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The formation and evolution of bars at high redshift

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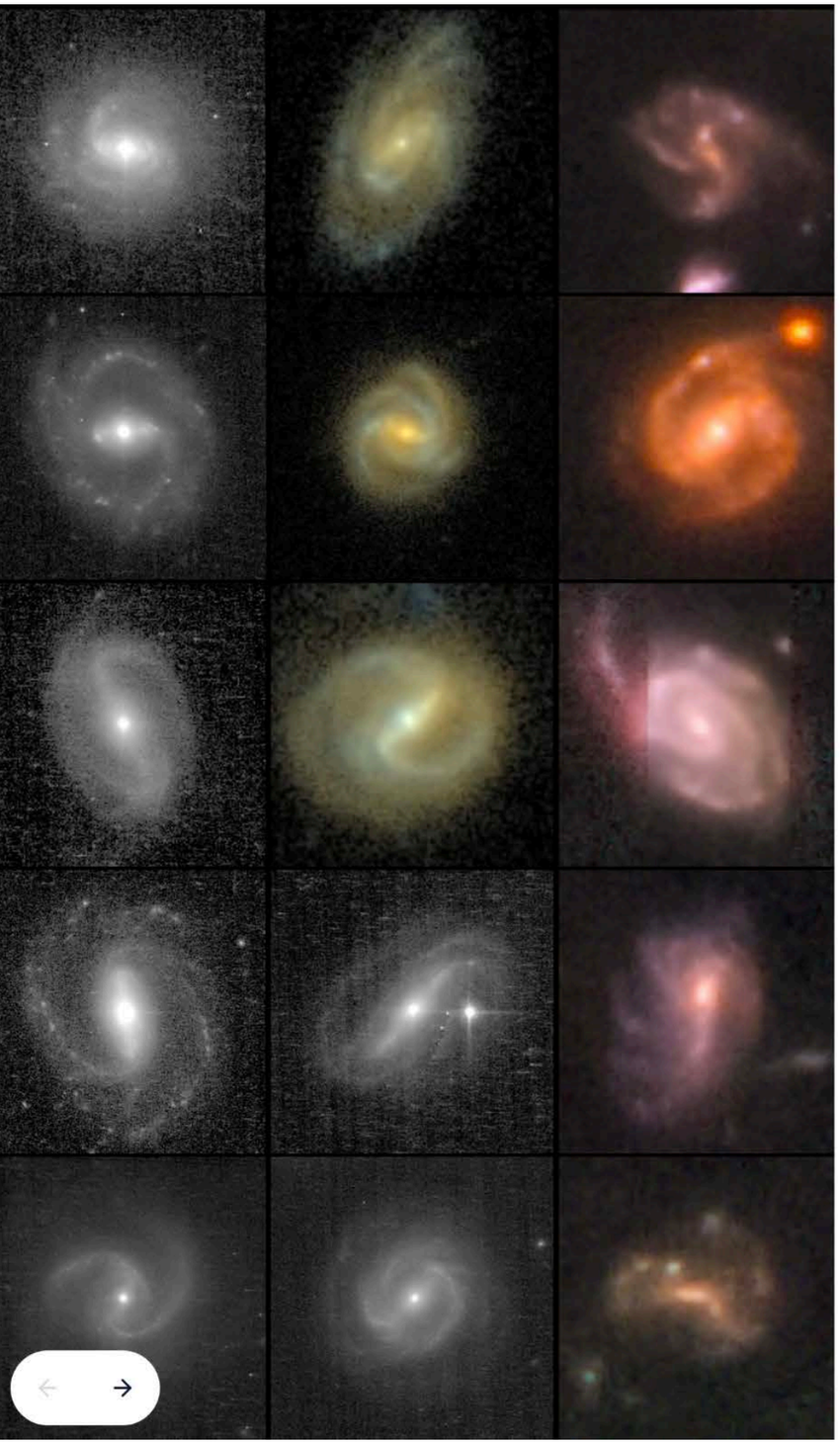
In the context of bars, what is “high redshift”?



Join at **menti.com** use code [redacted]

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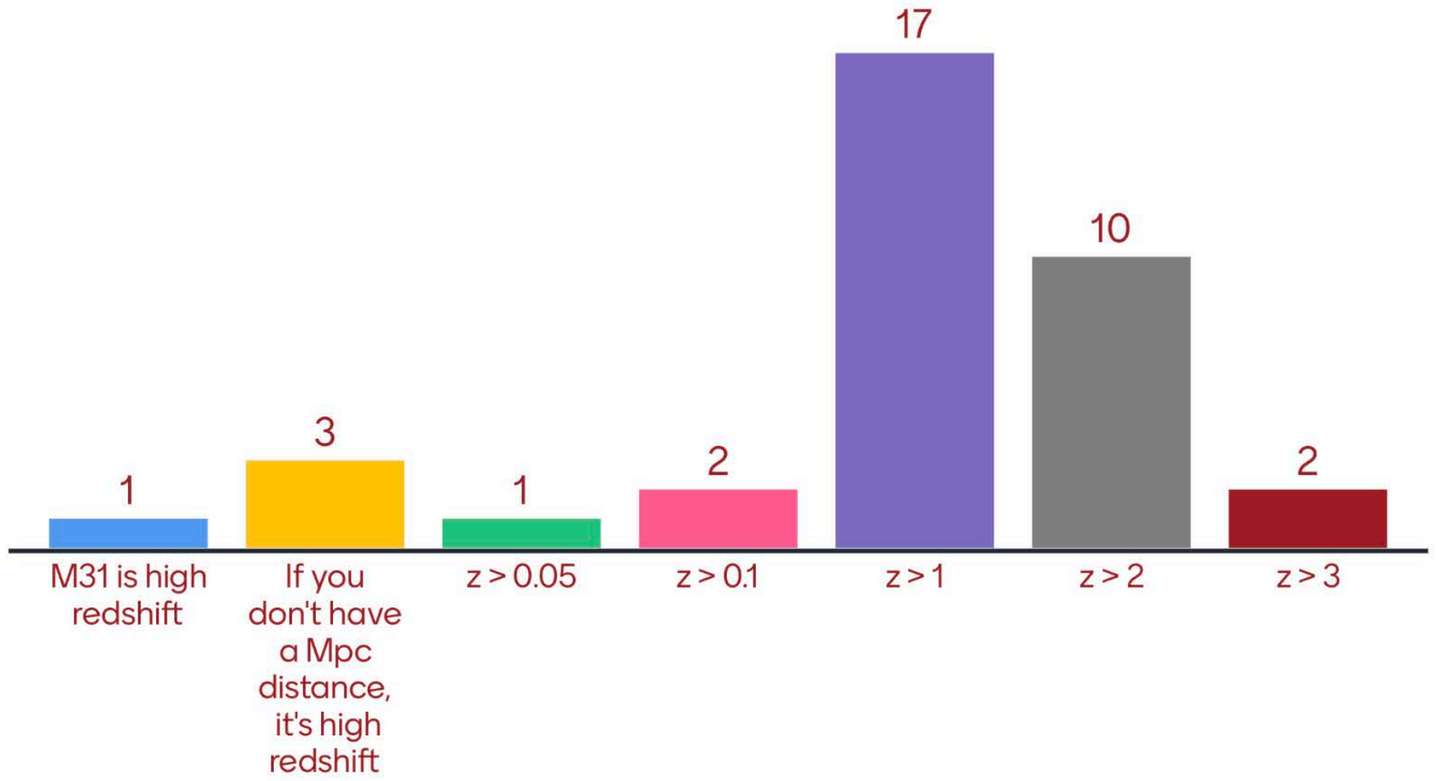
What counts as "high redshift" in the context of bars?



An informal poll of conference attendees, 7 July 2023

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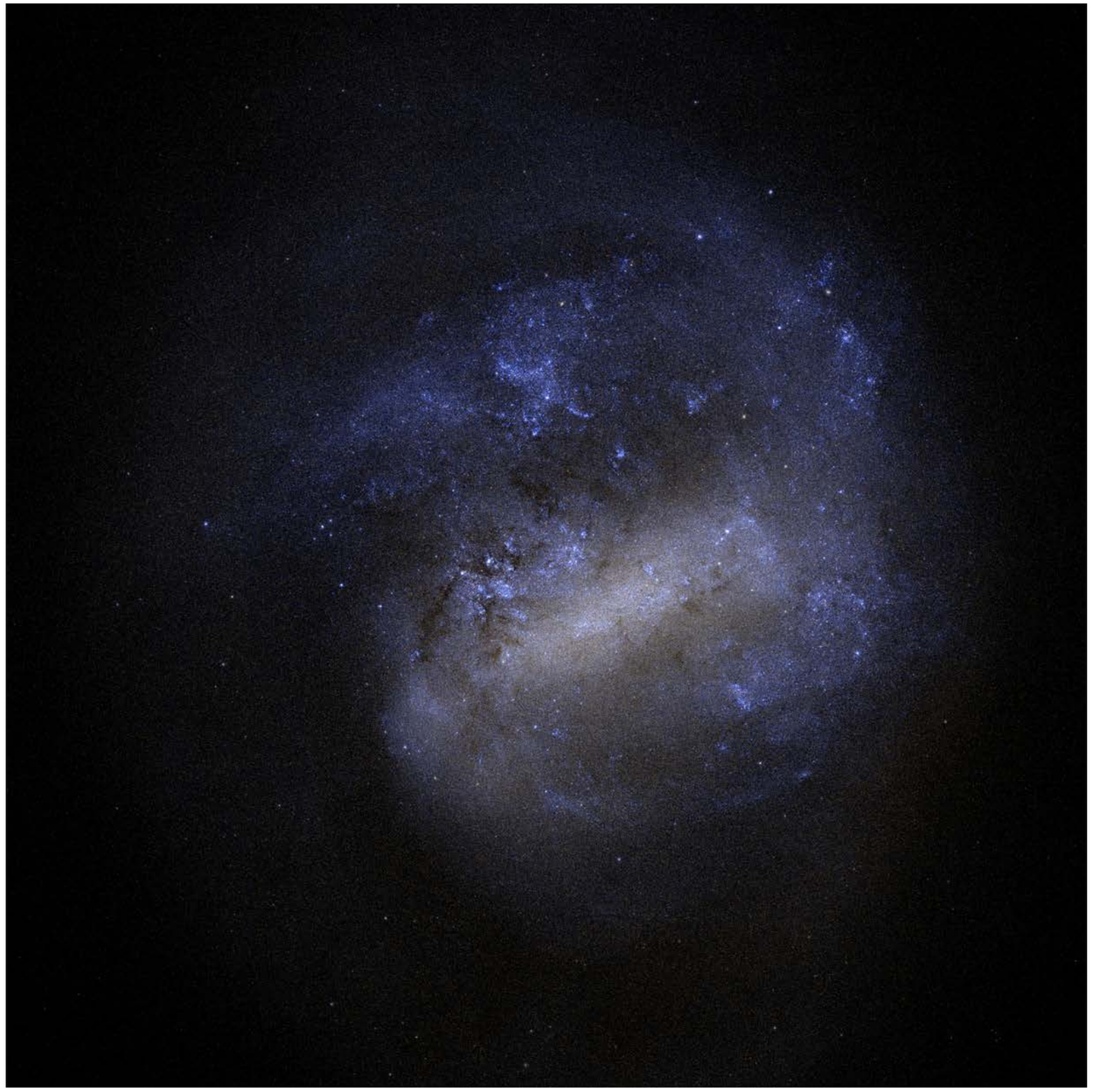
Our second-nearest bar is offset from the disk center…

LMC reconstructed from Gaia EDR3
Image credit: Kevin M. Loch, CC BY-SA

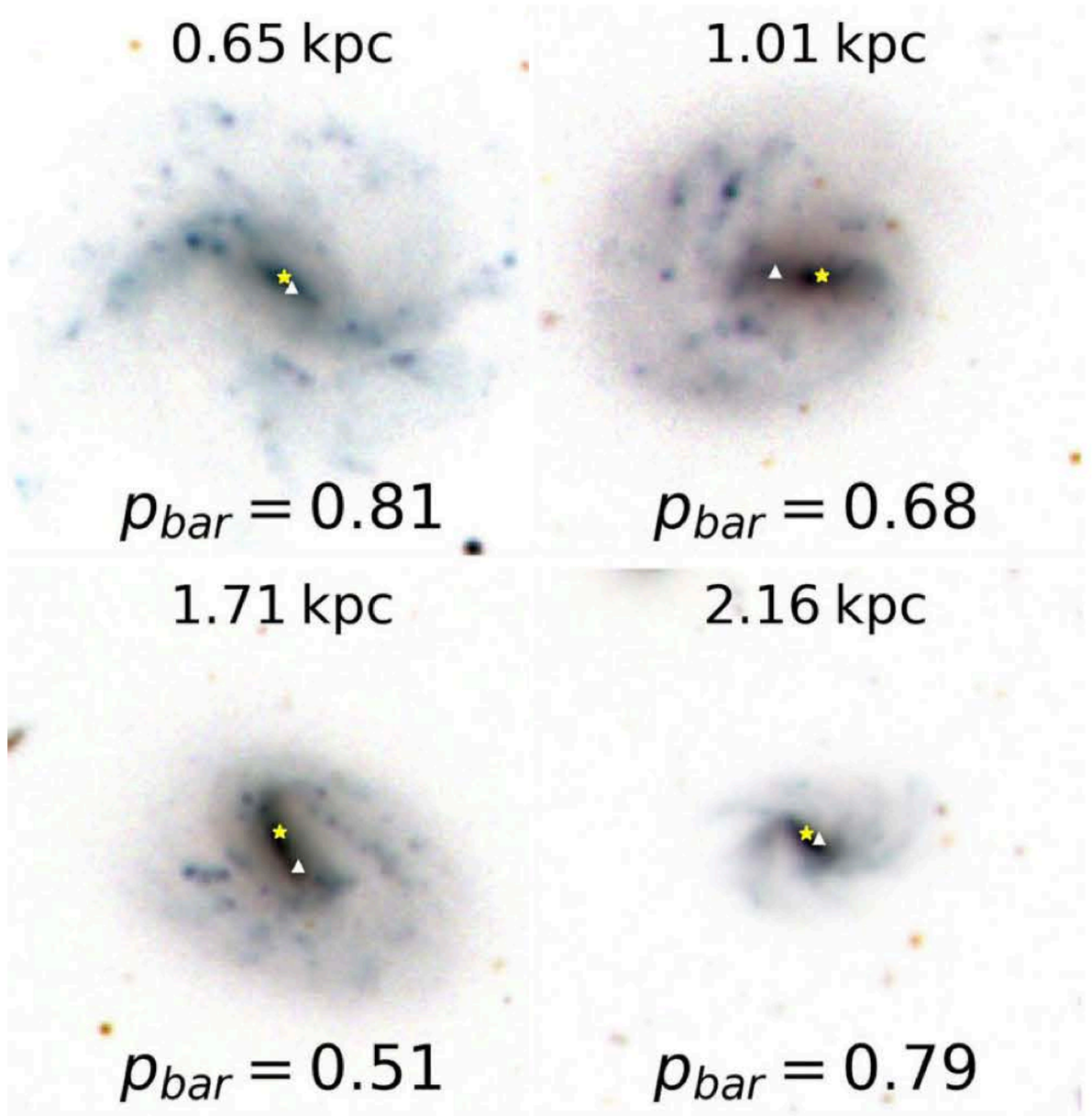
Simulations: Bekki (2009), Besla et al. (2012), Pardy et al. (2016)



… and the LMC is not that unusual in having an offset bar.

Kruk et al. (2017)

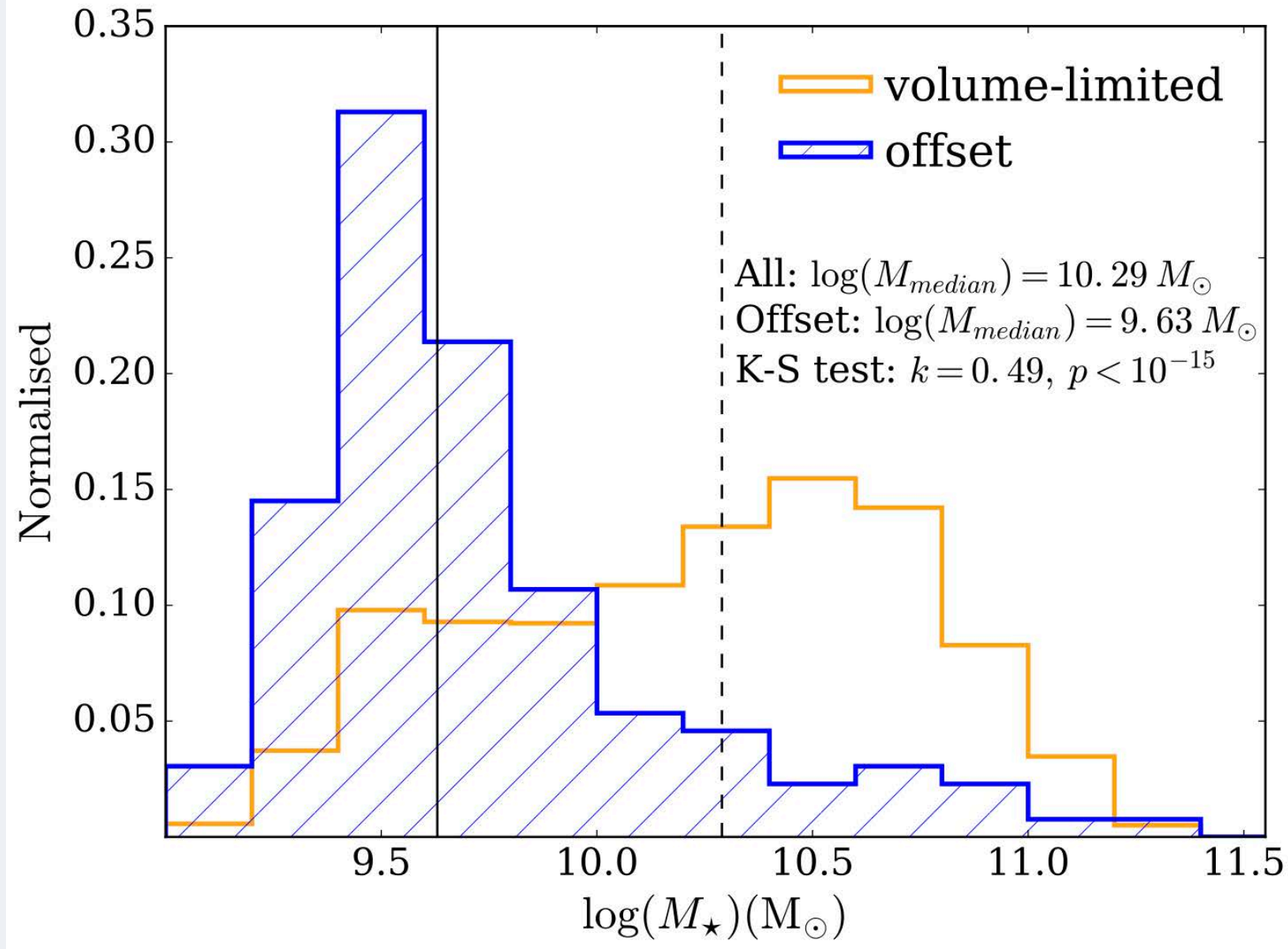
Simulations (Illustris): Łokas (2021)



Offset bars tend to be in lower-mass galaxies…

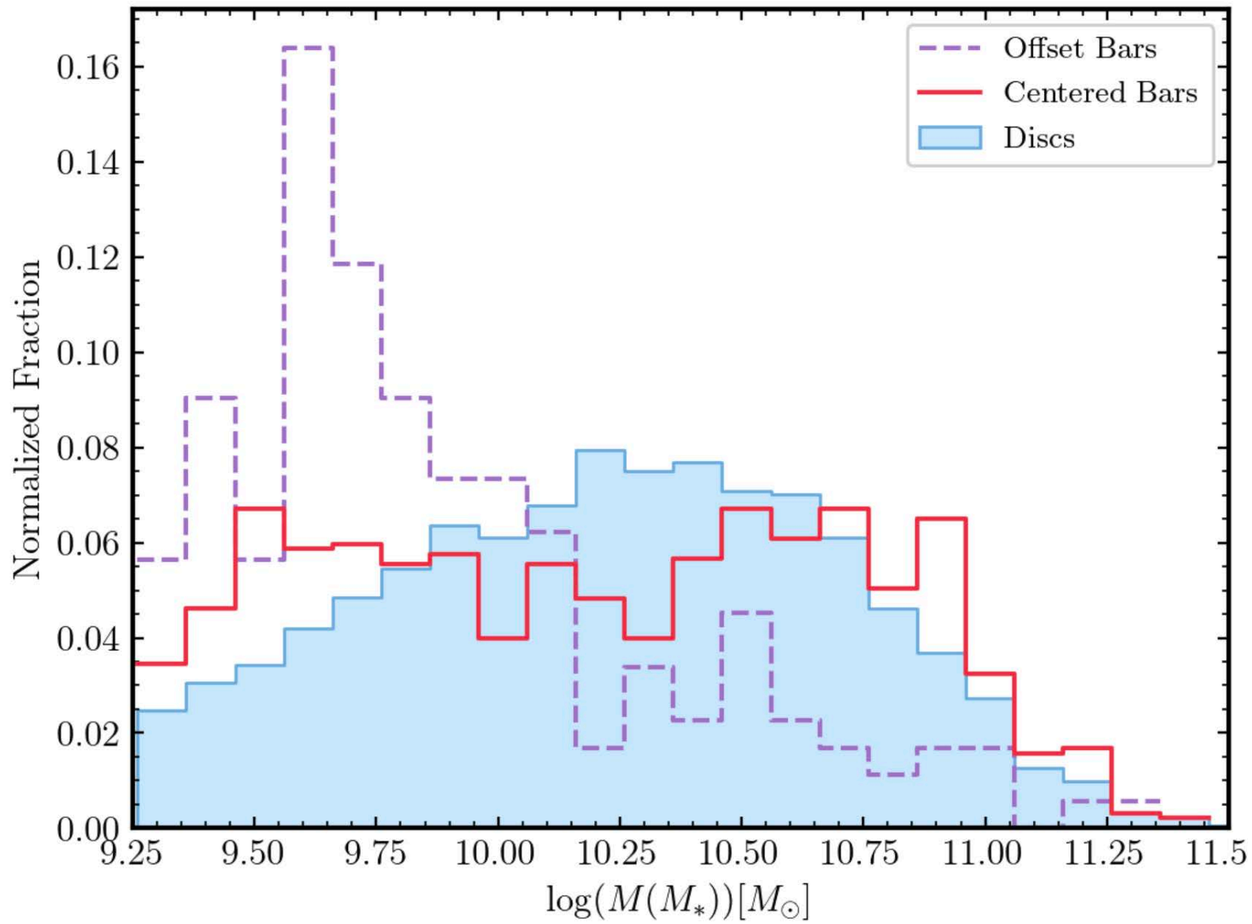
Kruk et al. (2017)

Simulations (Illustris): Łokas (2021)



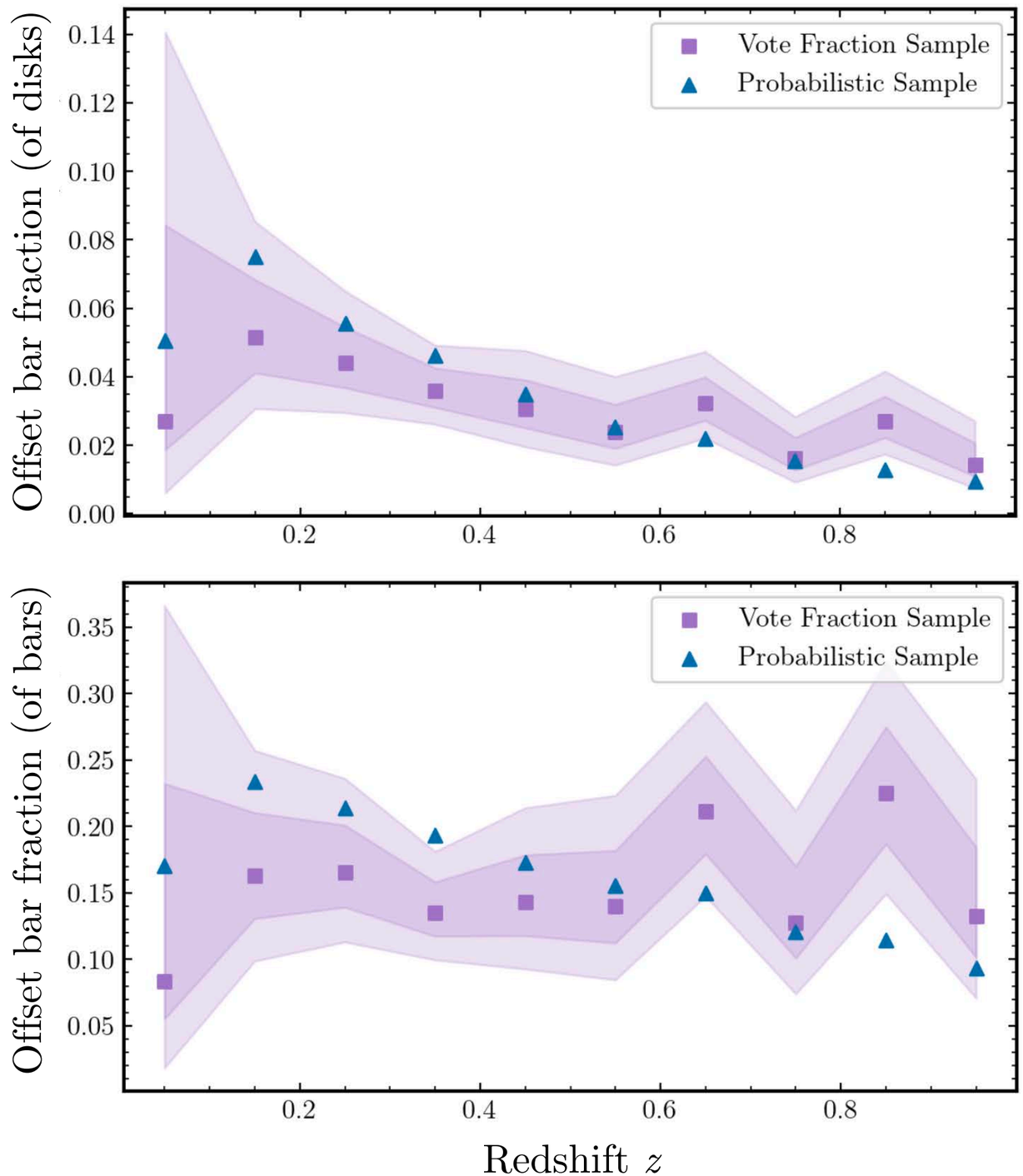
… the mass difference between offset & centered bars persists out to z ~ 1.

Kruk et al. (2017), Imaz Blanco et al. (in prep)



The offset bar fraction evolves much as the overall bar fraction does to z ~ 1.

Imaz Blanco et al. (in prep)

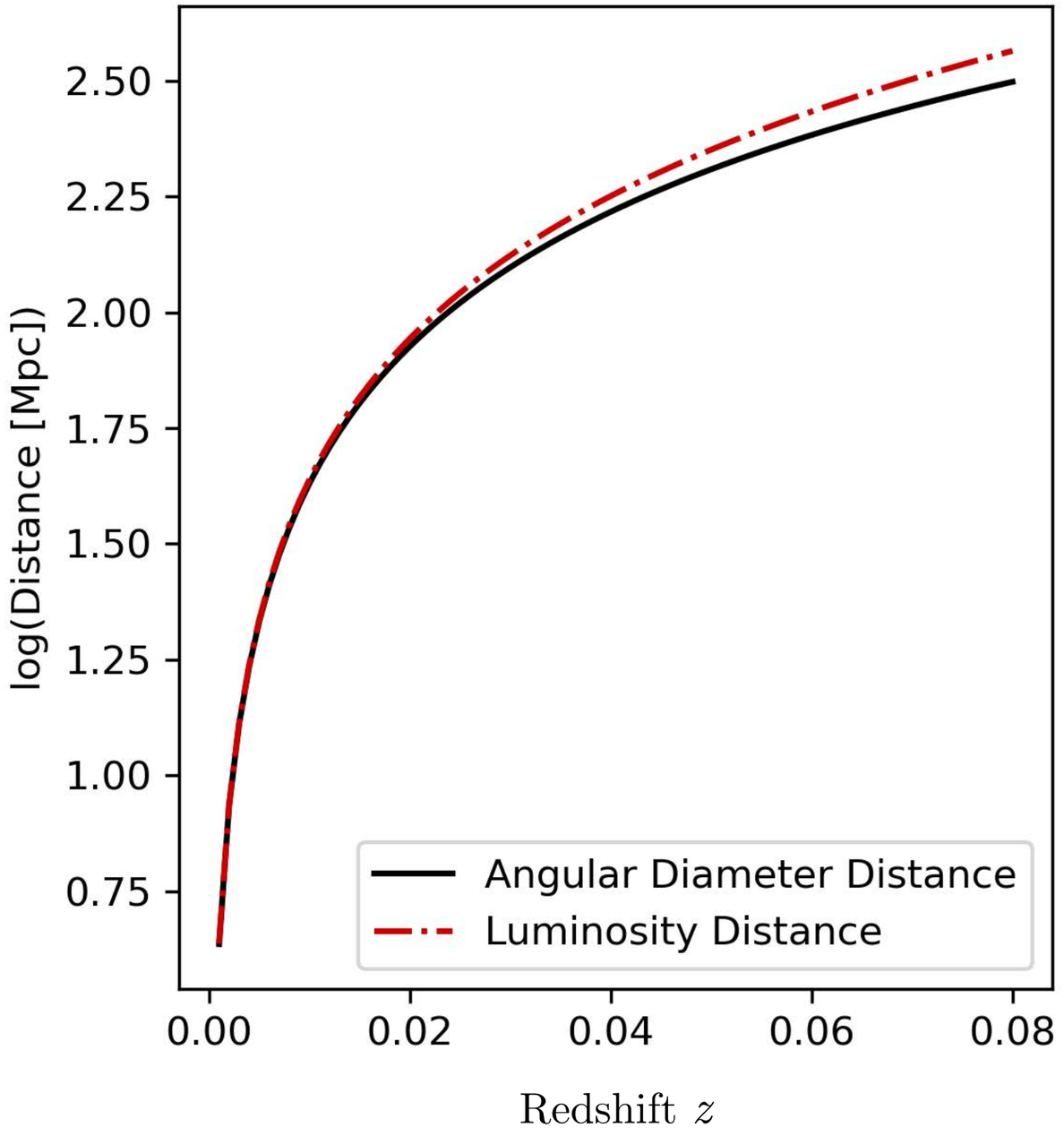


Caveats and Considerations

Understanding the selection function is critical.

(as usual)

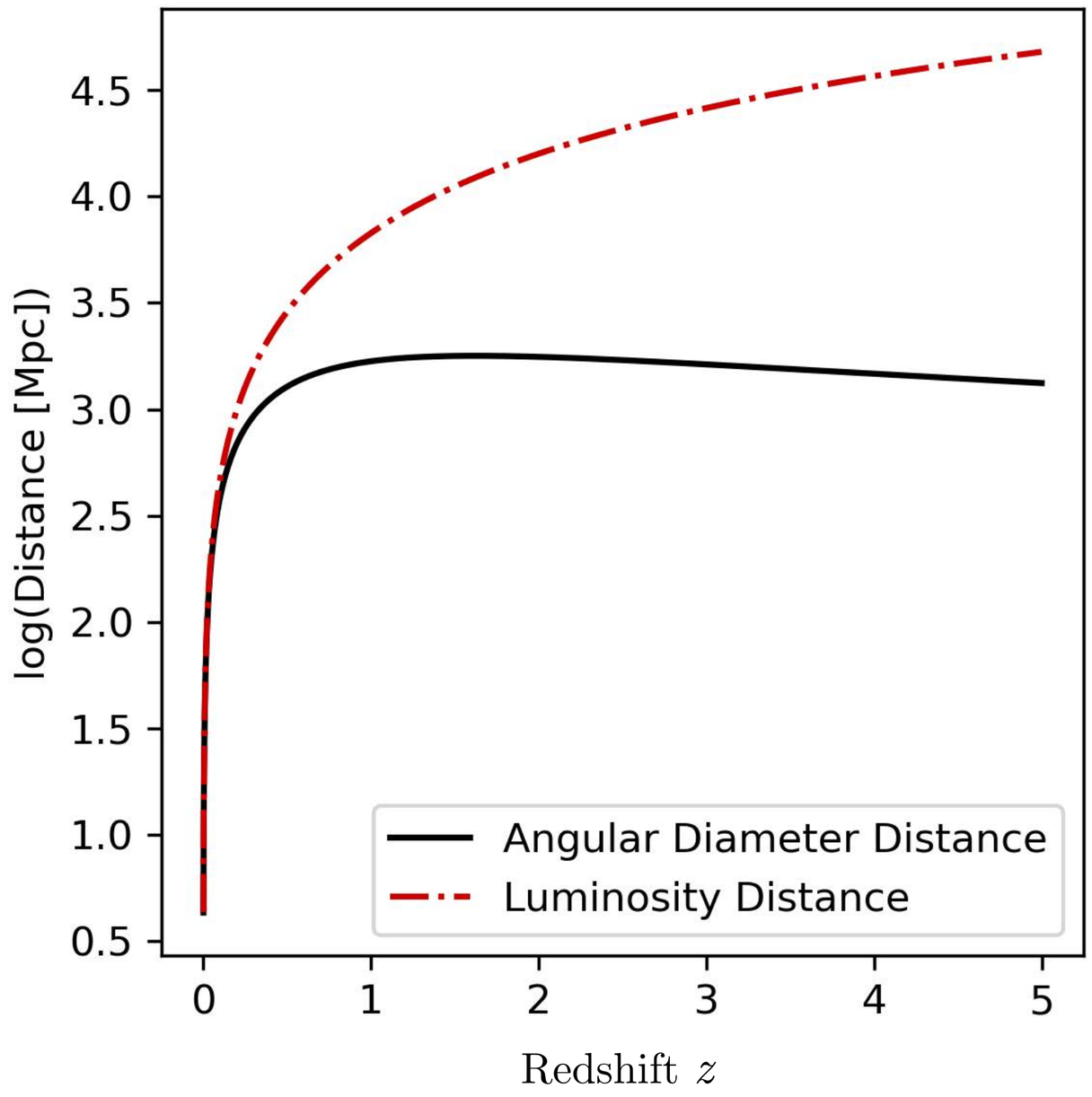
1. The smallest bar you can resolve with a given telescope/instrument goes as D_A
2. A given galaxy's surface brightness goes as $(D_A/D_L)^2$



Sensitivity to bars *and* sensitivity to disks change with z, but not in the same way.

1. The smallest bar you can resolve with a given telescope/instrument goes as D_A
2. A given galaxy's surface brightness goes as $(D_A/D_L)^2$

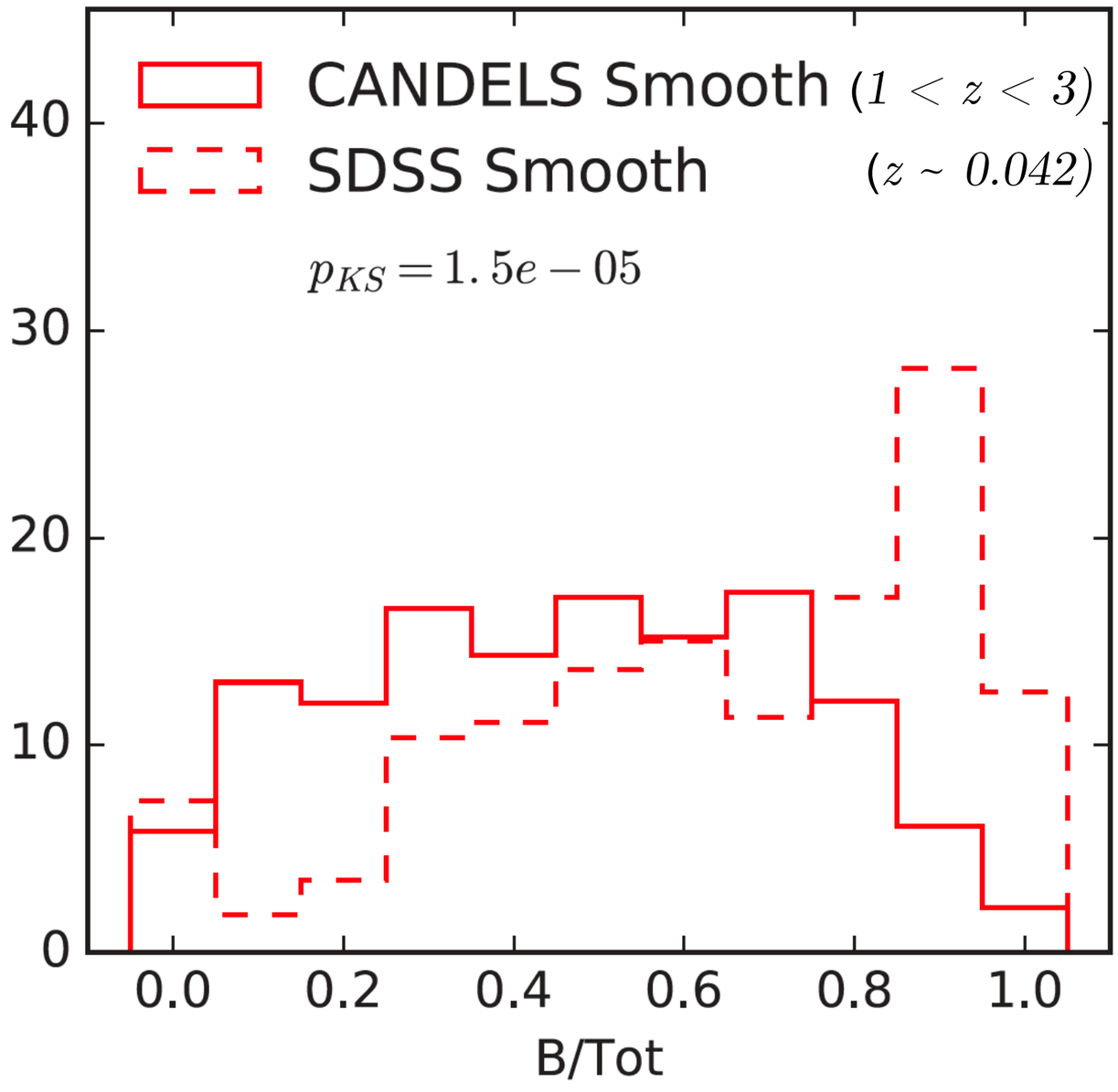
For bar fractions: <u>mind your denominator</u>



Smooth disks are a bit more common at higher redshift, which affects bar fraction calculations.

Simmons et al. (2017)

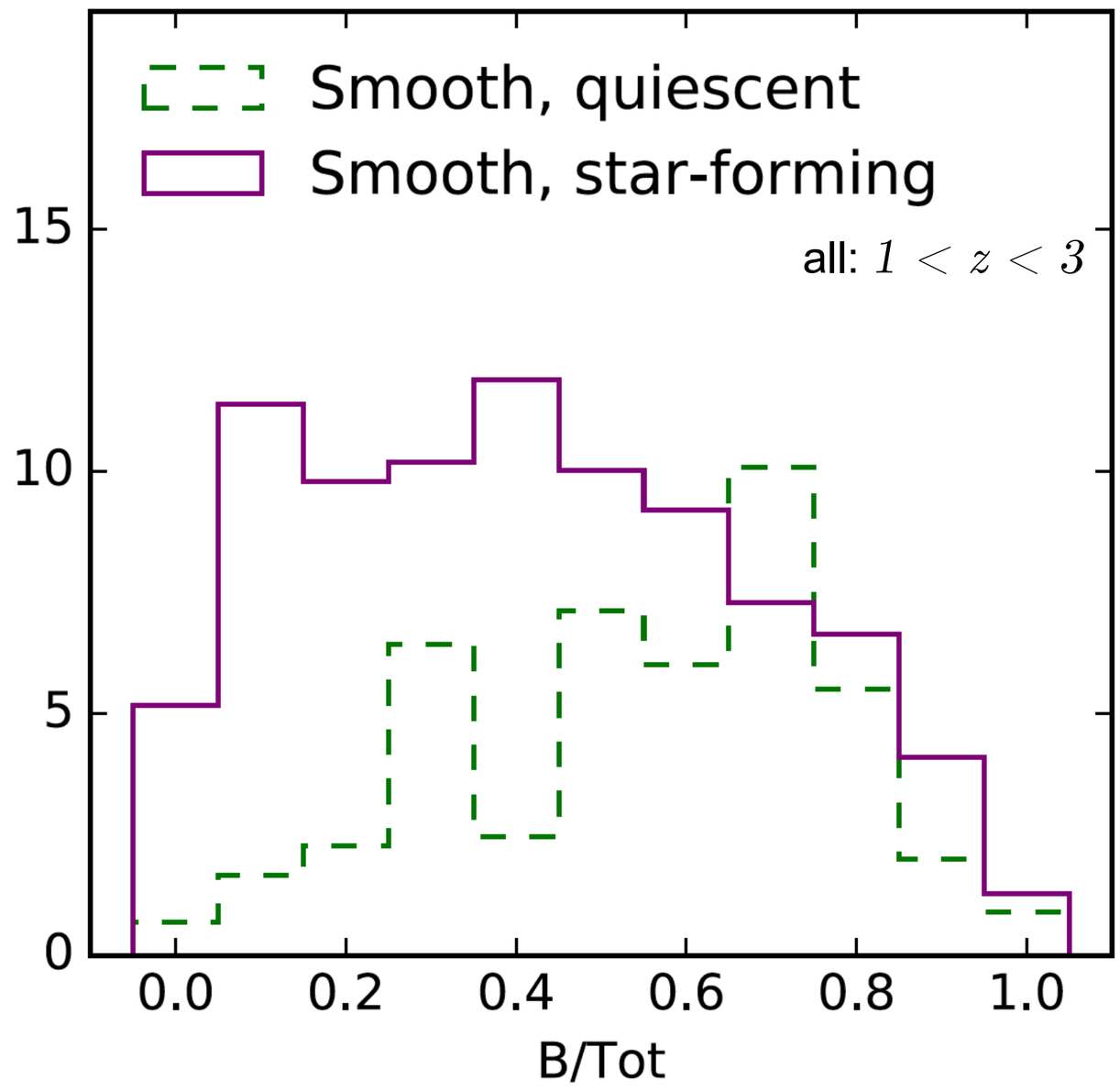
redshift ranges chosen to match resolutions between SDSS & CANDELS (~1 kpc resol.)



Smooth disks are a bit more common at higher redshift, which affects bar fraction calculations.

Simmons et al. (2017)

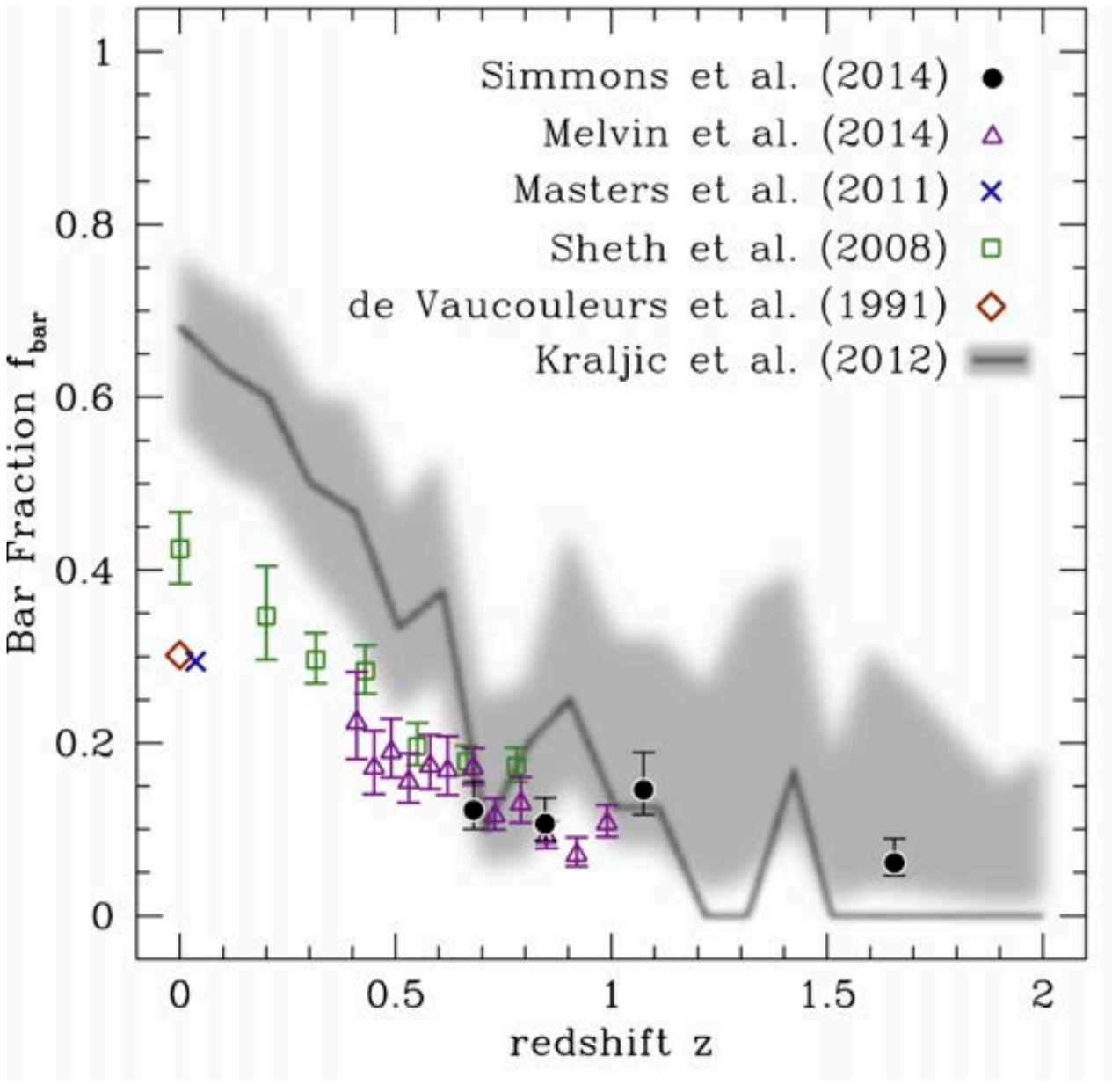
The disk-dominated featureless galaxies are more likely to be star-forming.



The bar fraction traces the overall dynamical temperature of the disk population.

from: Simmons et al. (2014)
Dynamical picture: see e.g. Förster Schreiber+2011, Kassin+2012, Swinbank+2017, Espejo Salcedo+2022

See upcoming talks!

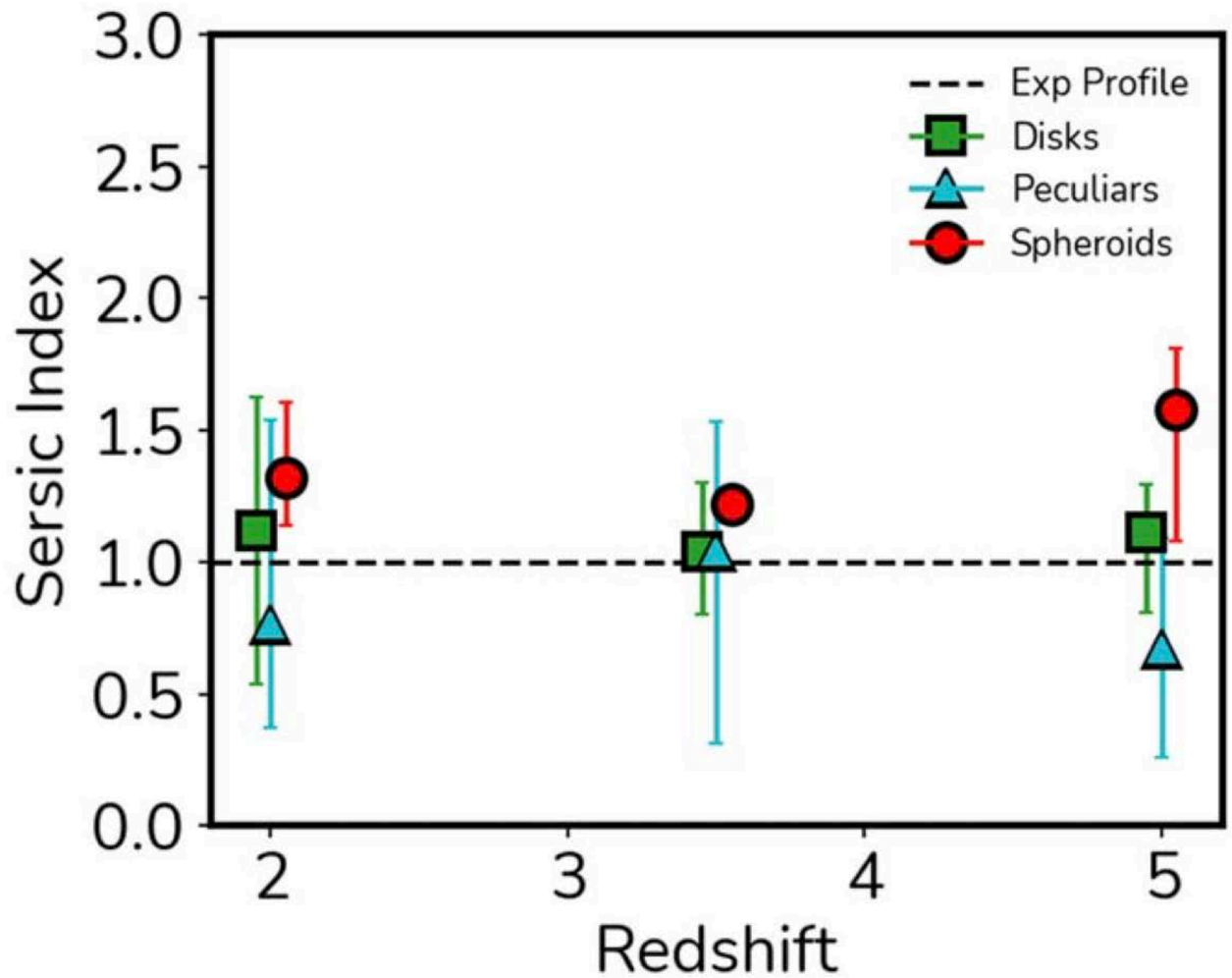


What is the highest redshift at which bars can form?

Disk galaxies seem to be very common at $z > 2$.

Ferreira et al. (2022)
Also: Margalef-Bentabol et al. (2022)

Q: does Sérsic n trace dynamics at high z?



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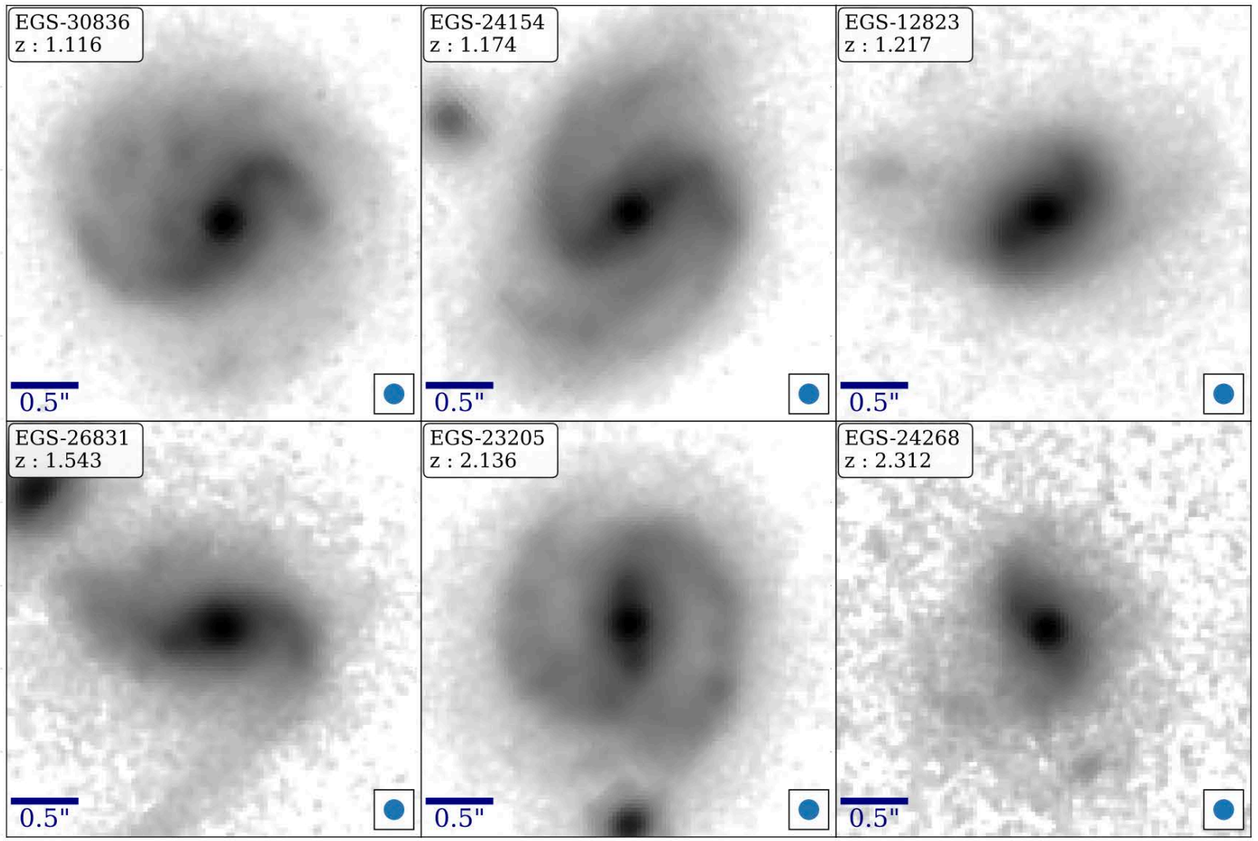
JWST: rest-frame optical to $z \sim 4.4$ in NIRCam

Guo et al. (2022)



See upcoming talks to find out whether we can break this record ($z = 2.312$) today…

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Bear in mind: high-z studies will always find lighthouses first.

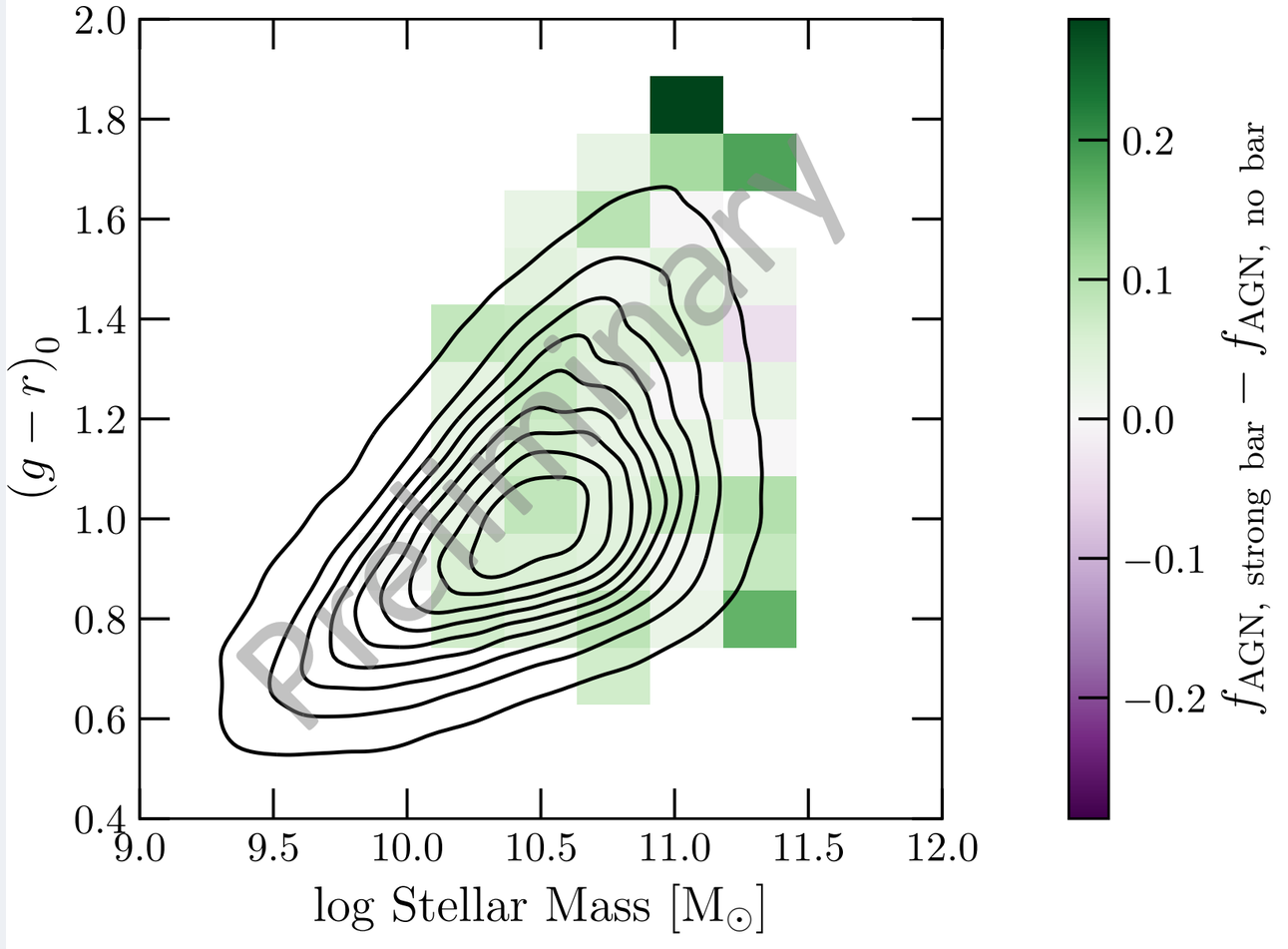
That doesn't mean they're not useful, just that they might not represent what's typical.

Image credit: NASA/ESA and the CEERS team

AGN and bars: good consensus now on correlation at lower z. High-z: Euclid?

Garland et al., in prep

See also excellent posters by Silva-Lima et al., Margalef-Bentabol et al.



Bar populations at “high” redshift probe disk galaxy evolution

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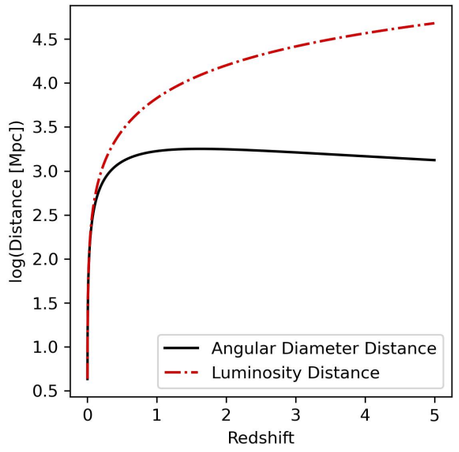
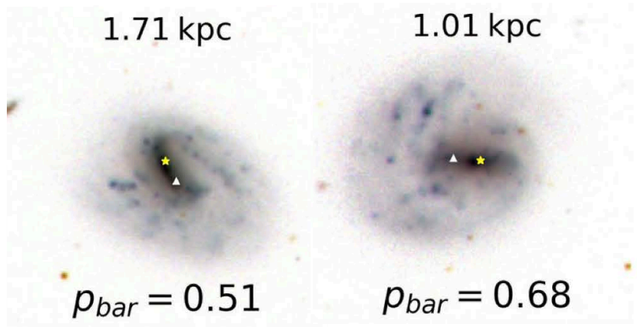
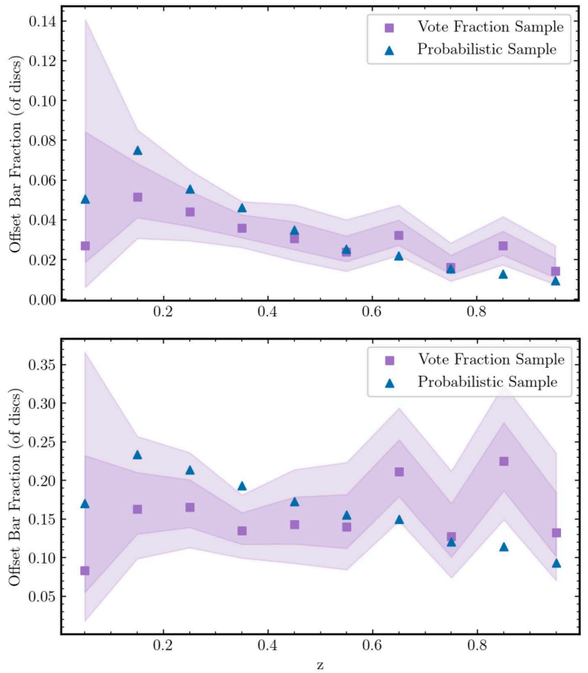
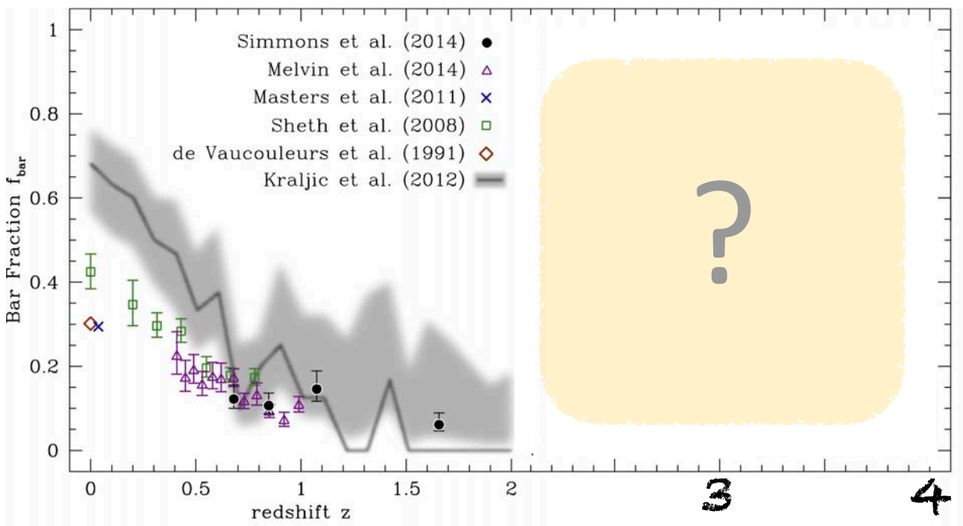
higher volumes mean better sample sizes, but poorer physical resolution









The future is here!

But also, we need more data!

Thank you!