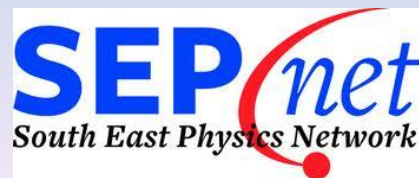


Galaxy Zoo: Evolution of the bar fraction over the last eight billion years from HST-COSMOS

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Cosmic Evolution Survey



- ~2 square degree equatorial field
- Observe over 100,000 galaxies
- Imaging taken in F814W band by ACS
- Follow up observations from several other telescopes
- Combines photometric and spectroscopic redshifts (zCOSMOS)

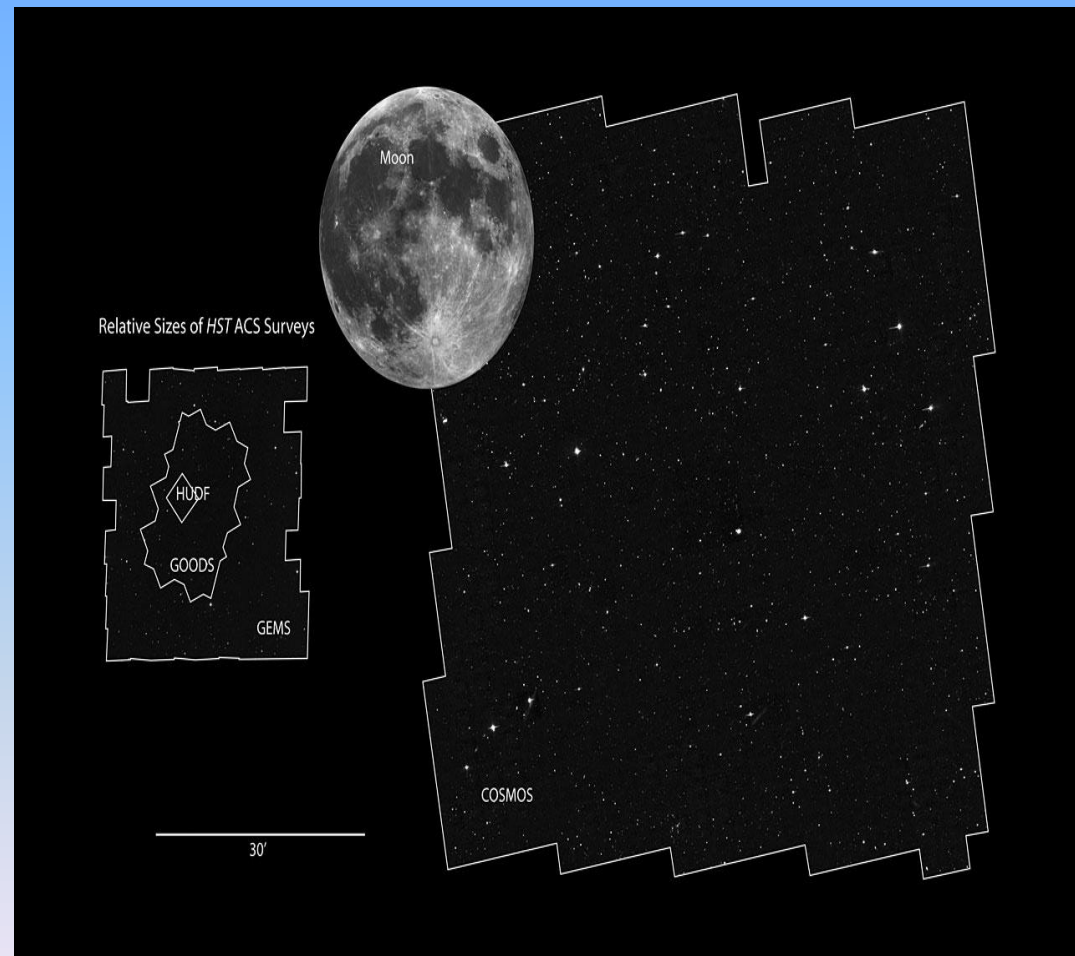


Image from <http://candels-collaboration.blogspot.co.uk/2012/07/cosmos-cosmic-evolution-survey.html>

Galaxy Zoo: Hubble

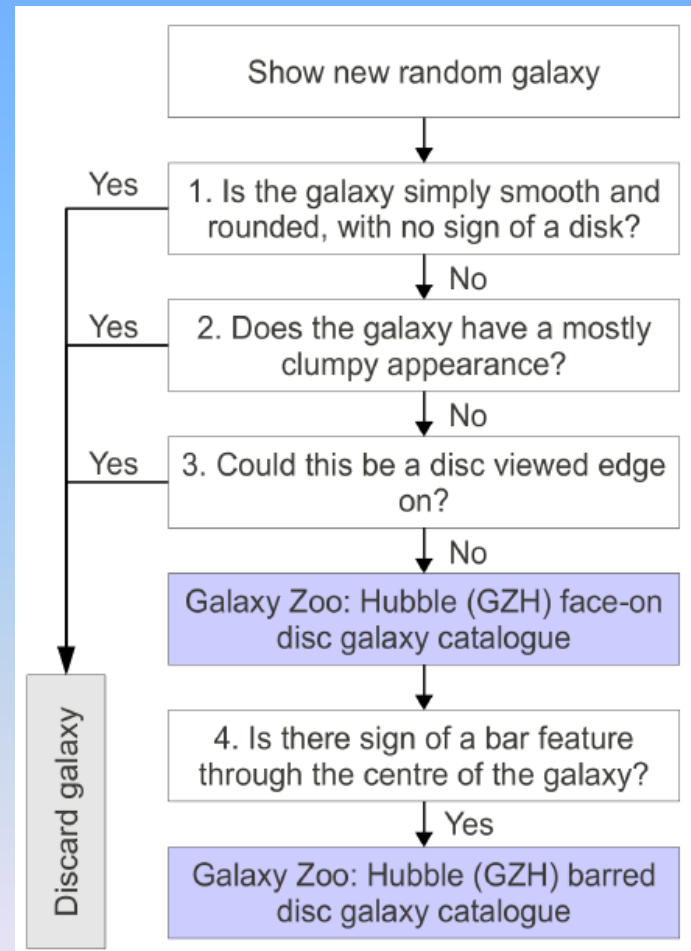


- 3rd phase of Galaxy Zoo project
 - First not to use SDSS images
 - Ran from 2010-2012
 - Attracting 86,520 volunteers
- Who provided 40,631,068 clicks

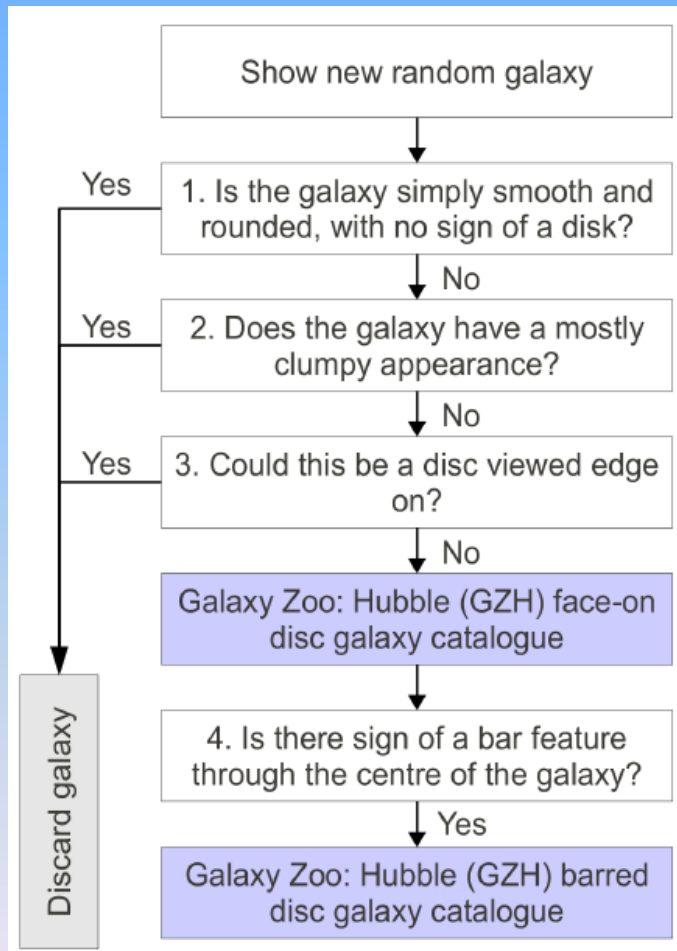
Galaxy Zoo: Hubble



- 3rd phase of Galaxy Zoo project
 - First not to use SDSS images
 - Ran from 2010-2012
 - Attracting 86,520 volunteers
- Who provided 40,631,068 clicks
- Median of 47 classifiers per galaxy
 - Minimum of 33 classifiers per galaxy



Galaxy Zoo: Hubble



Final sample details

$$0.4 \leq z \leq 1.0$$

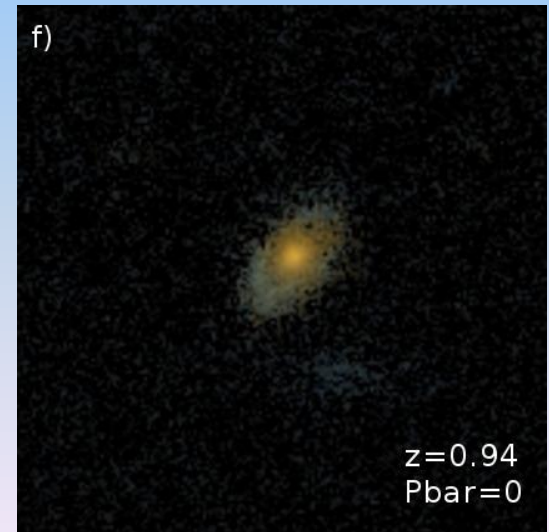
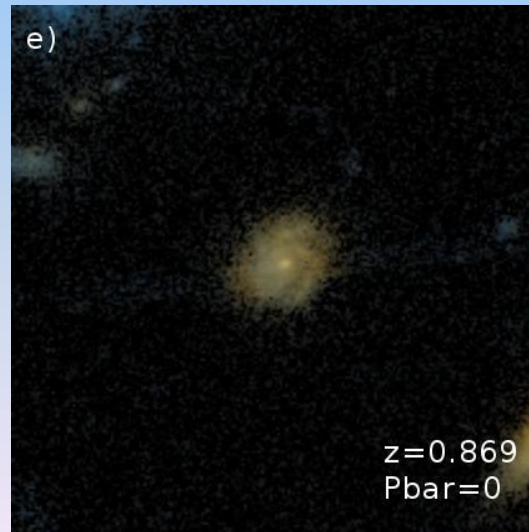
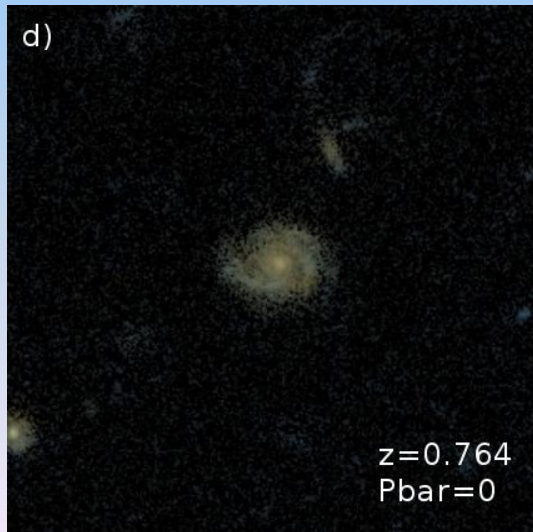
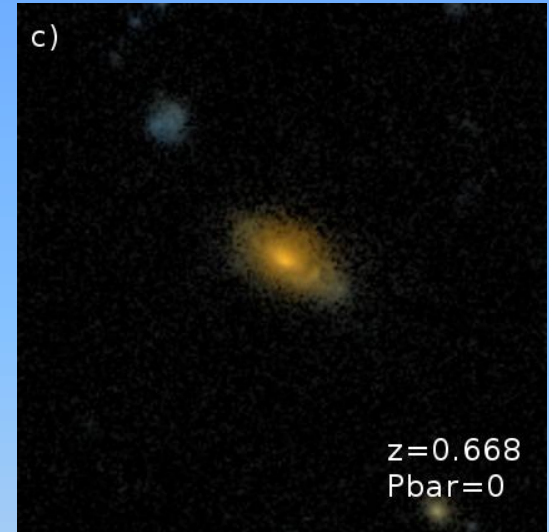
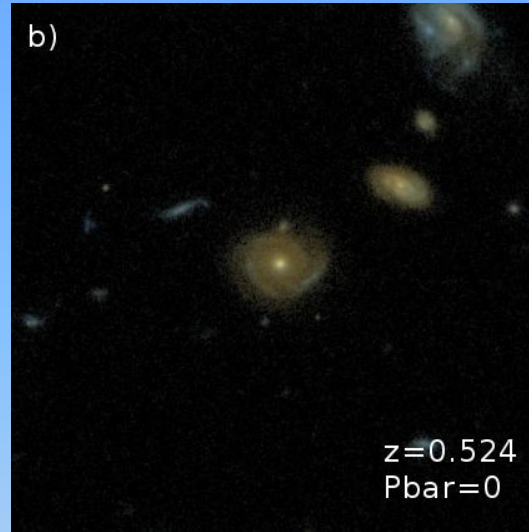
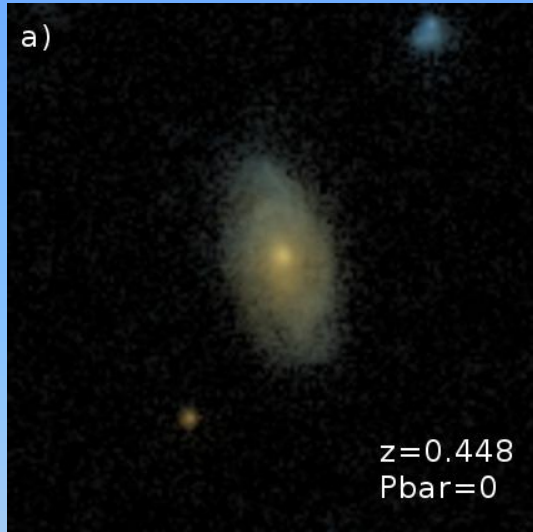
$$\log (M_{\text{star}}/M_{\text{sun}}) \geq 10.0$$

$$p \geq 0.5 \text{ (GZH thresholds)}$$

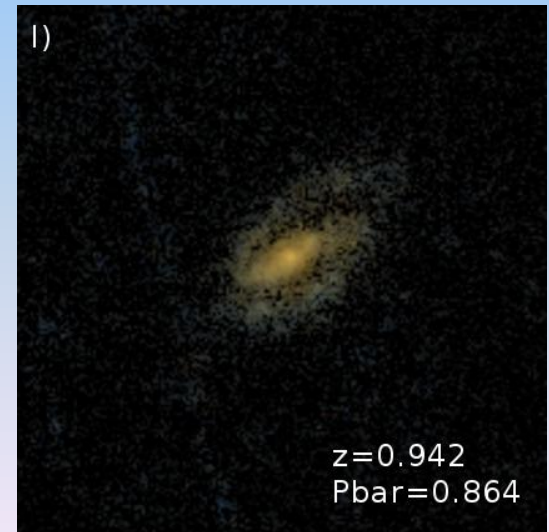
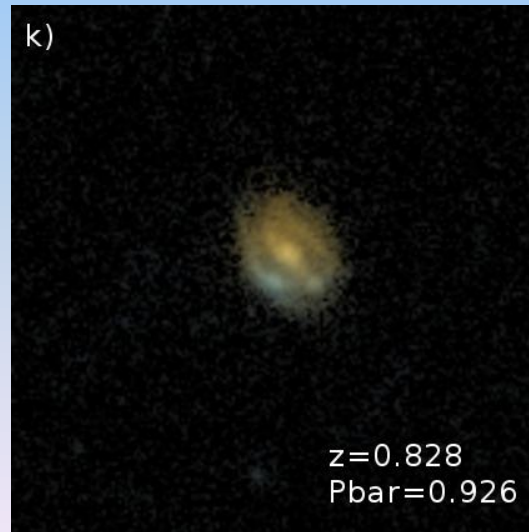
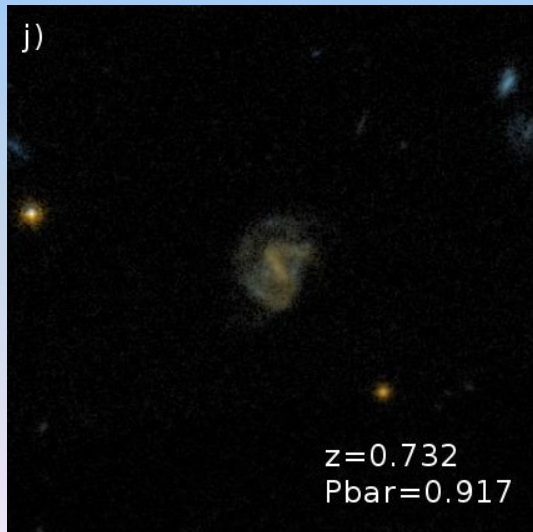
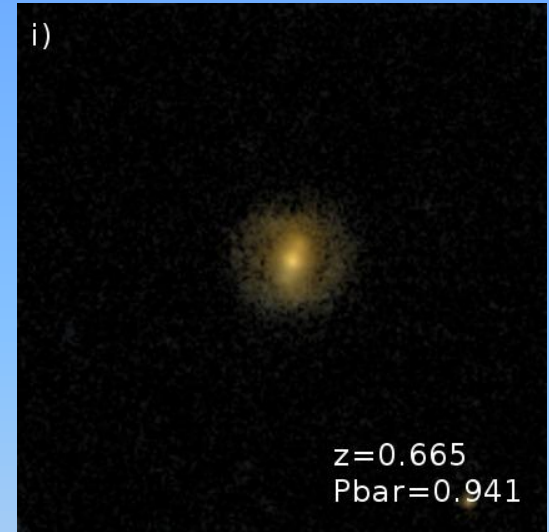
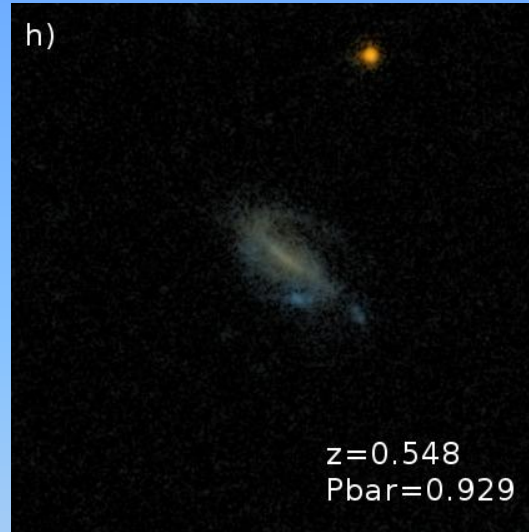
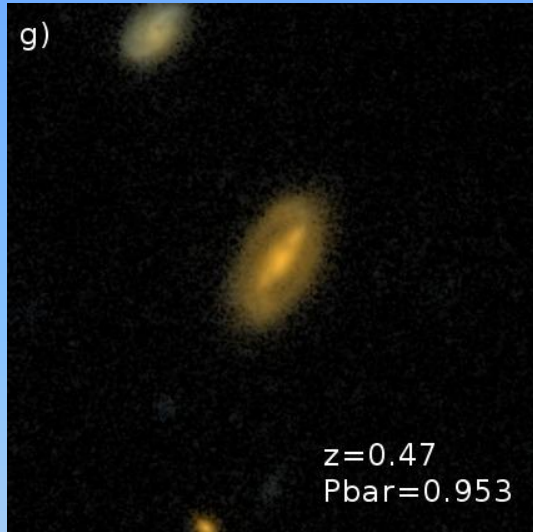
2,380 face-on disc galaxies

317 barred (13.3%)

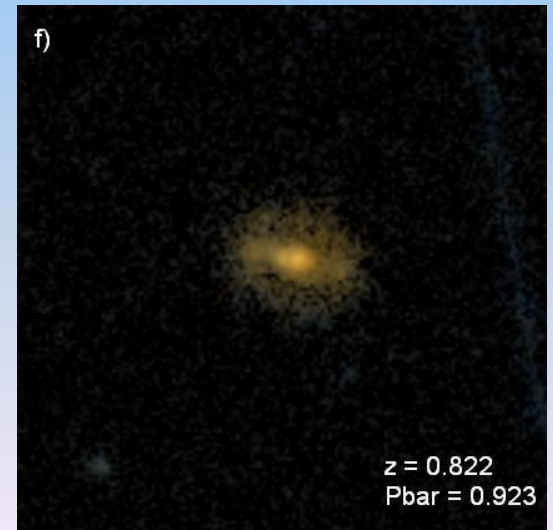
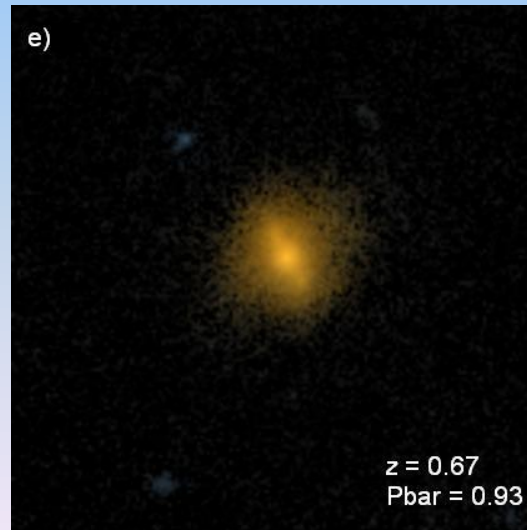
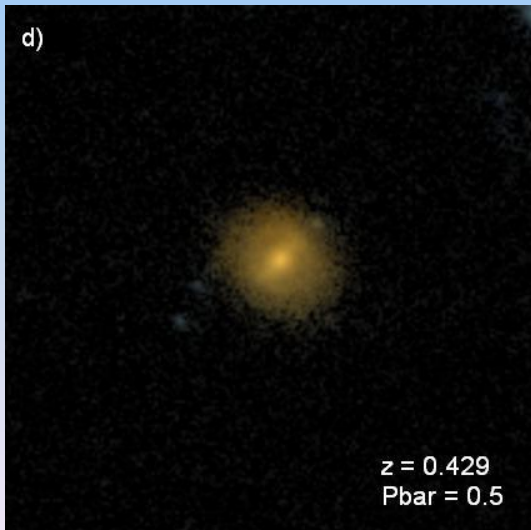
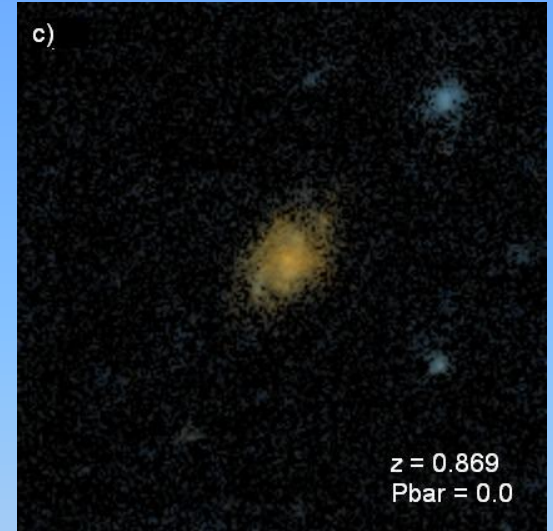
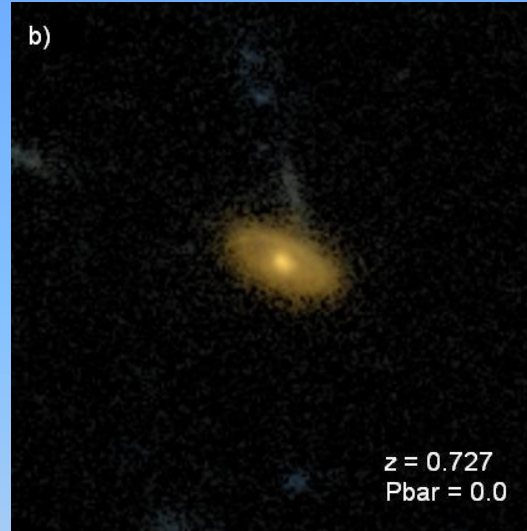
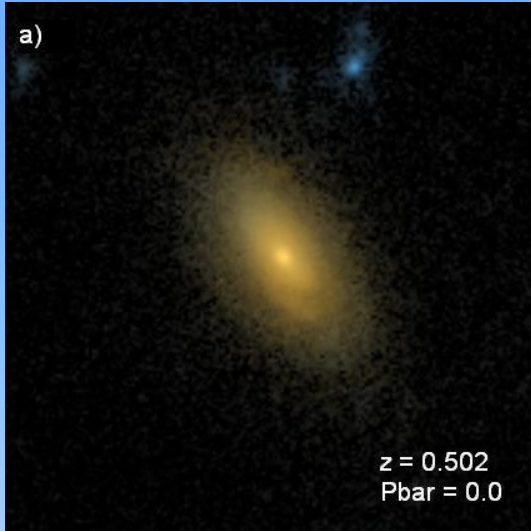
GZH face-on discs



Barred GZH face-on discs



Quiescent disc galaxies

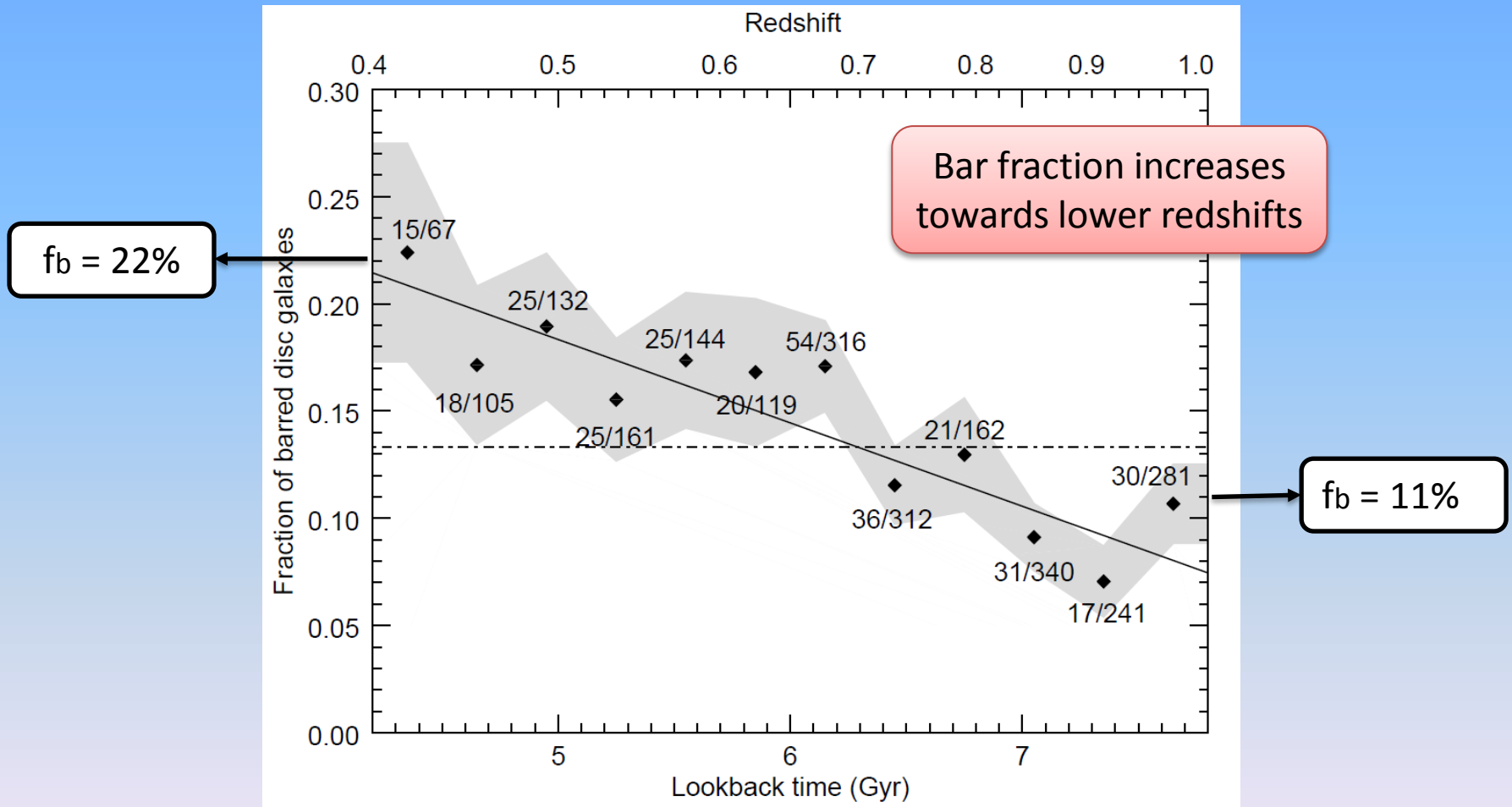


Time evolution of the bar fraction

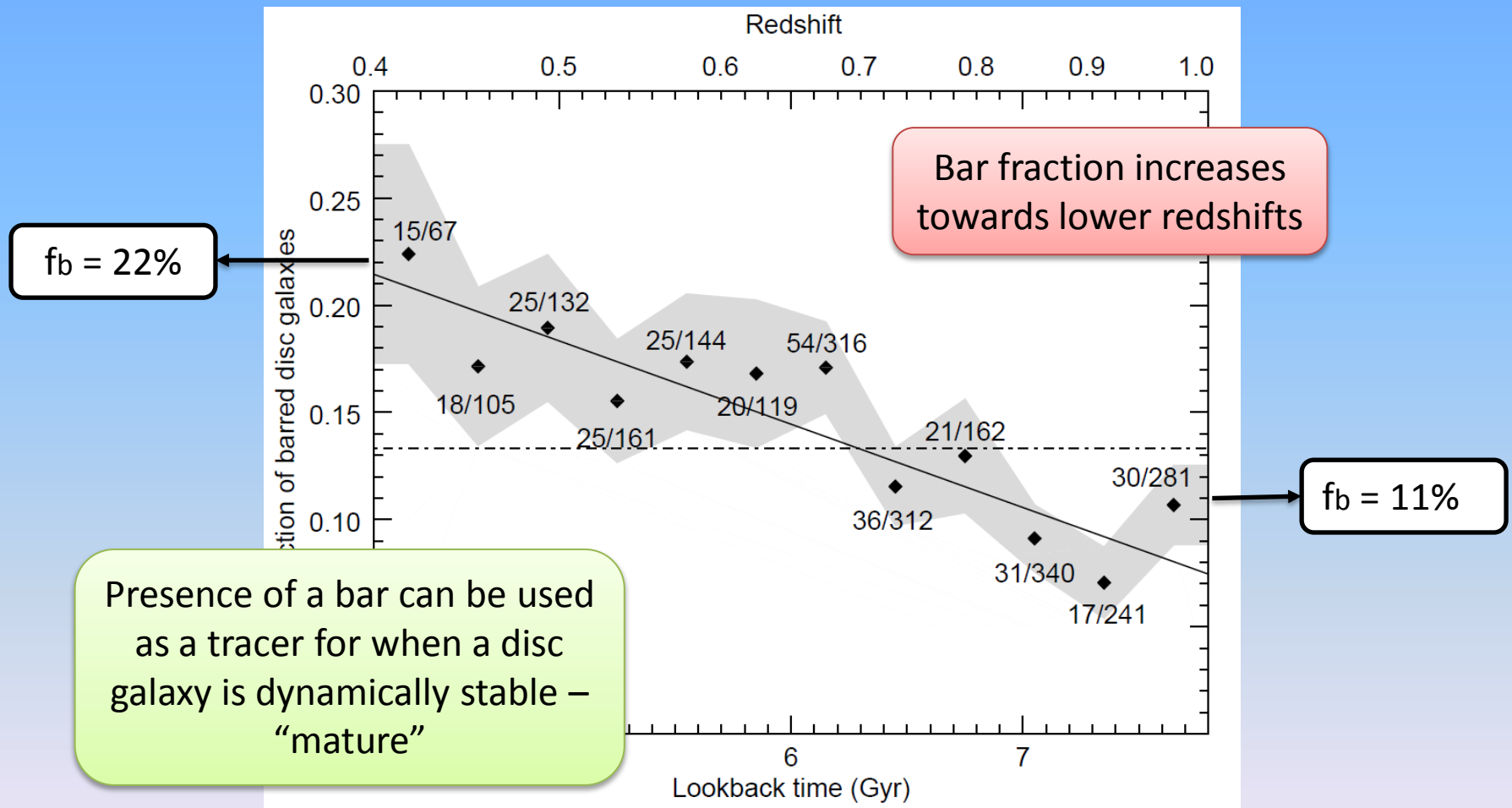
$$\text{Bar fraction} = \frac{\text{Number of disc galaxies with a bar}}{\text{Number of disc galaxies}}$$

(f_b)

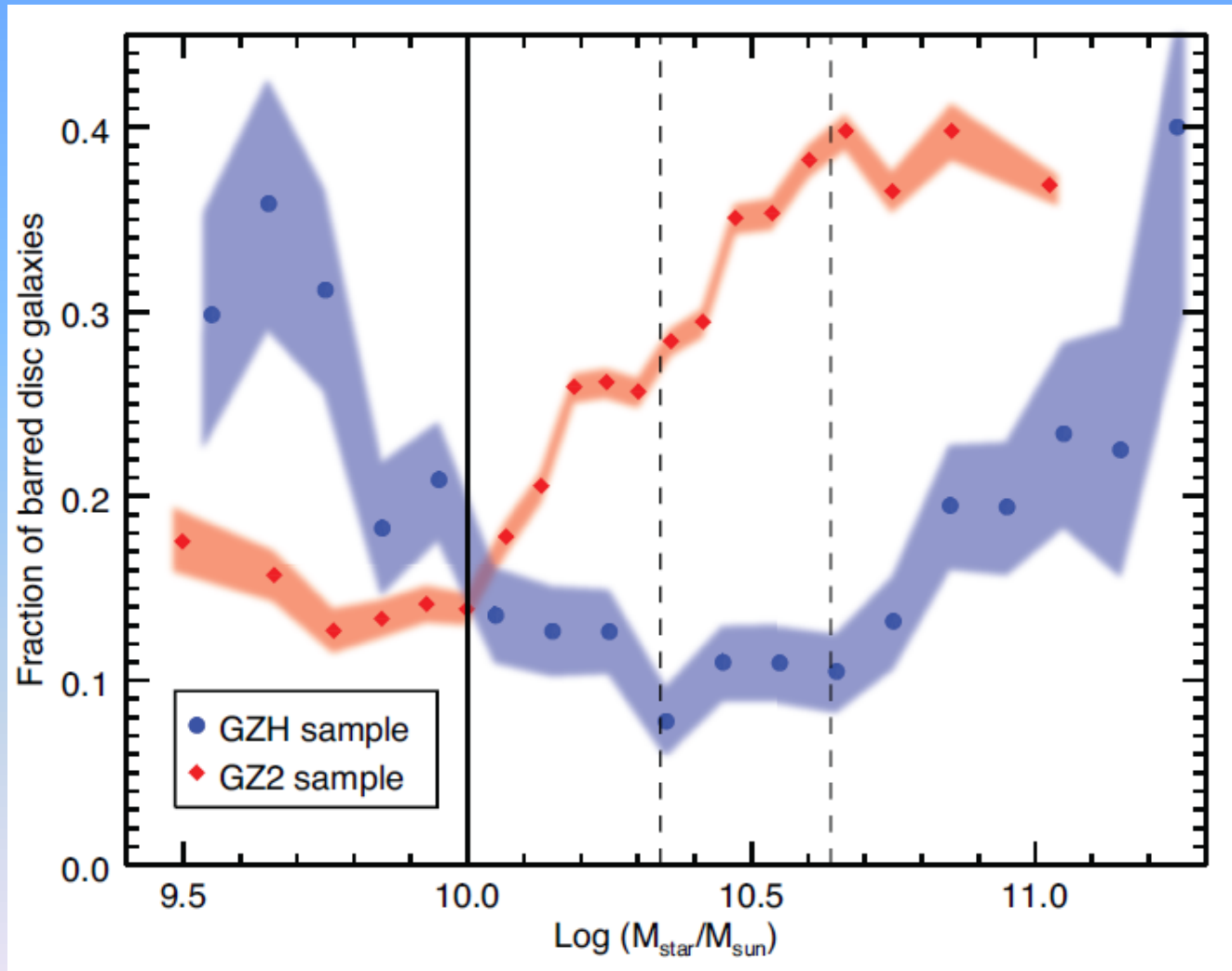
Time evolution of the bar fraction



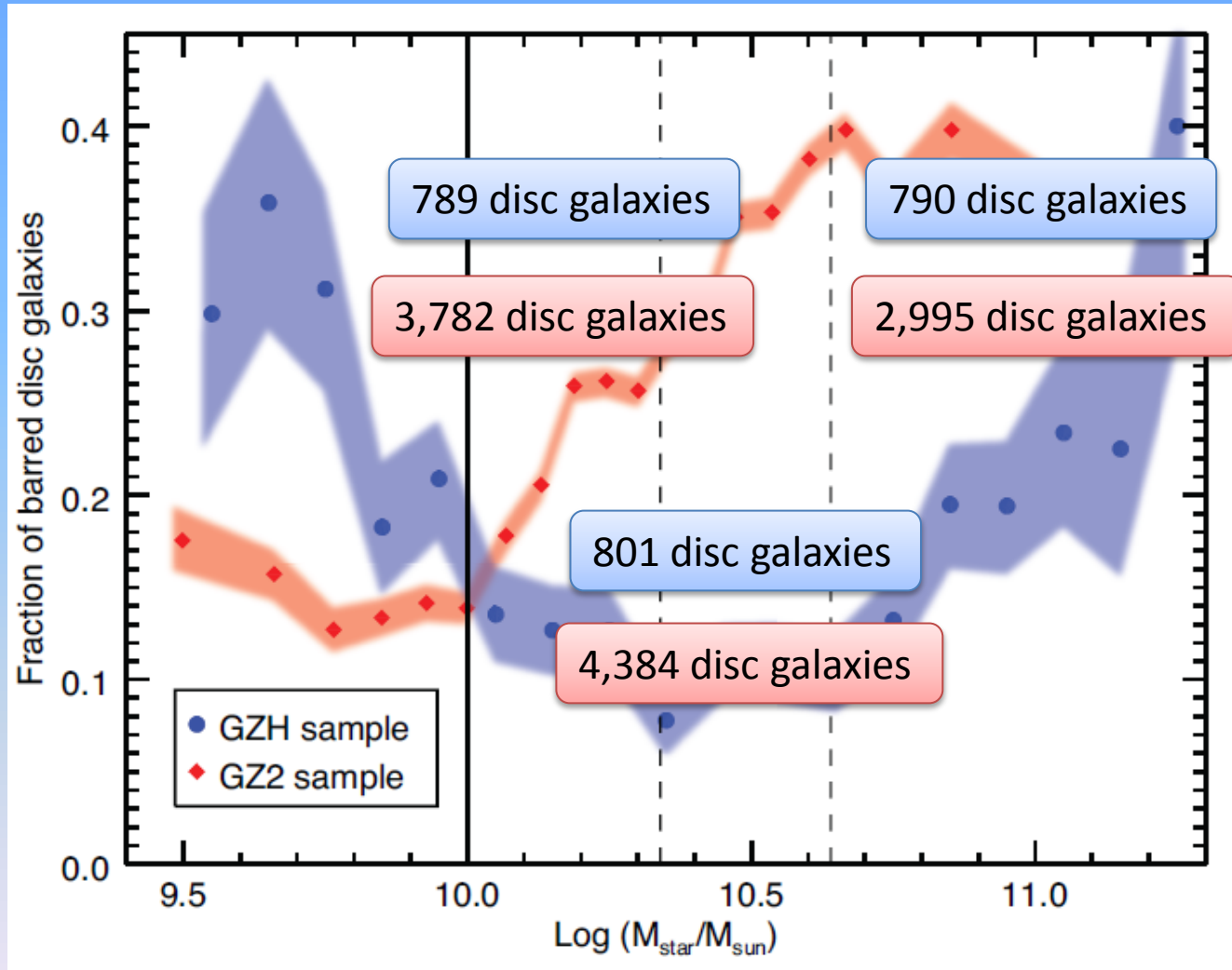
Time evolution of the bar fraction



Does the evolution depend on stellar mass?

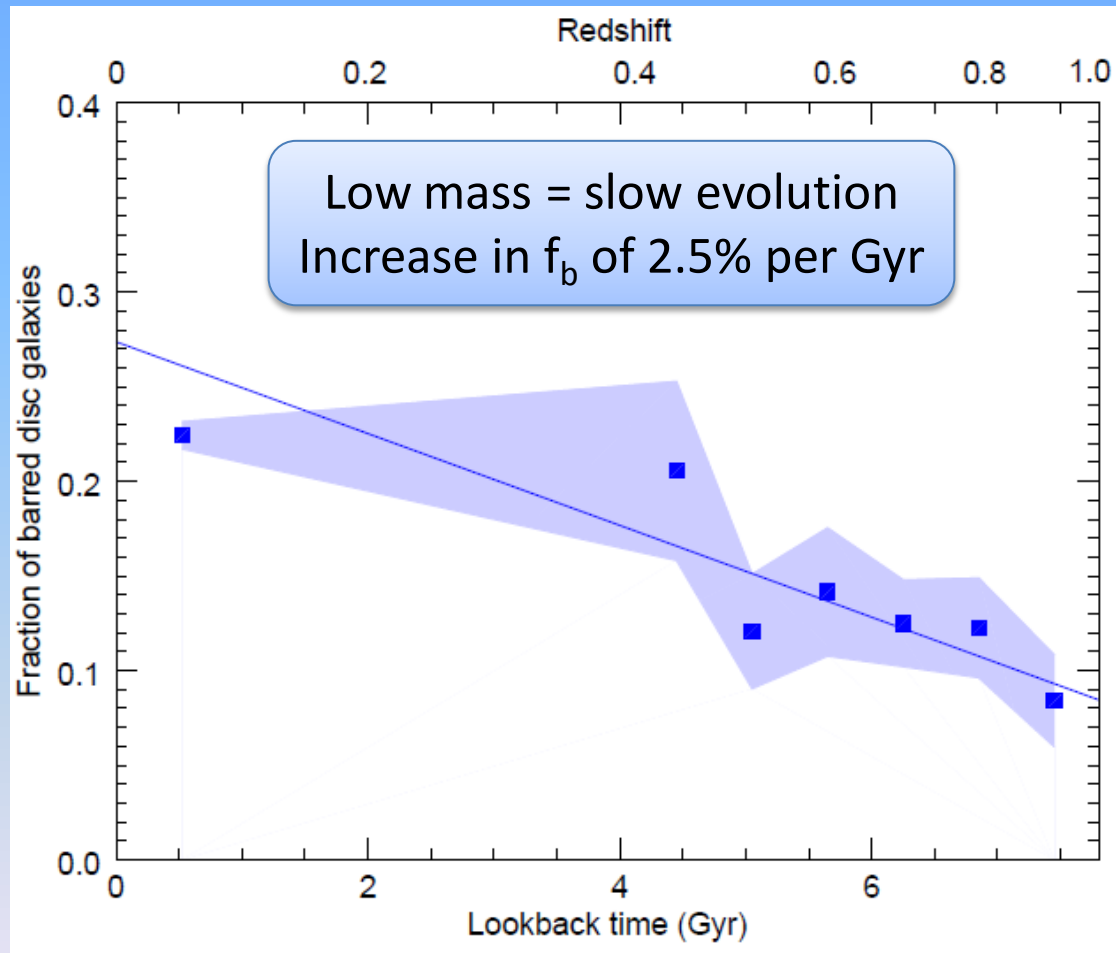


Does the evolution depend on stellar mass?



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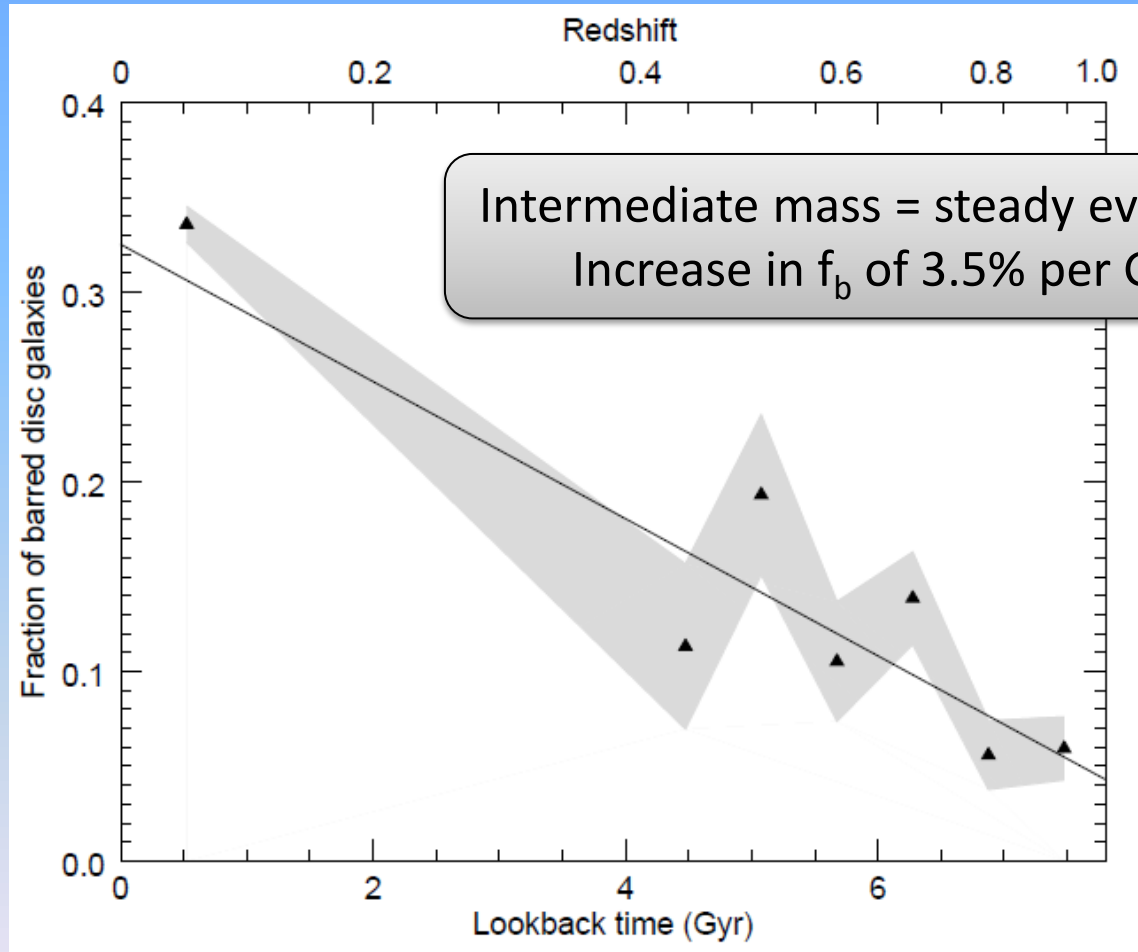
$f_b=22\%$



$f_b=8\%$

Does the evolution depend on stellar mass?

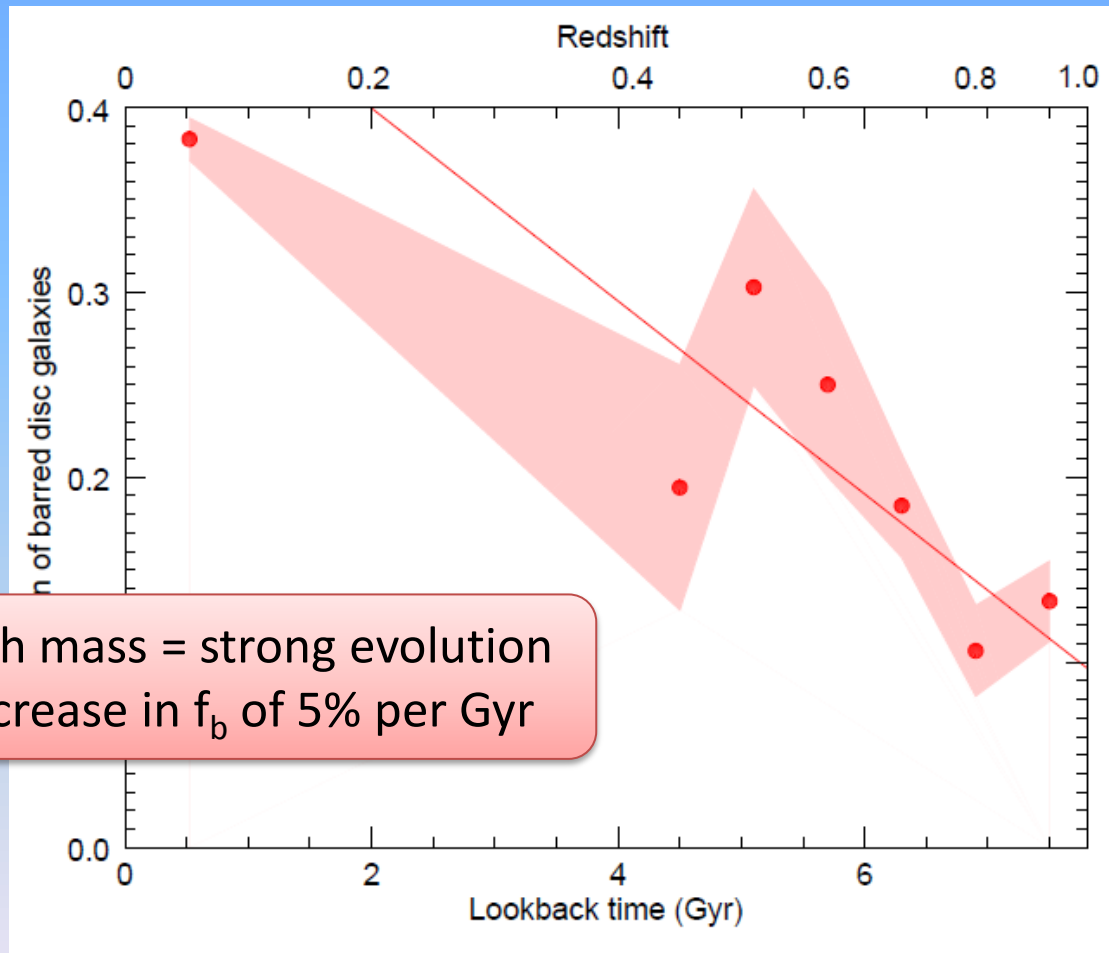
$f_b=34\%$



$f_b=6\%$

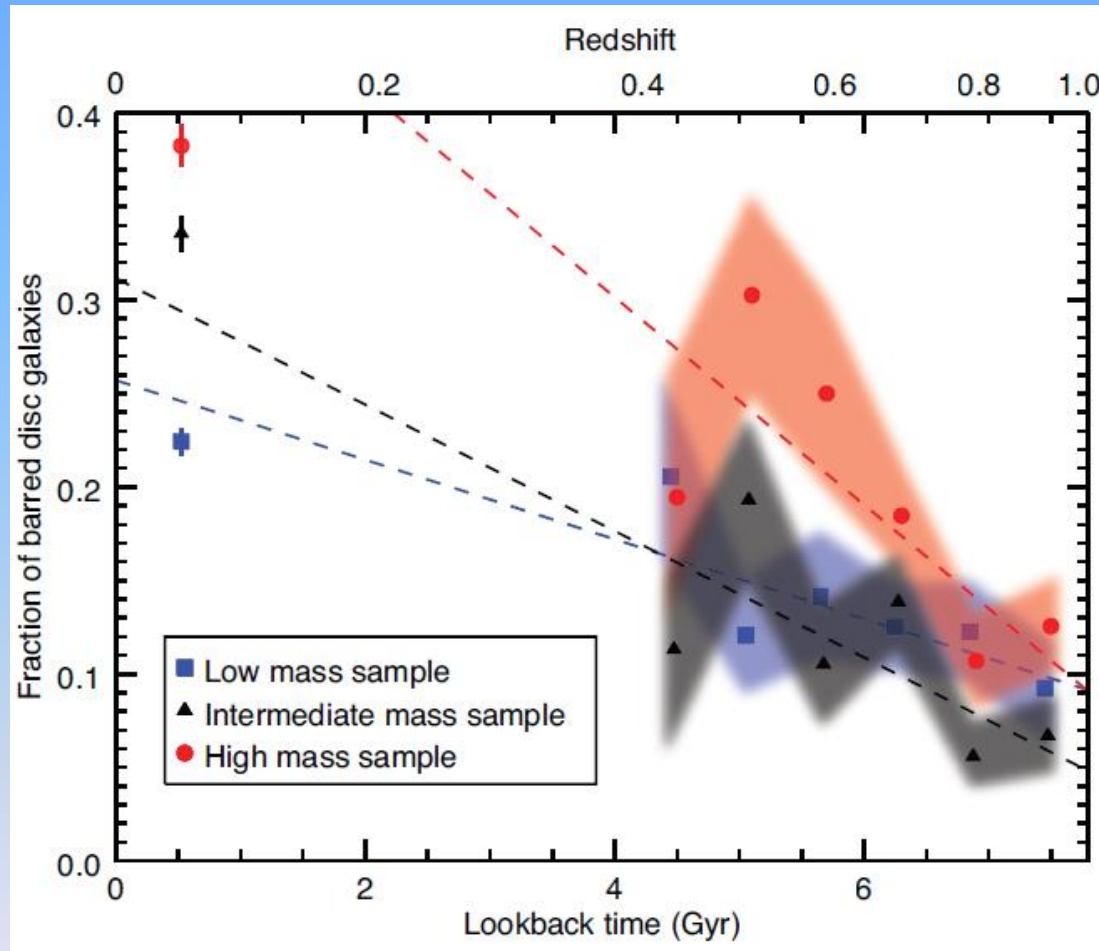
Does the evolution depend on stellar mass?

$f_b=38\%$

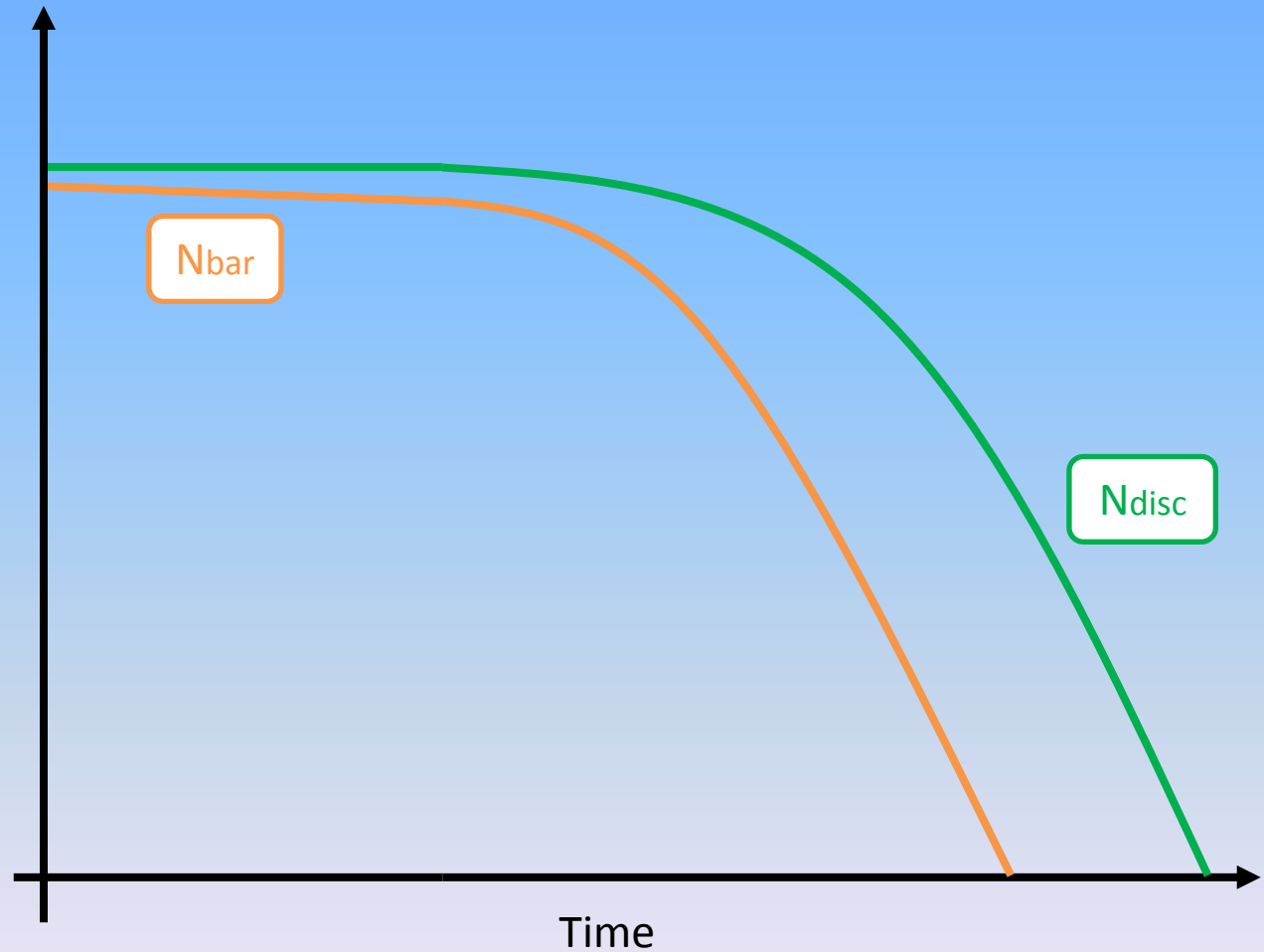
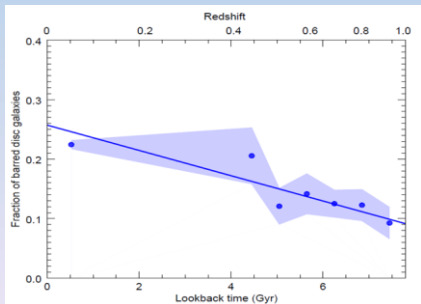
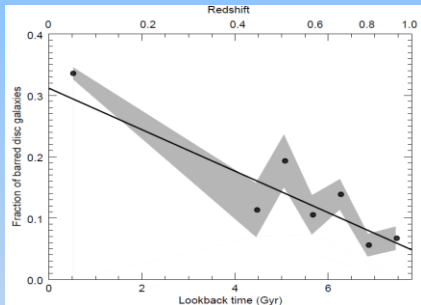
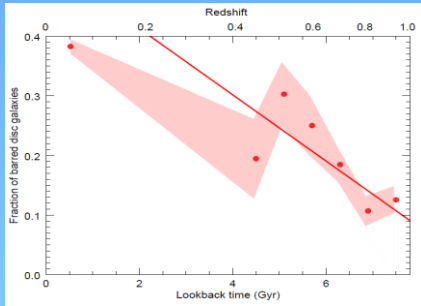


$f_b=13\%$

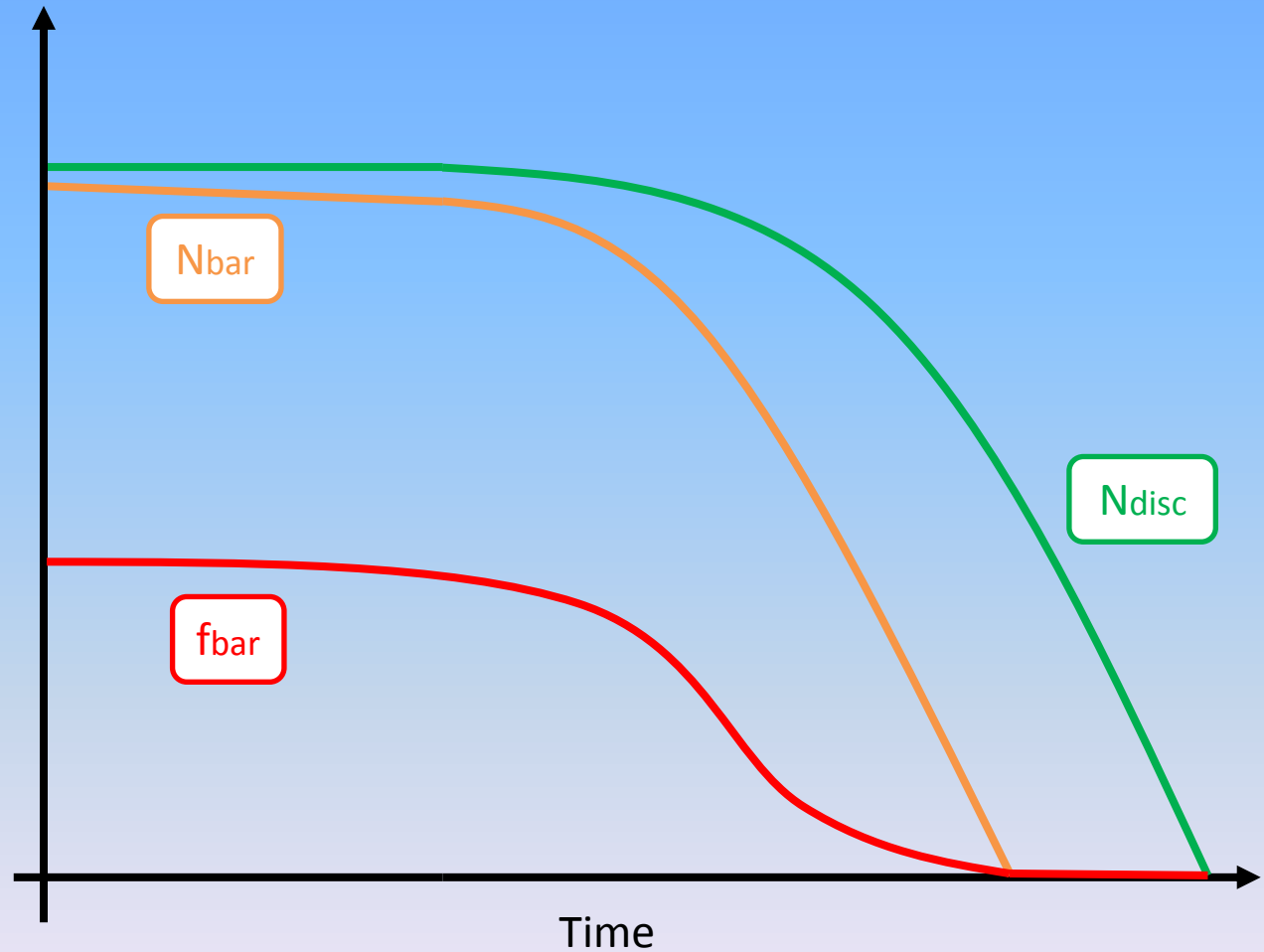
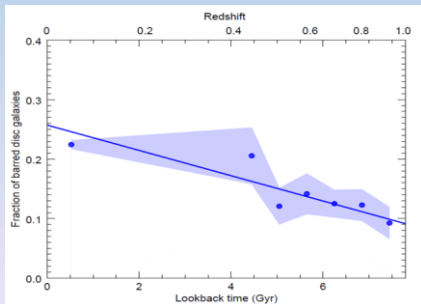
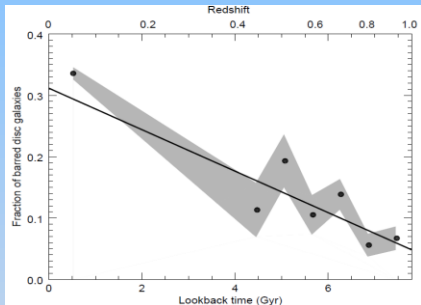
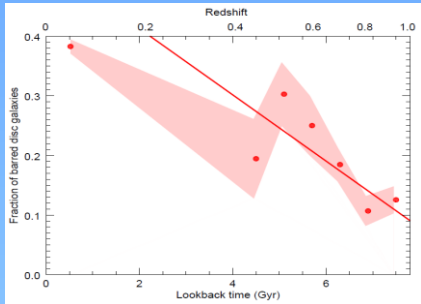
Does the evolution depend on stellar mass?



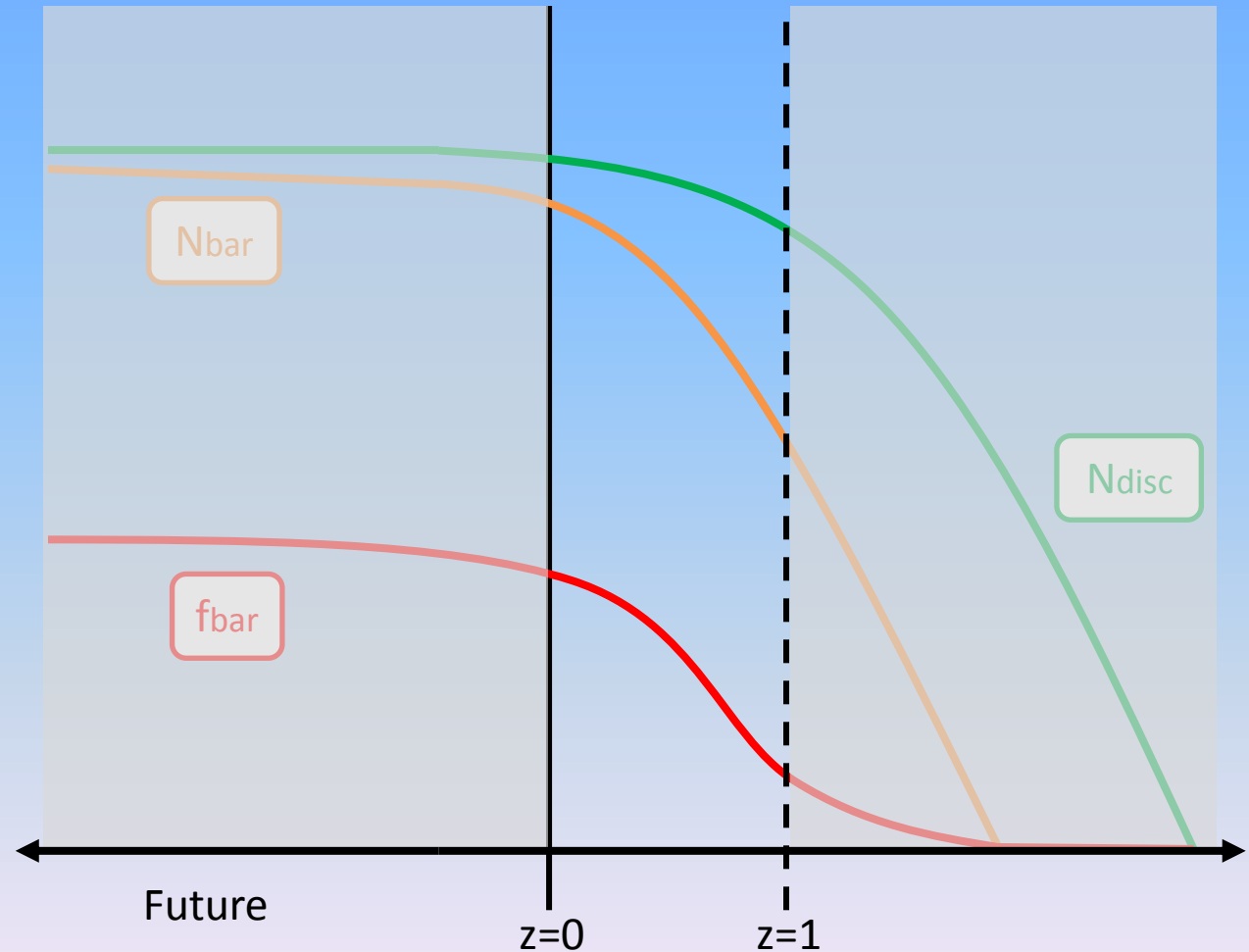
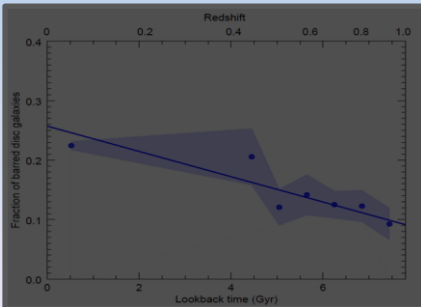
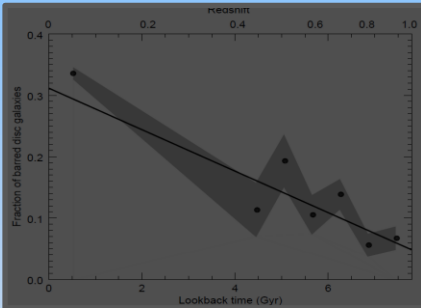
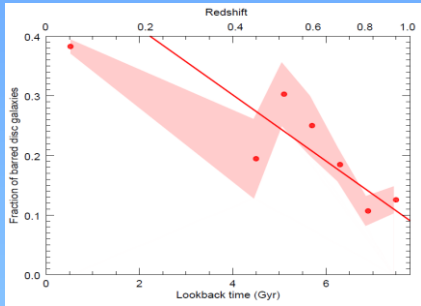
What drives the mass evolution of f_b ?



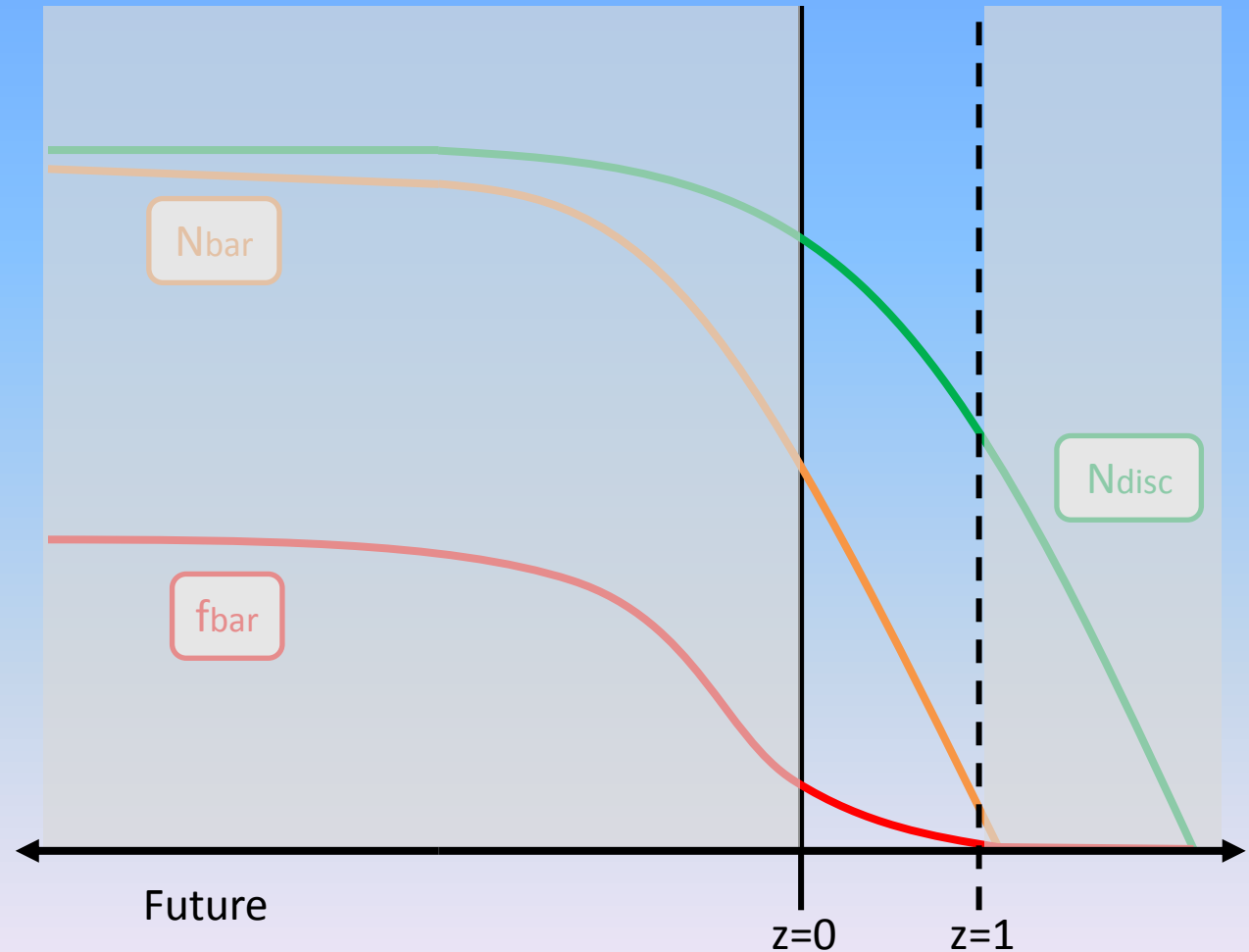
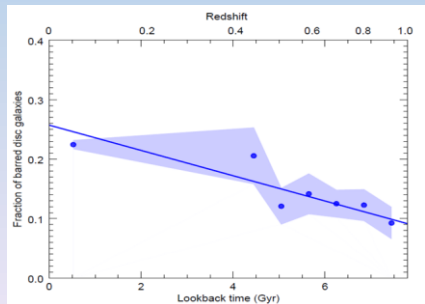
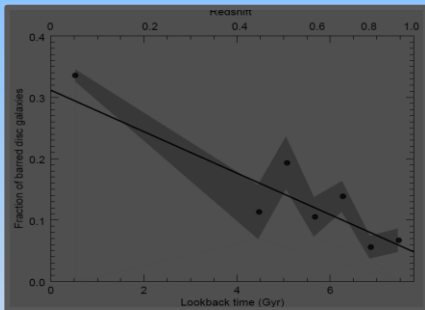
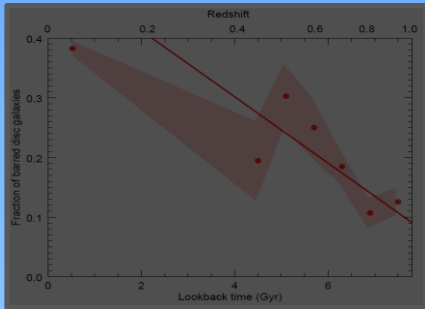
What drives the mass evolution of f_b ?



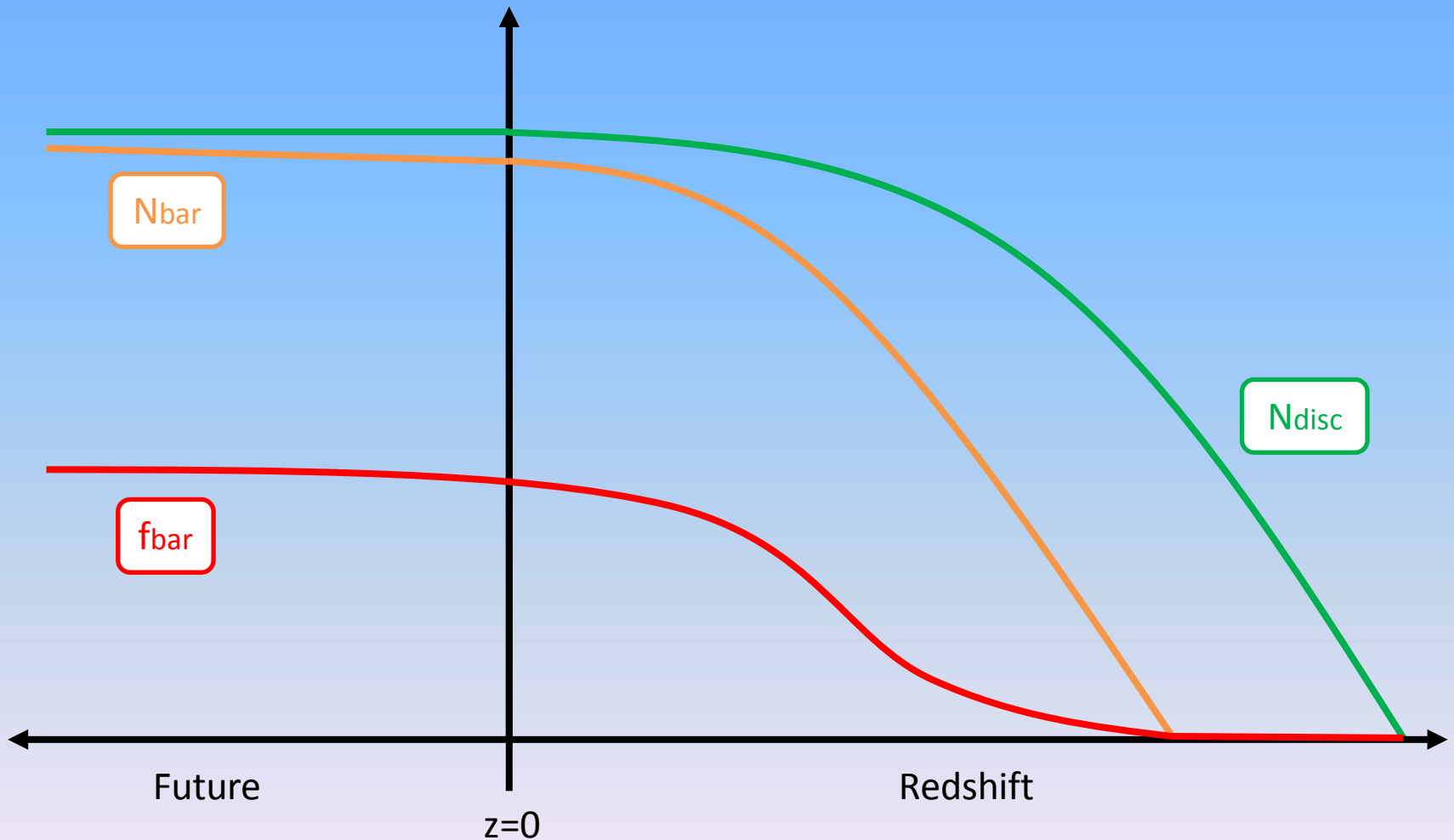
What drives the mass evolution of f_b ?



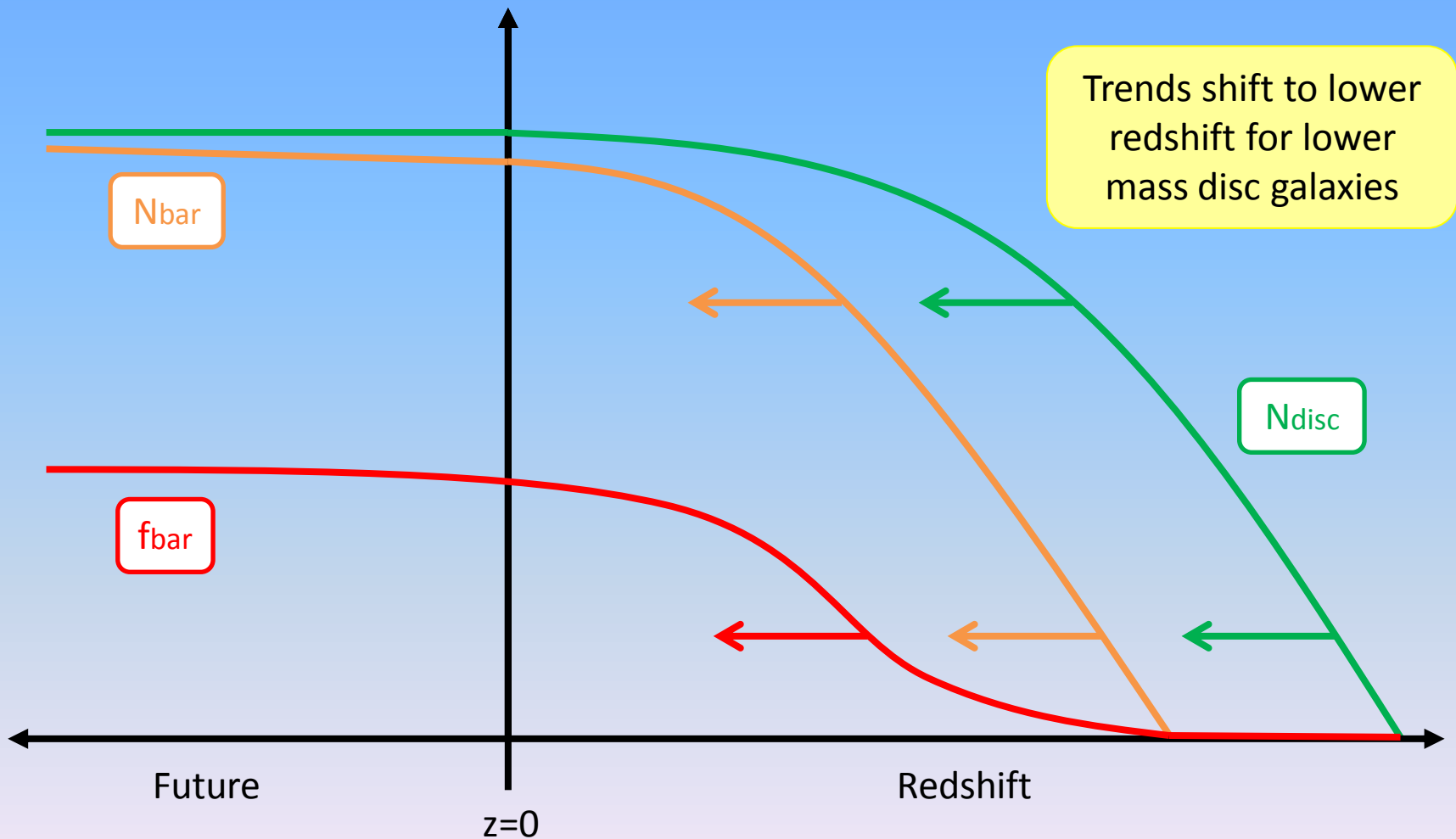
What drives the mass evolution of f_b ?



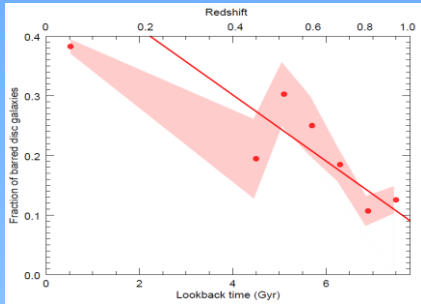
What drives the mass evolution of f_b ?



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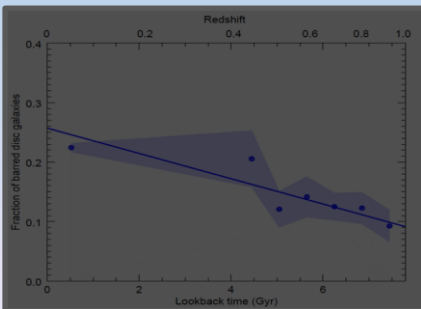
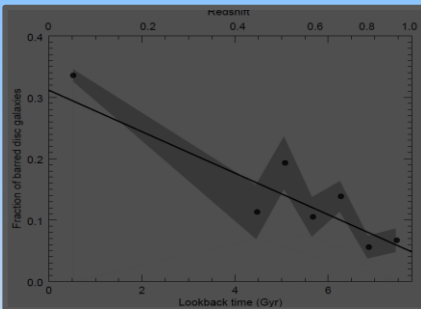


What drives the mass evolution of f_b ?

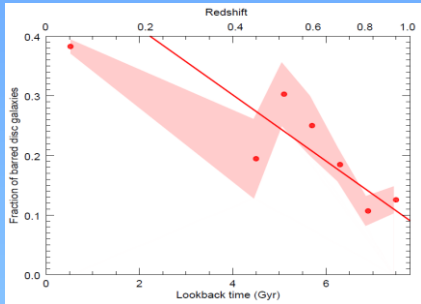


- Massive disc galaxies are more likely to be dynamically cool, relaxed and disc dominated at earlier redshifts

- **Increasing bar fraction predominantly driven by number of bars being formed across 8 Gyrs**

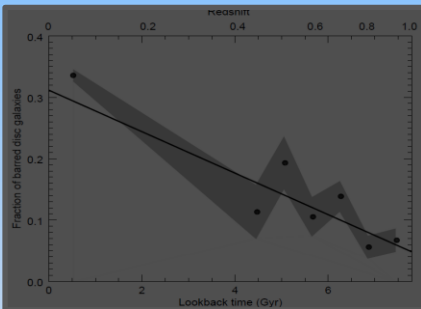


What drives the mass evolution of f_b ?

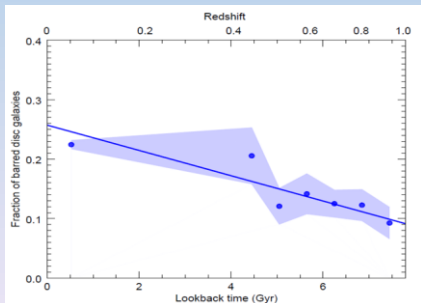


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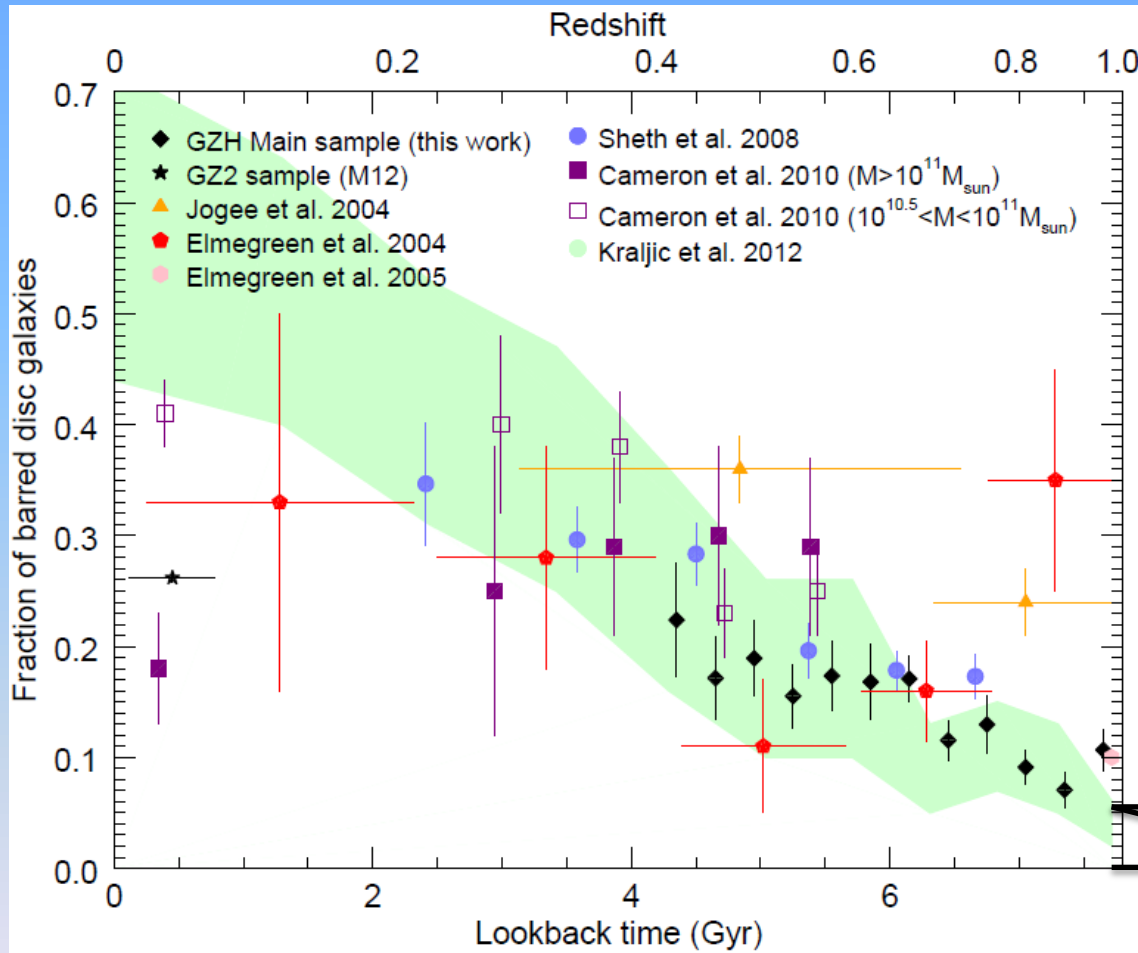


- Low mass disc galaxies are more likely to be gas rich and dynamically hot



- **Shallow increase of bar fraction due to number of unbarred discs entering sample being similar to number of bars being formed**

What happens at $z > 1$?



CANDELS Zoo

? f_b levels off, still bars at $z > 1$?

f_b reaches zero point?