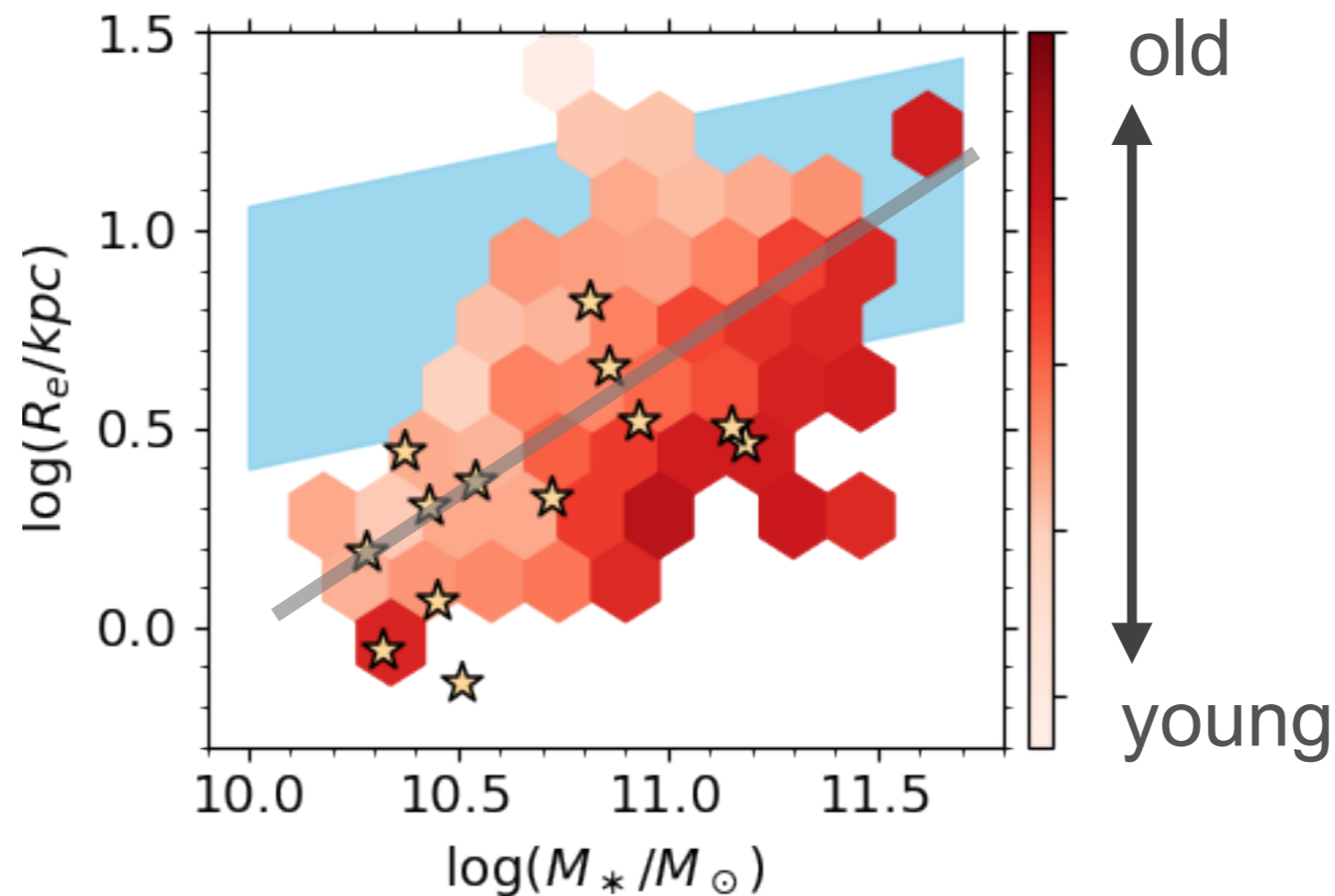
- Quiescent galaxies with strong Balmer absorption: **A-type stars**
- Star-formation declines rapidly
- “post-starburst galaxies”

Are these “A-type” galaxies larger?



Size of “A-type” galaxies

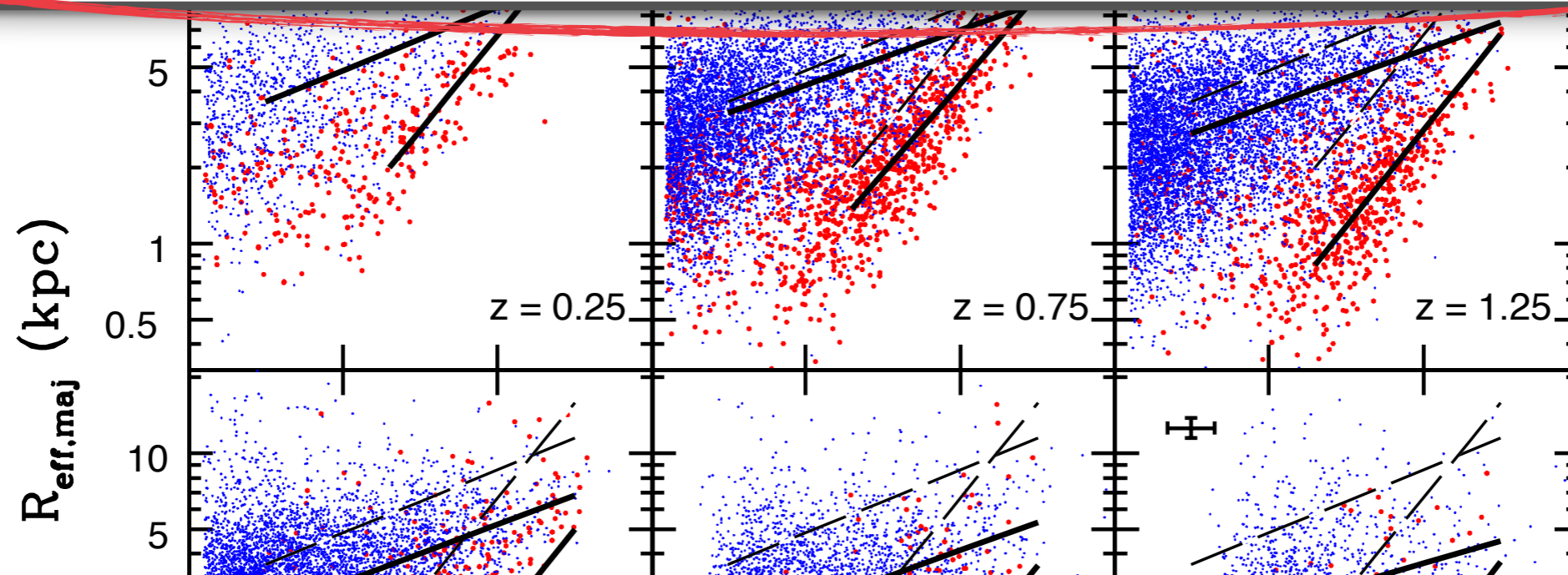
No! “A-type” galaxies are not large
& much smaller than average SF galaxies



(Wu et al. 2018b)

Mass-size relation

Scenario 1: SFR and size decrease at the same time

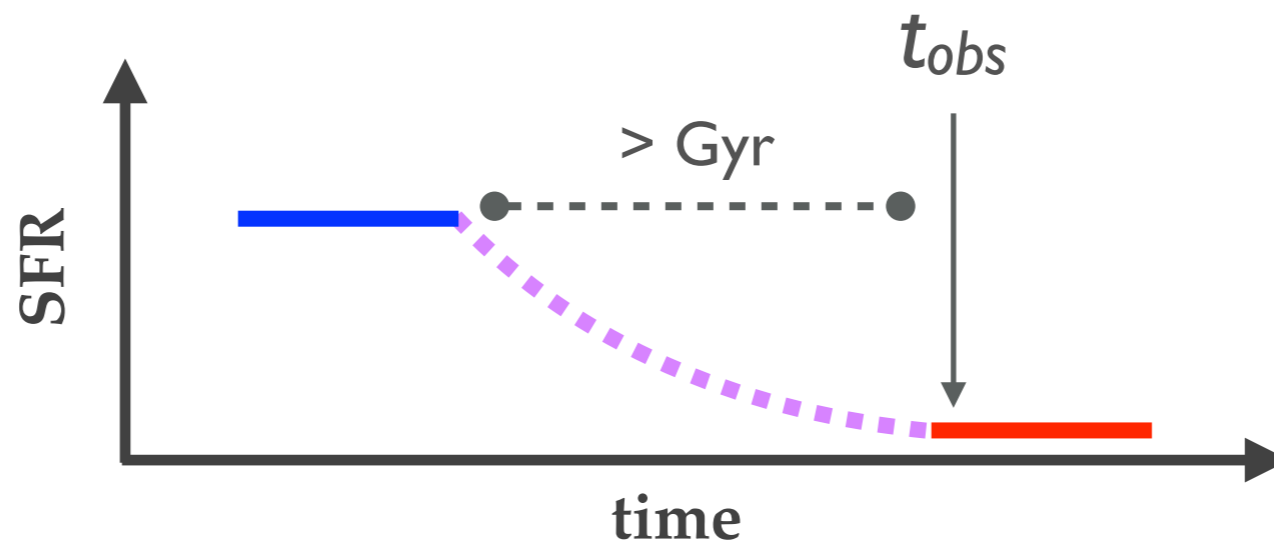
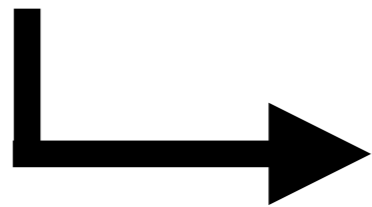
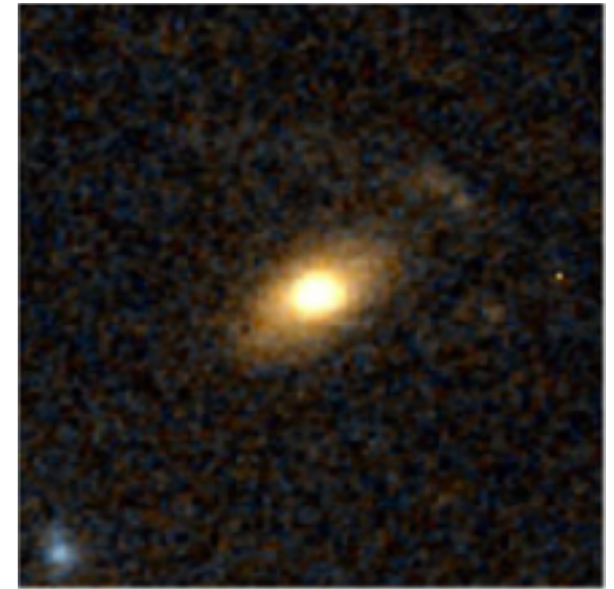
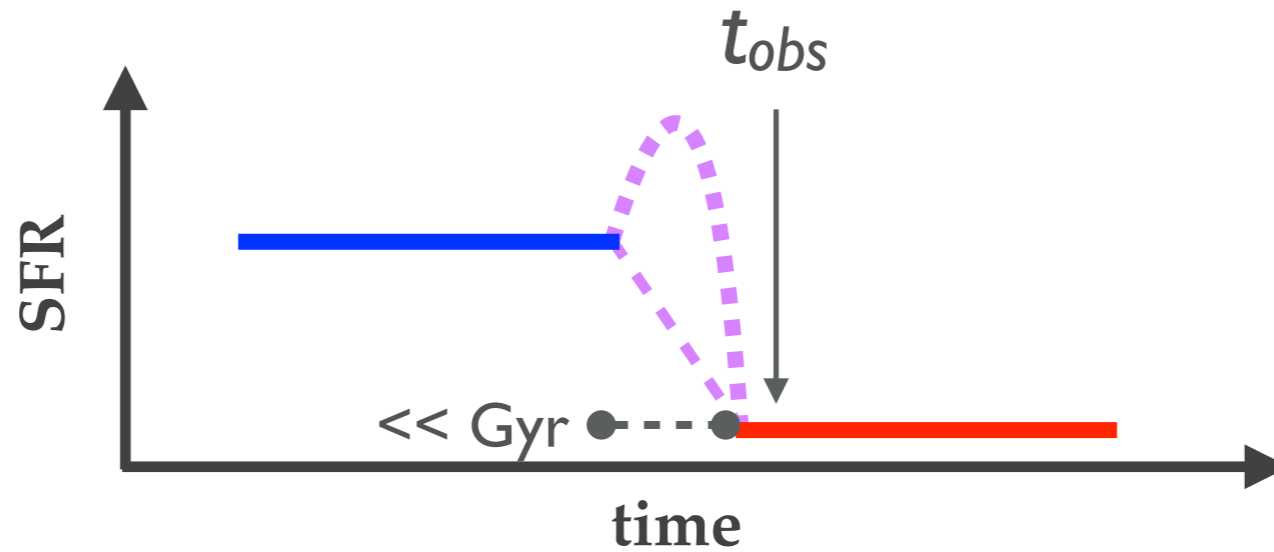
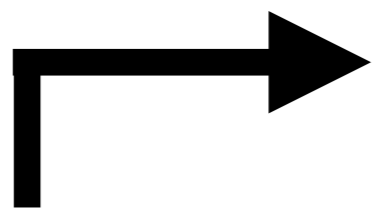


Scenario 2: Smaller galaxies evolve faster
— Smaller quiescent galaxies
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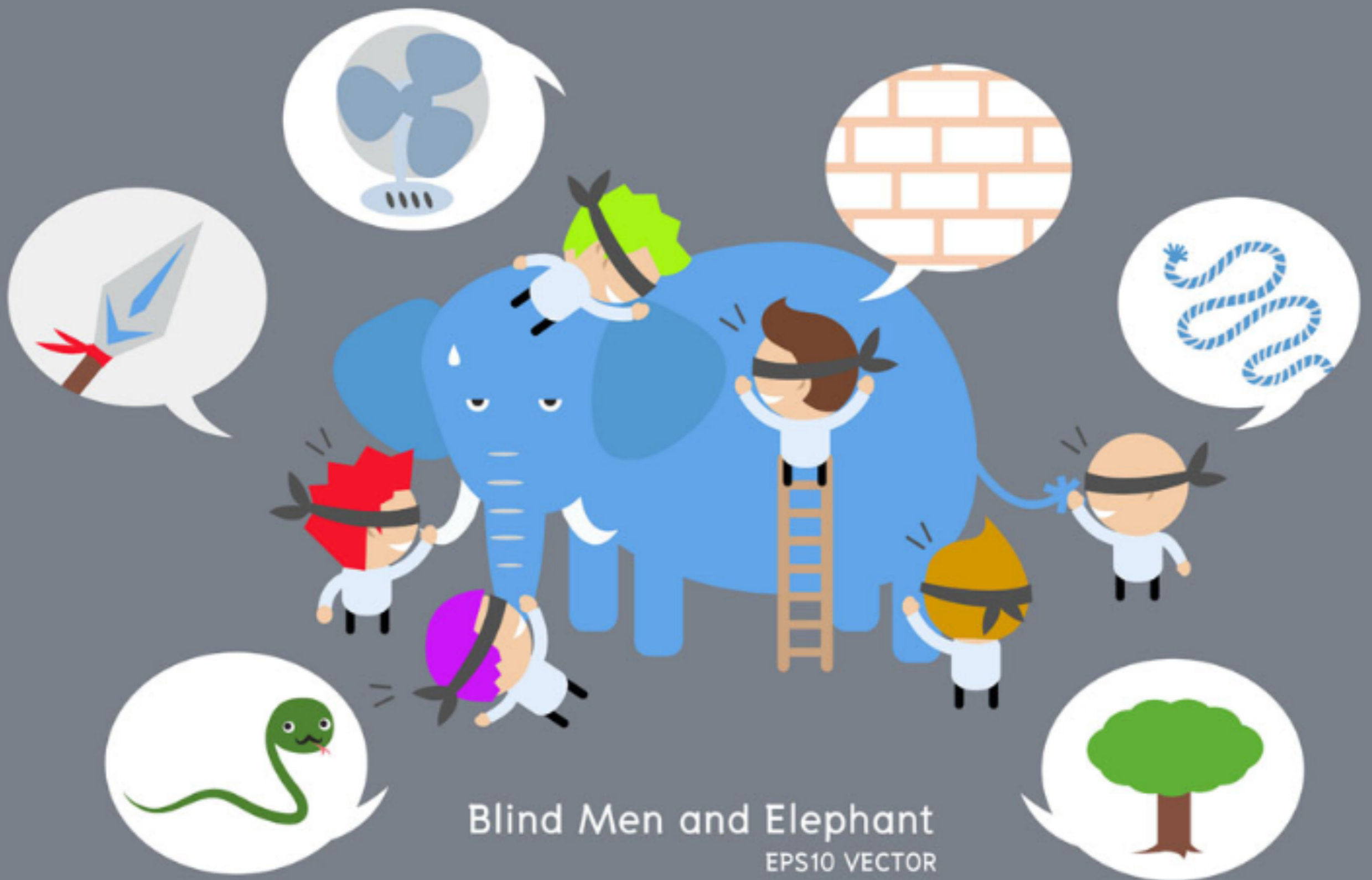
Stellar Mass (M_{\odot})

(van der Wel et al. 2014)

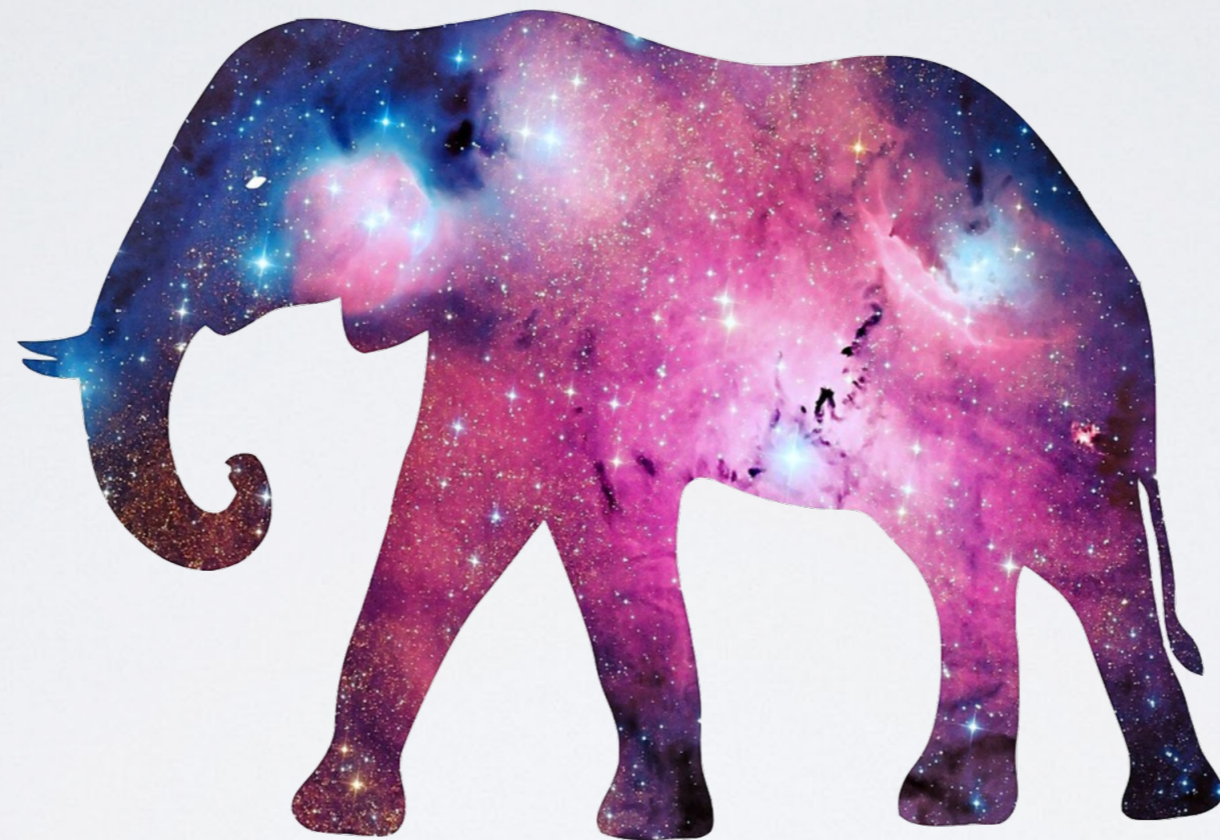
Multiple ways to quiescence (@ $z \sim 1$)?



(Adopted from
Wu et al. 2018b)

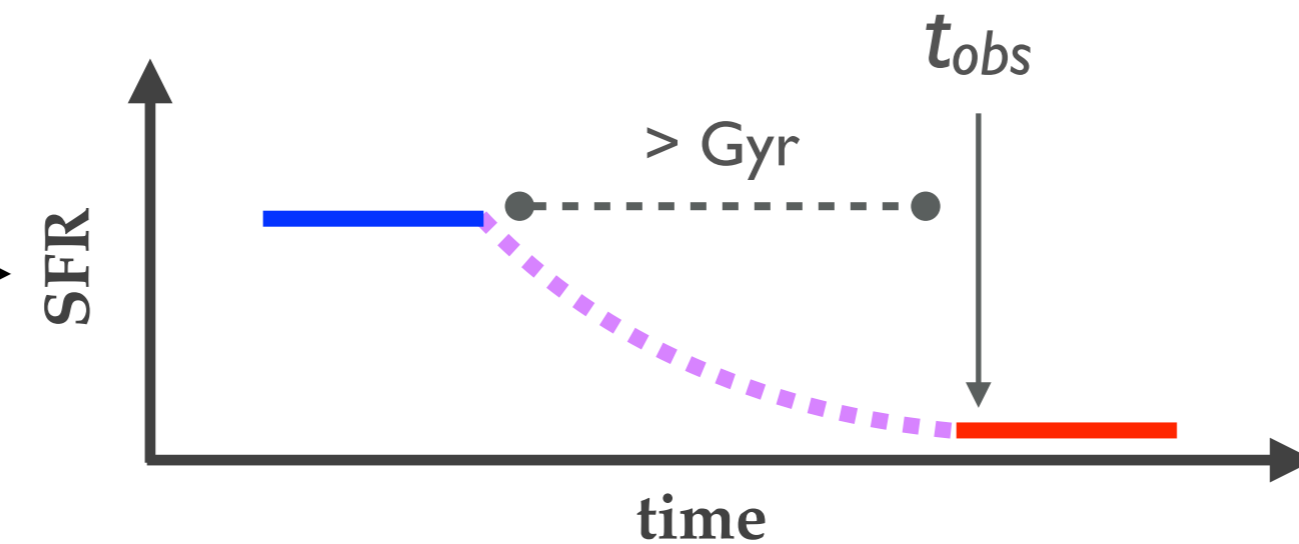
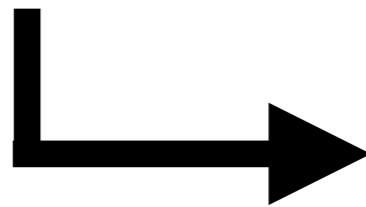
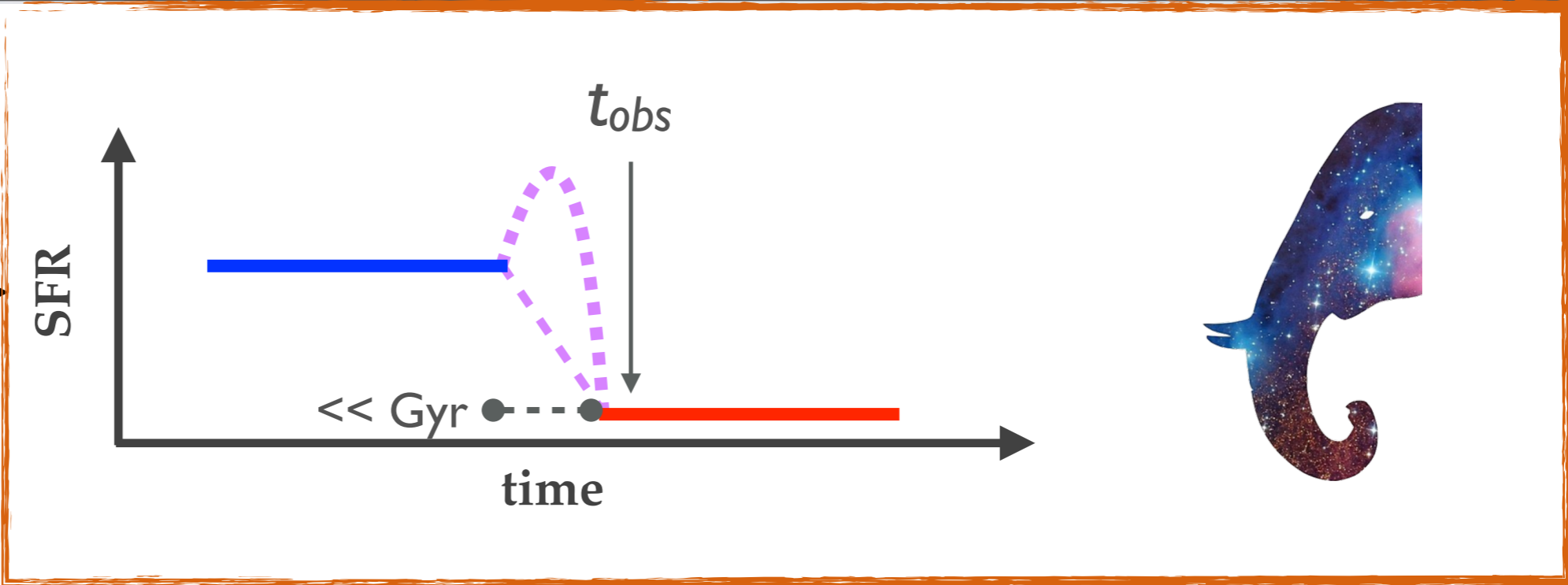
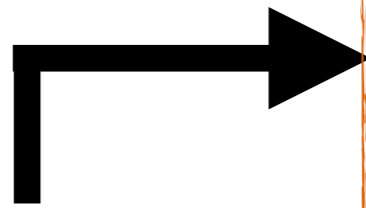


Blind Men and Elephant
EPS10 VECTOR





Multiple ways to quiescence (@ $z \sim 1$)?

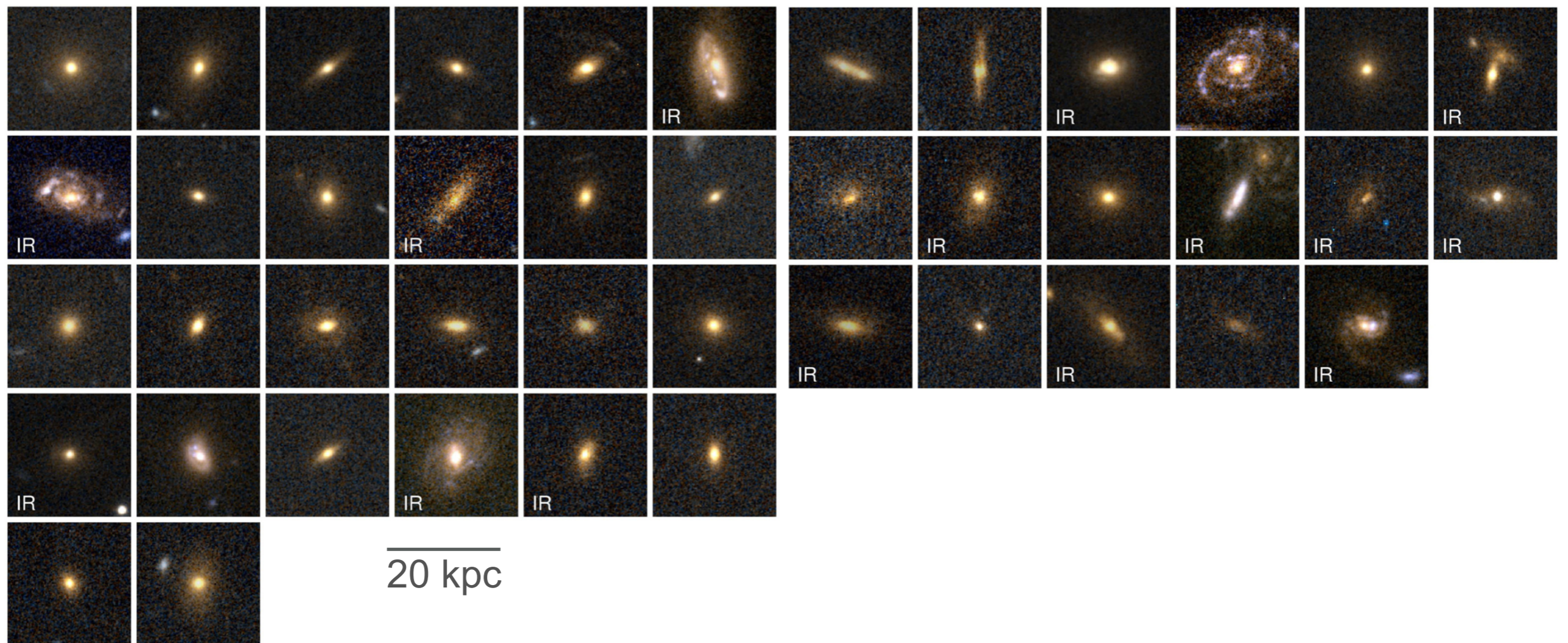


(Adopted from
Wu et al. 2018b)

Gallery of “A-type” Galaxies

$z=1$, *HST* F606W + F814W

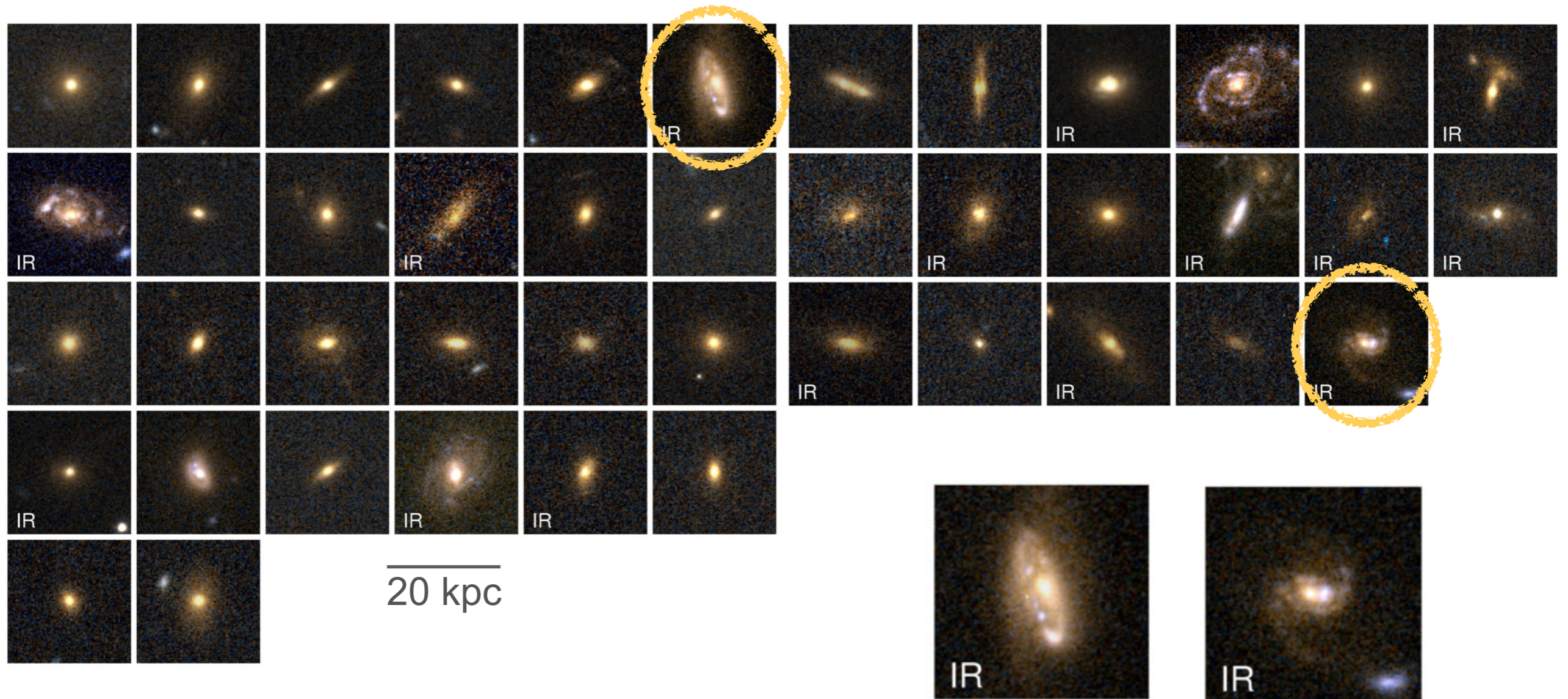
(Wu et al. 2014)



Gallery of “A-type” Galaxies

z=1, *HST F606W + F814W*

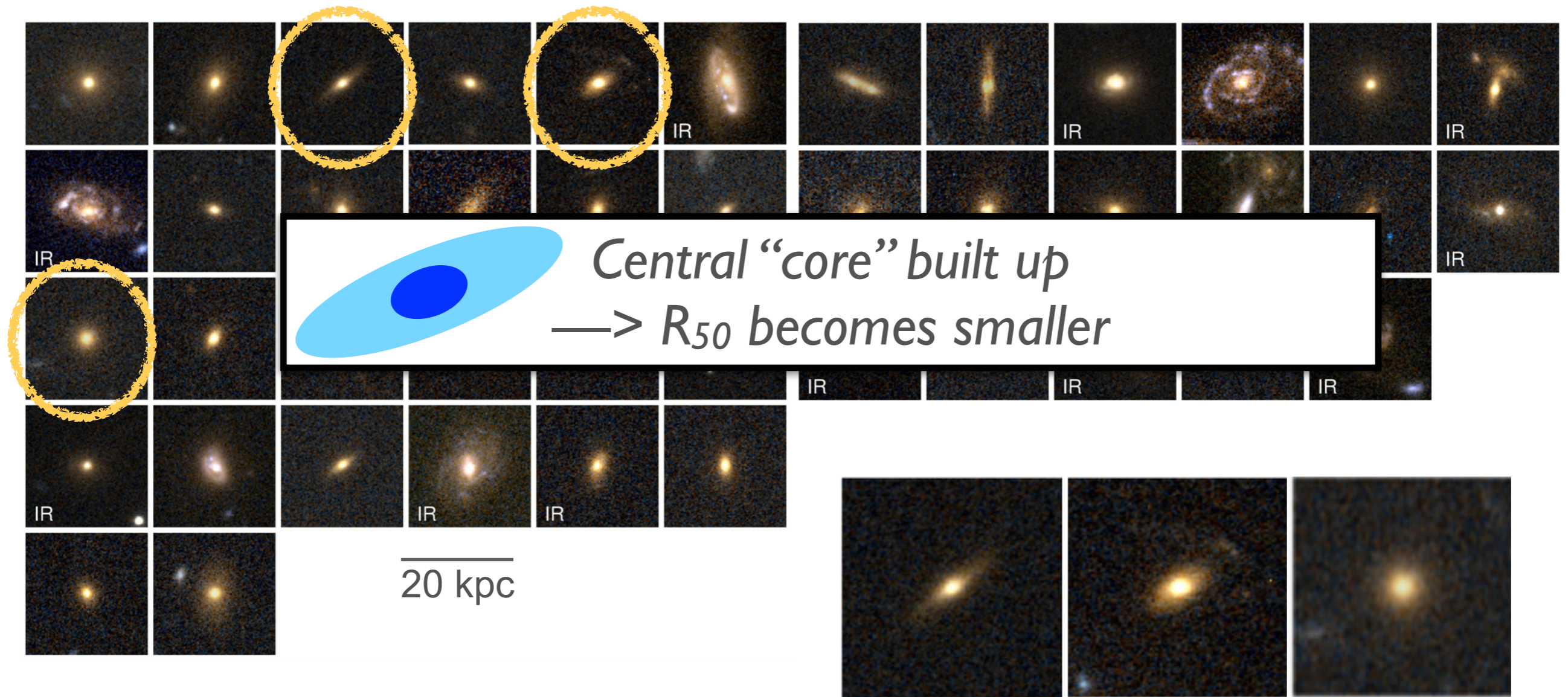
(Wu et al. 2014)



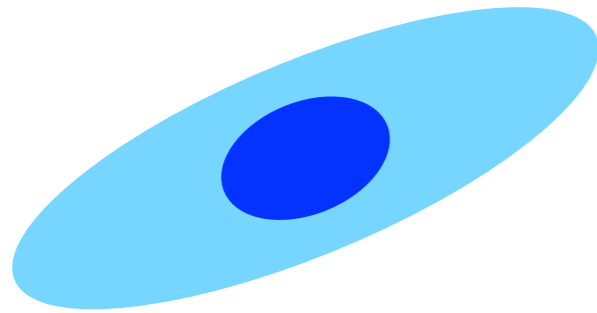
Gallery of “A-type” Galaxies

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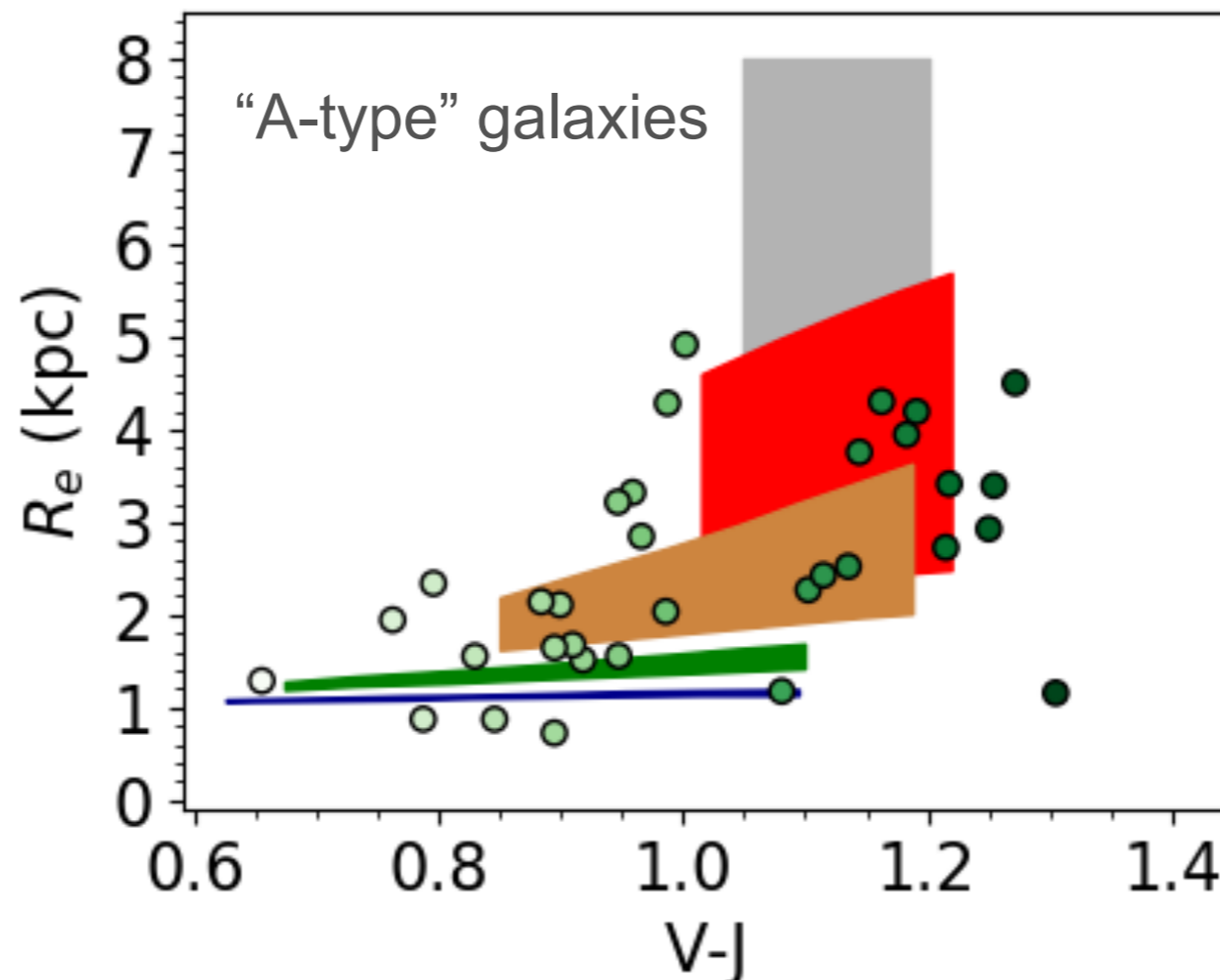
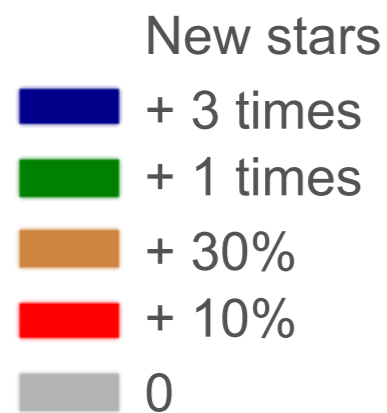


Correlation between colors and sizes



More new stars in the center ->

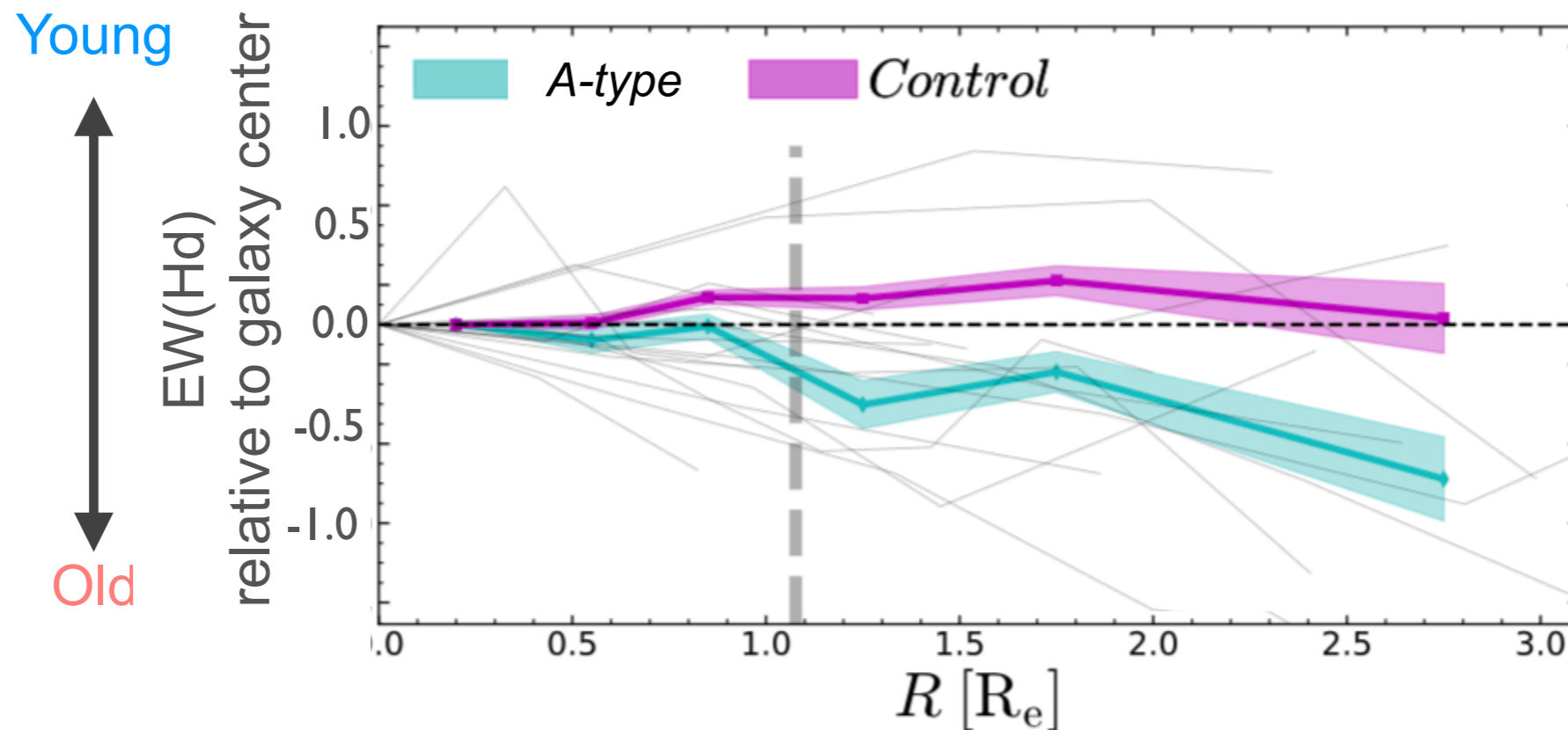
1. Smaller R_{50}
2. Bluer color



(Wu et al. 2019, sub.)

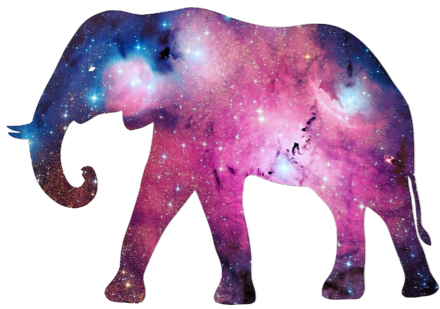
Age gradient

“A-type” galaxies have younger center
—> Different formation paths



(D' Eugenio et al. 2019, in prep)

Take-away points



Multiple mechanisms are shutting down SF:

- Slow, little structural transformation
- Rapid, significant structural transformation



Before a galaxy *rapidly* shuts down star-formation,
new stars formed in the galaxy center

*Deep spectroscopic survey is useful
to picture the elephant
and **PFS** can do it*