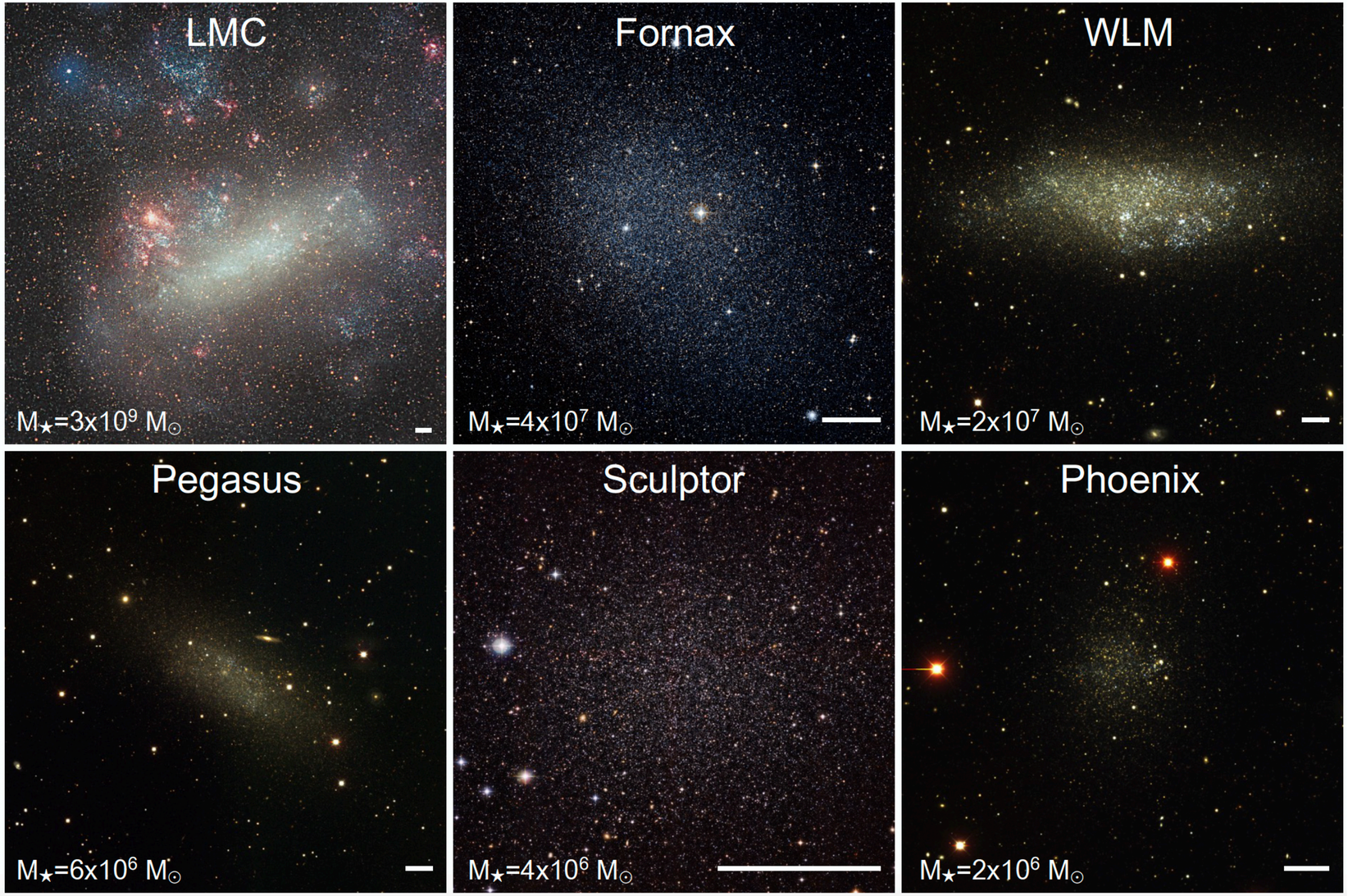
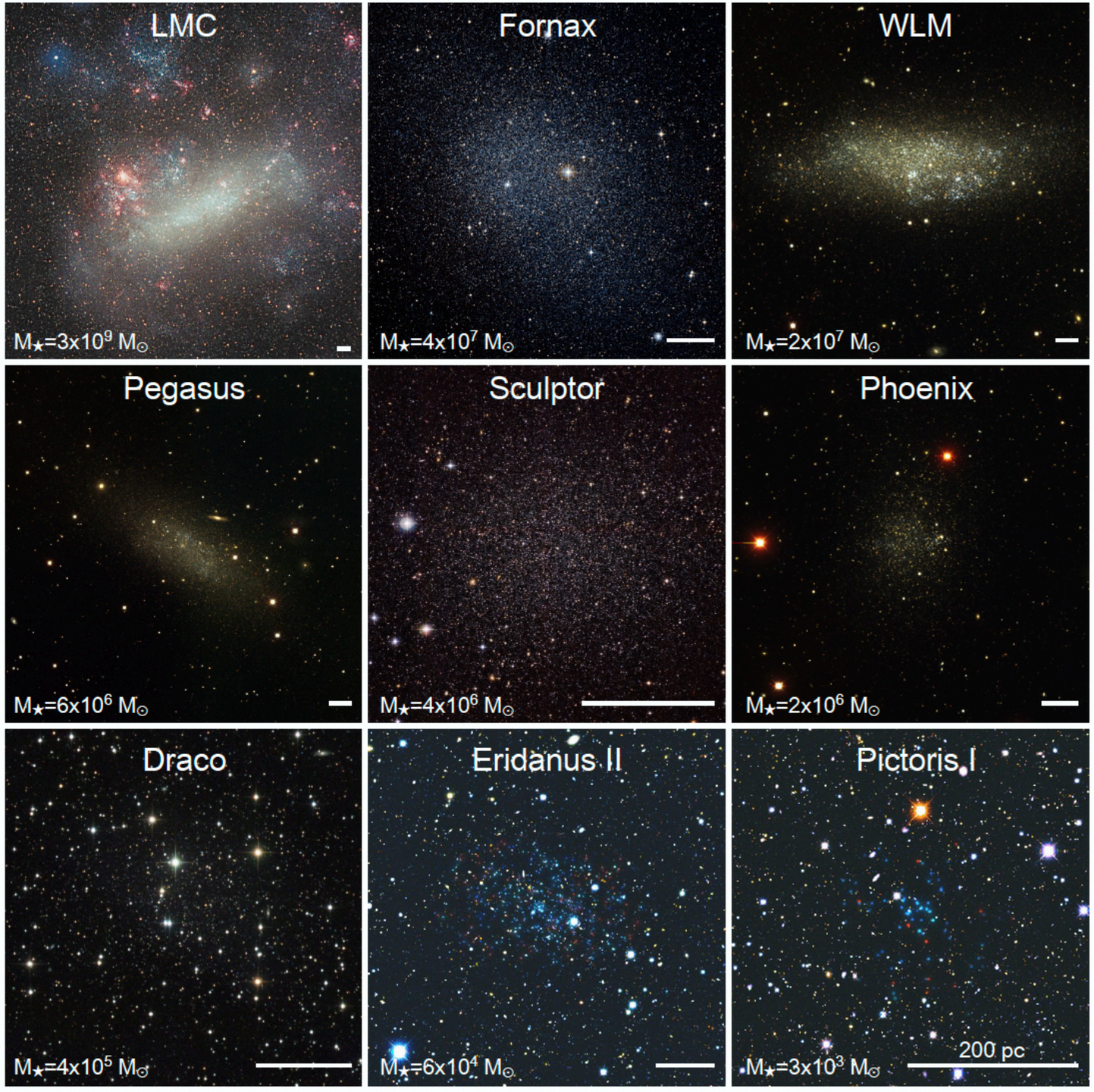
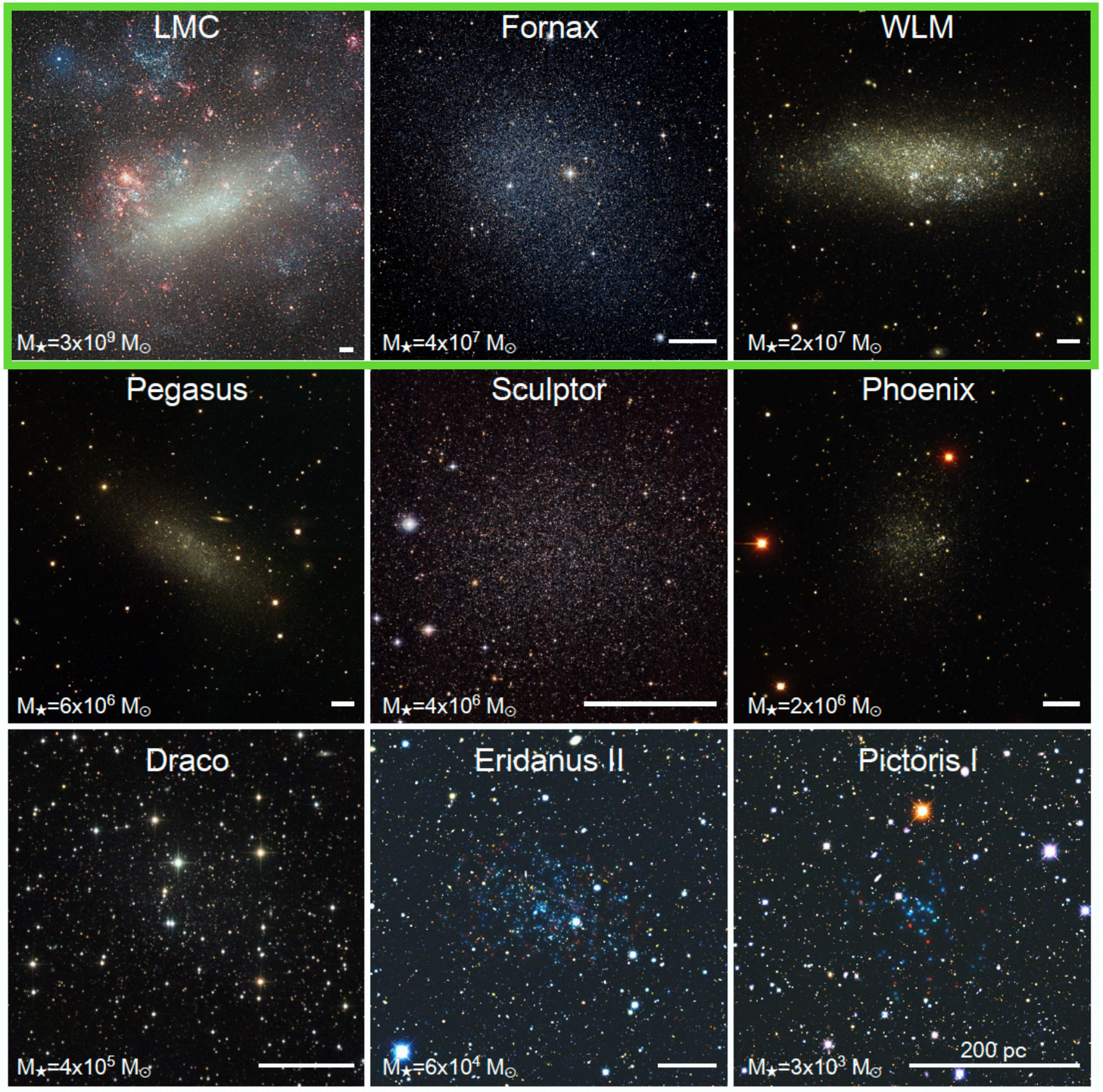
The Low-Mass, Low-Metallicity Galaxy Frontier



James Bullock (UC Irvine)



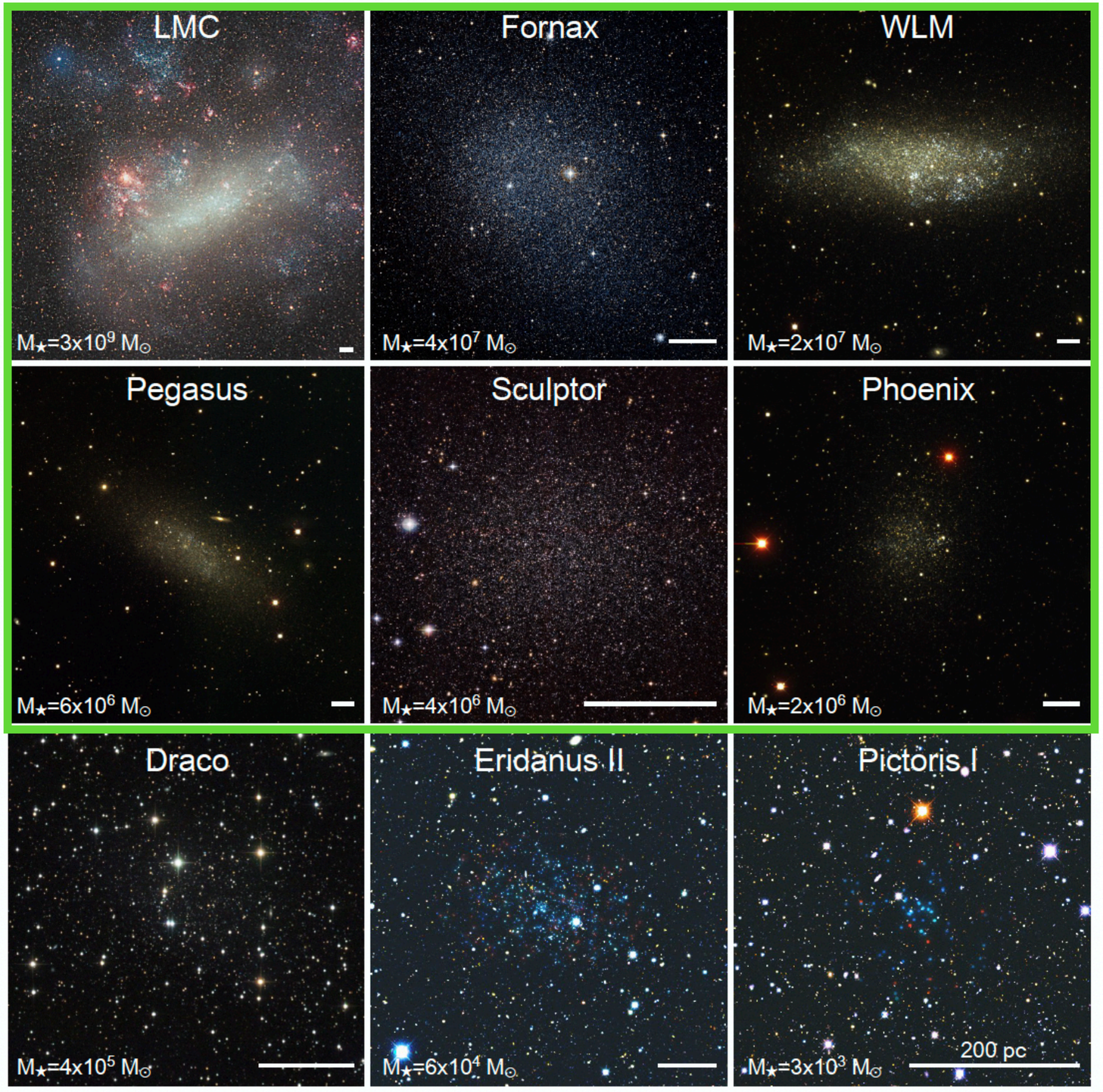
Scale bar is 200 pc



$M_{star} >\sim 10^7 M_{sun}$

~complete census in cosmological volumes (e.g. GAMA)

Scale bar is 200 pc

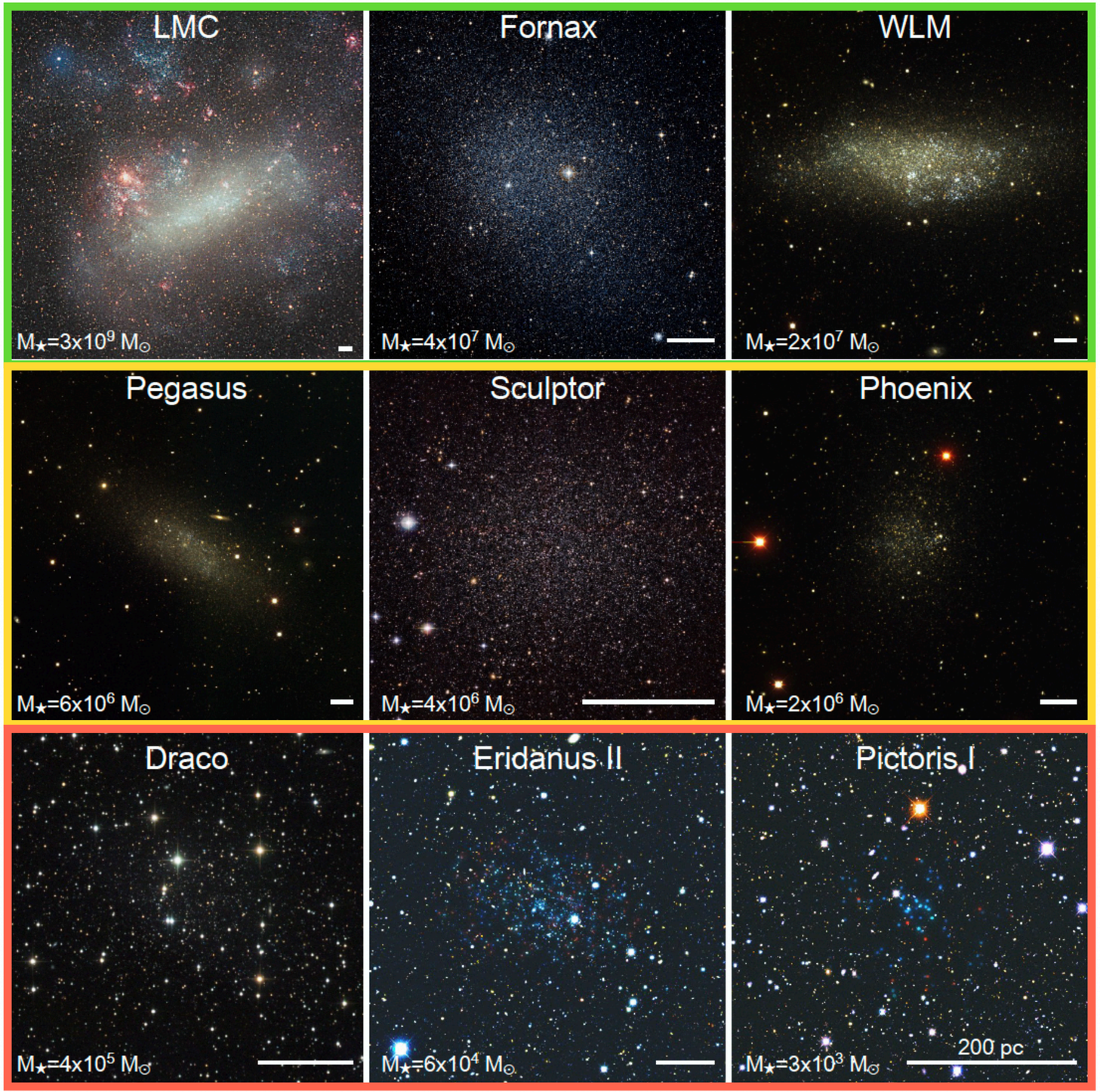


$M_{star} >\sim 10^7 M_{sun}$

~complete census in cosmological volumes (e.g. GAMA)

$M_{star} >\sim 10^6 M_{sun}$

~marginally complete within Local Group



$M_{star} >\sim 10^7 M_{sun}$

~complete census in cosmological volumes (e.g. GAMA)

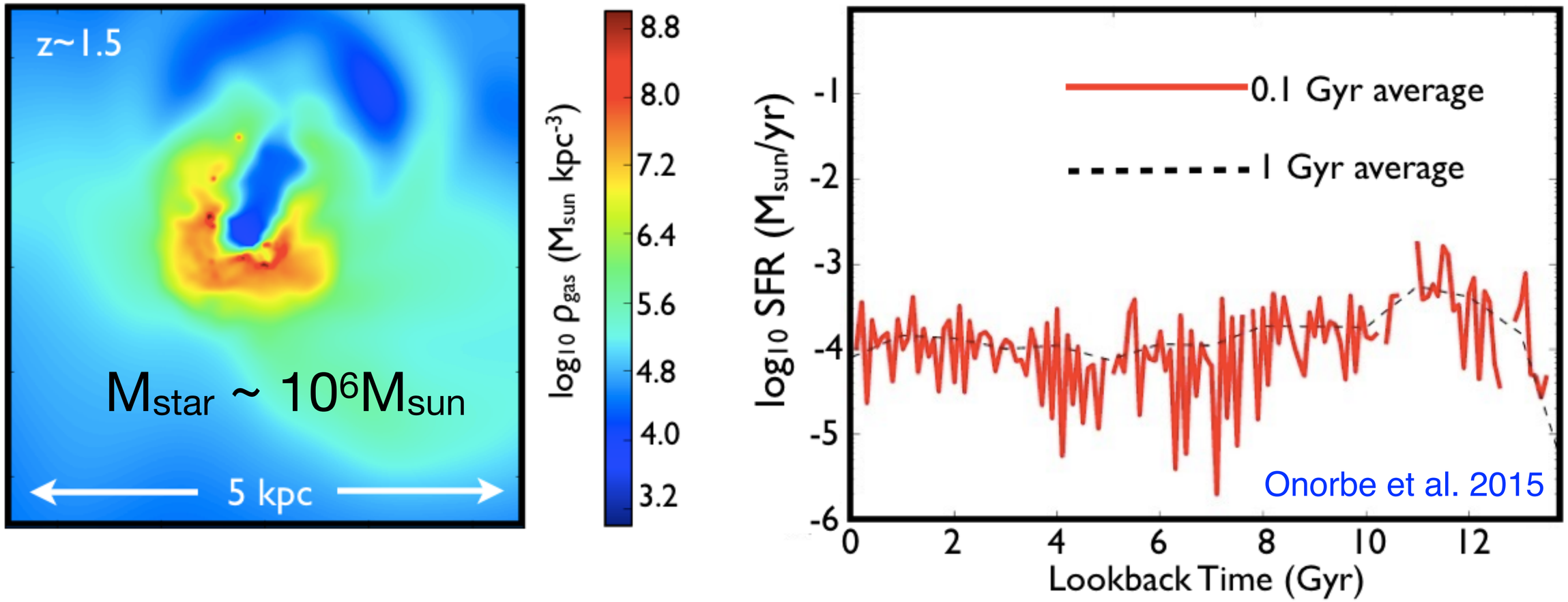
$M_{star} >\sim 10^6 M_{sun}$

~marginally complete within Local Group

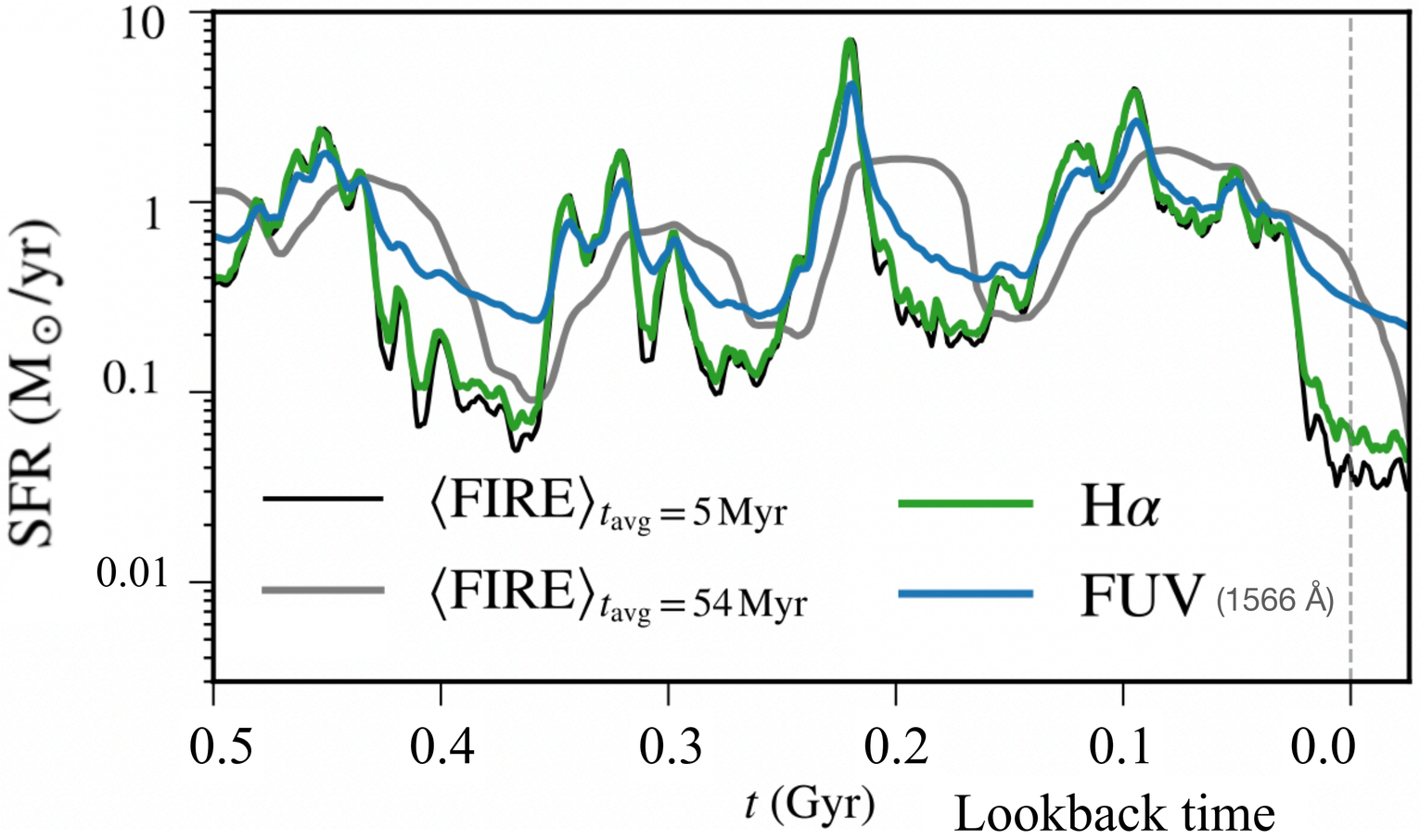
$M_{star} <\sim 10^5 M_{sun}$

Complete only in vicinity of Milky Way/ M31 & selected targets

Most simulated dwarfs have very bursty star formation histories



(Mashchenko, Wadsley & Couchman 2008; Pontzen & Governato 2012; Madau, Shen & Governato 2014; Read, Agertz & Collins 2016; Munshi et al. 2019;).



FUV luminosity can vary by factors of ~5 over 100Myr timescales

Flores Velazquez et al. 2021

The Low-Mass, Low-Metallicity Galaxy Frontier w/ UVEX

Kulkarni et al. 2023

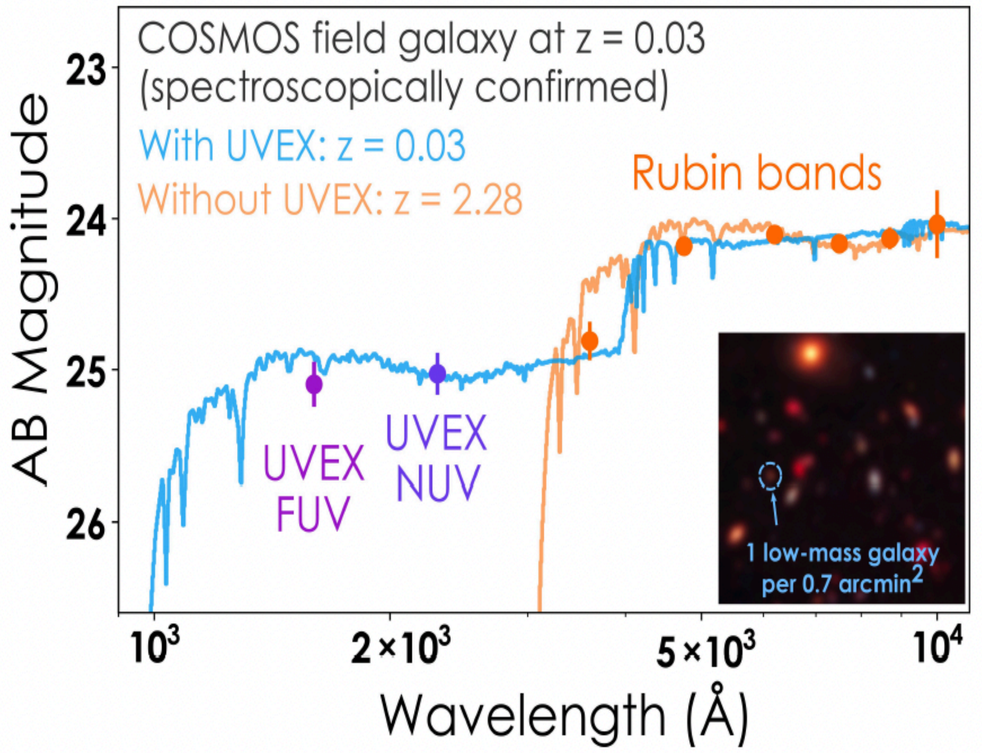


Figure 5. *UVEX* imaging picks out low-mass, $z < 0.3$ galaxies by providing the crucial UV photometry needed to differentiate the Balmer break for a low-redshift system (blue) from the Lyman break in far more numerous high-redshift galaxies (orange).

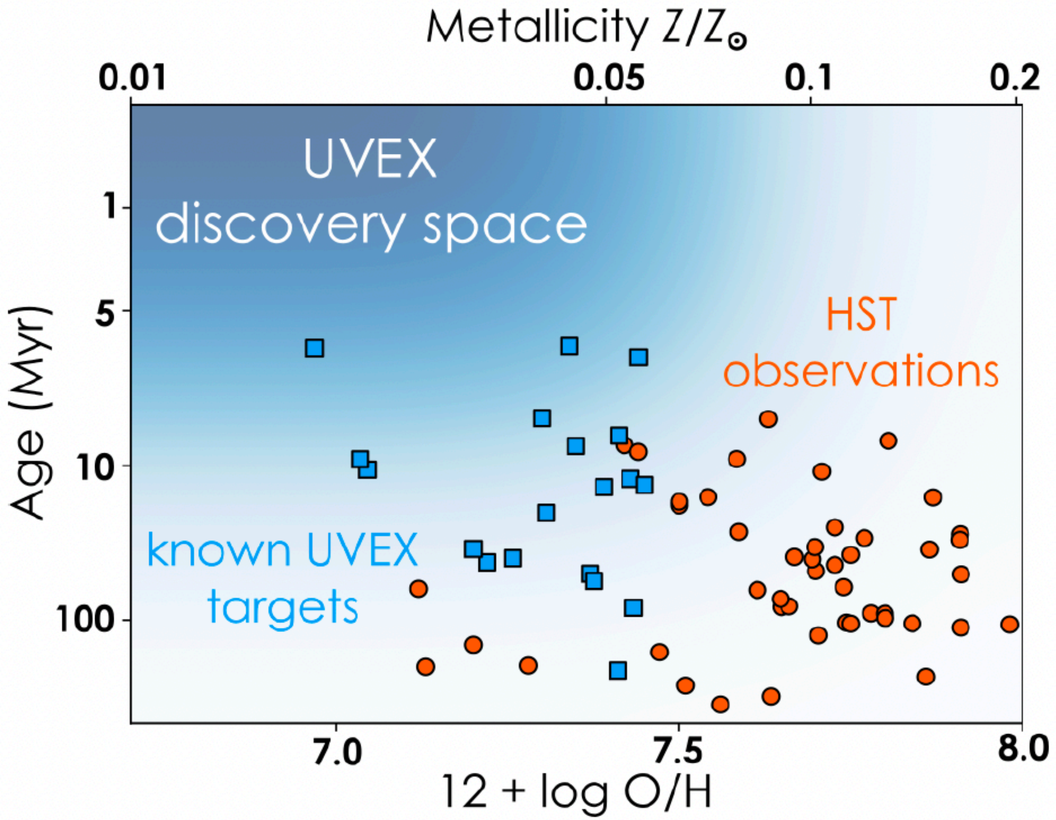
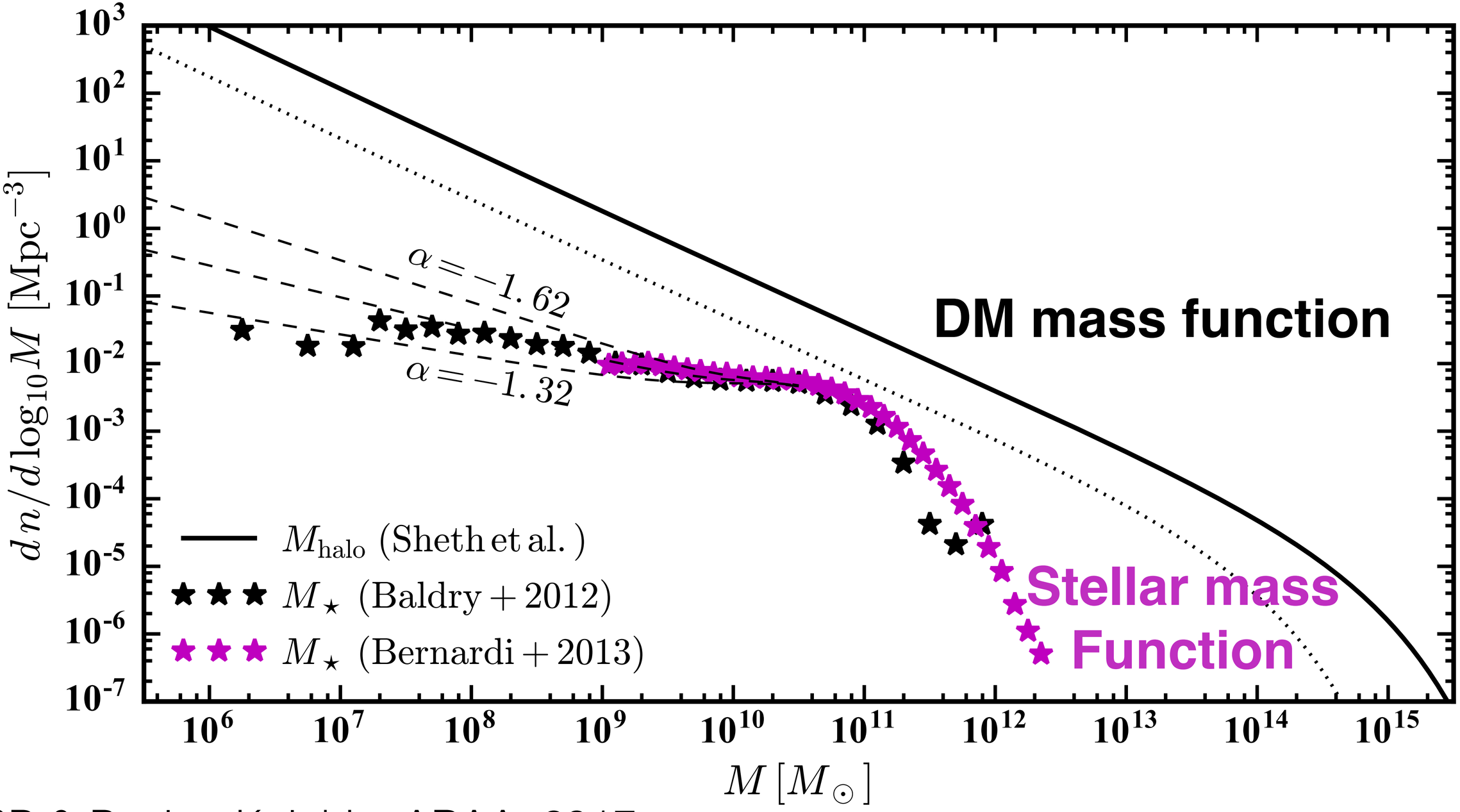
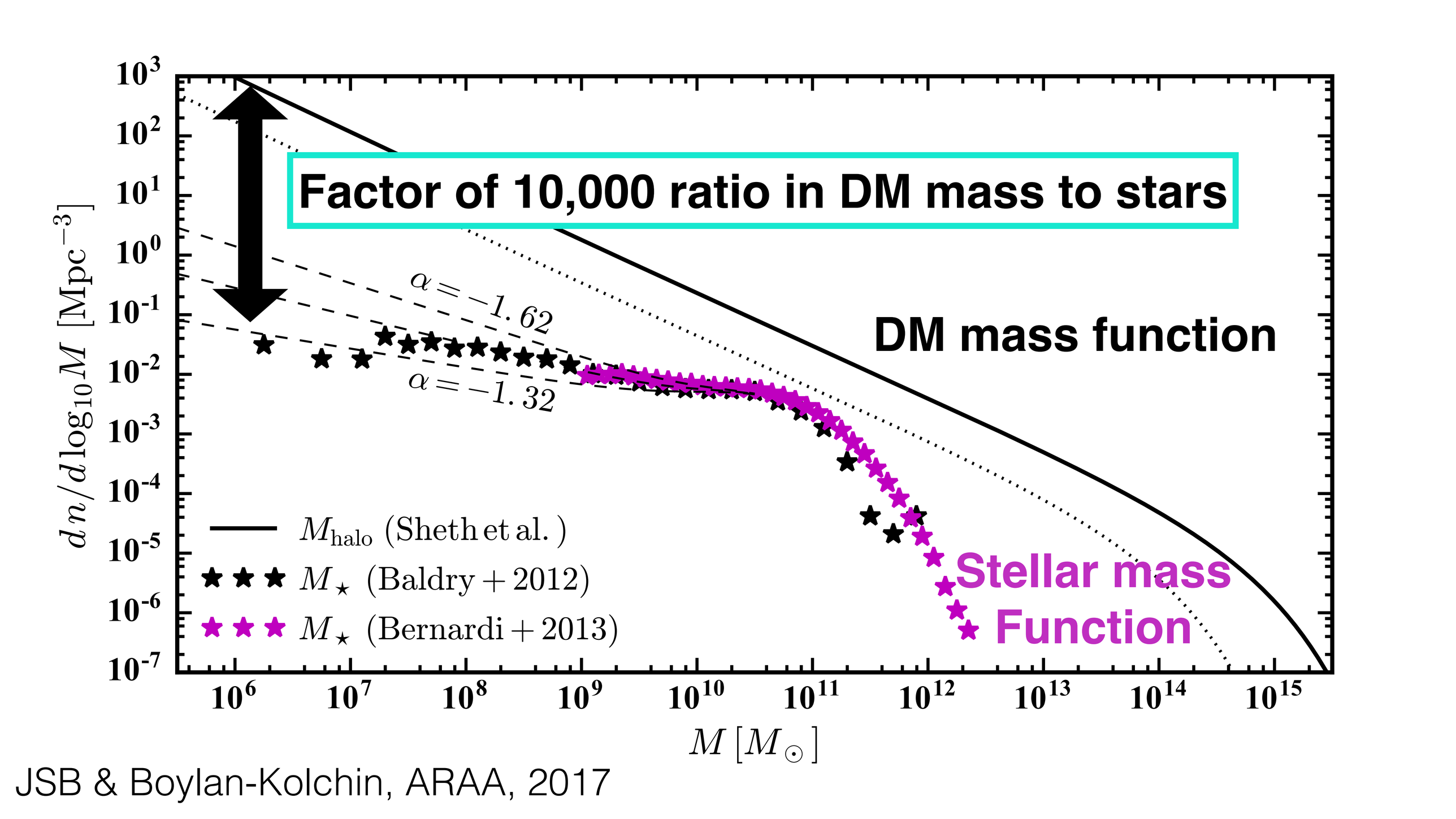


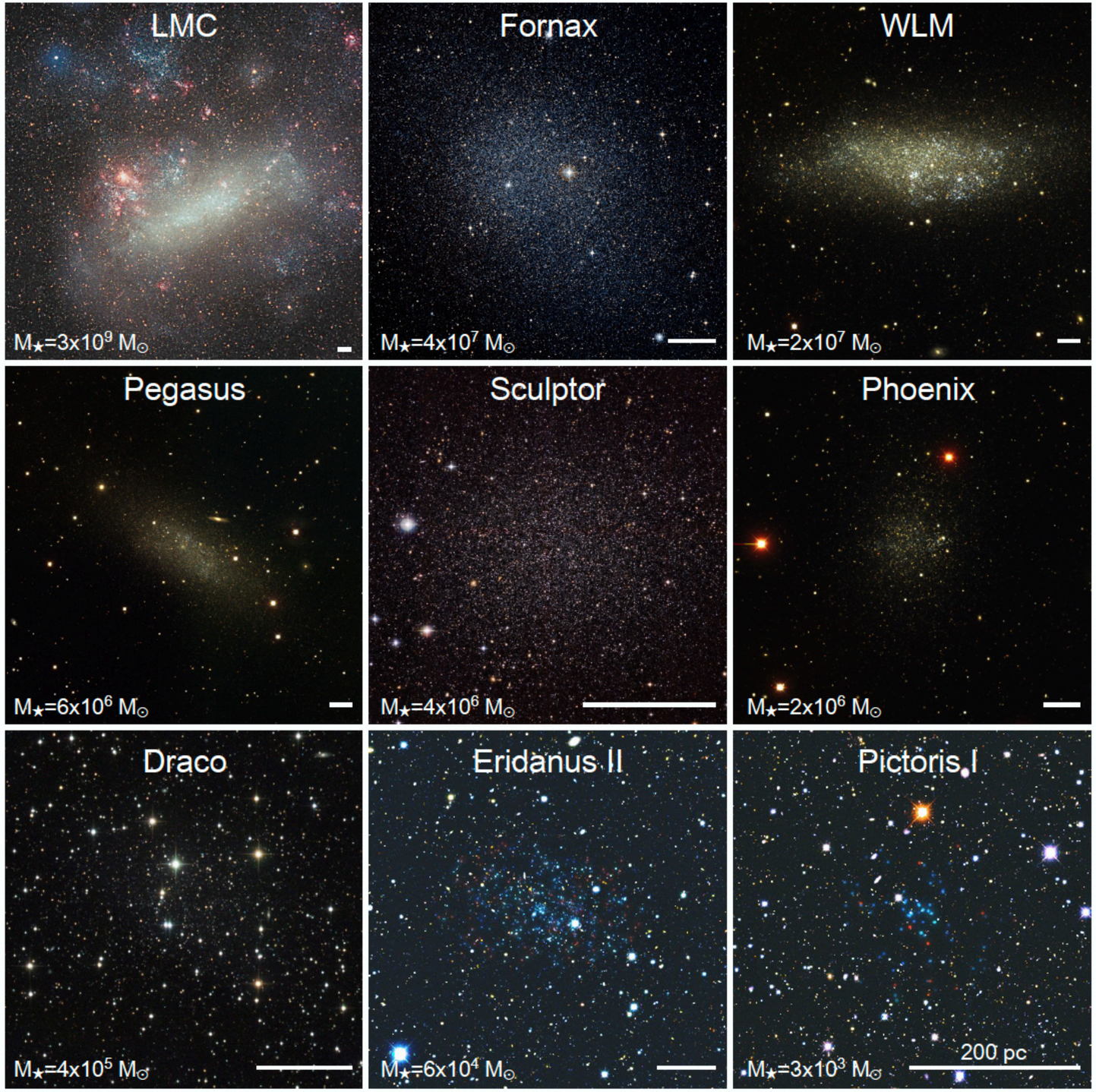
Figure 6. *UVEX* will obtain spectra of the lowest-metallicity galaxies in the local universe. Orange dots are measurements from *HST*, blue squares indicate the known sample selected for *UVEX* followup. *HST* can still make some progress in the lighter shaded blue regions but probing the darker blue region requires *UVEX*.



JSB & Boylan-Kolchin, ARAA, 2017

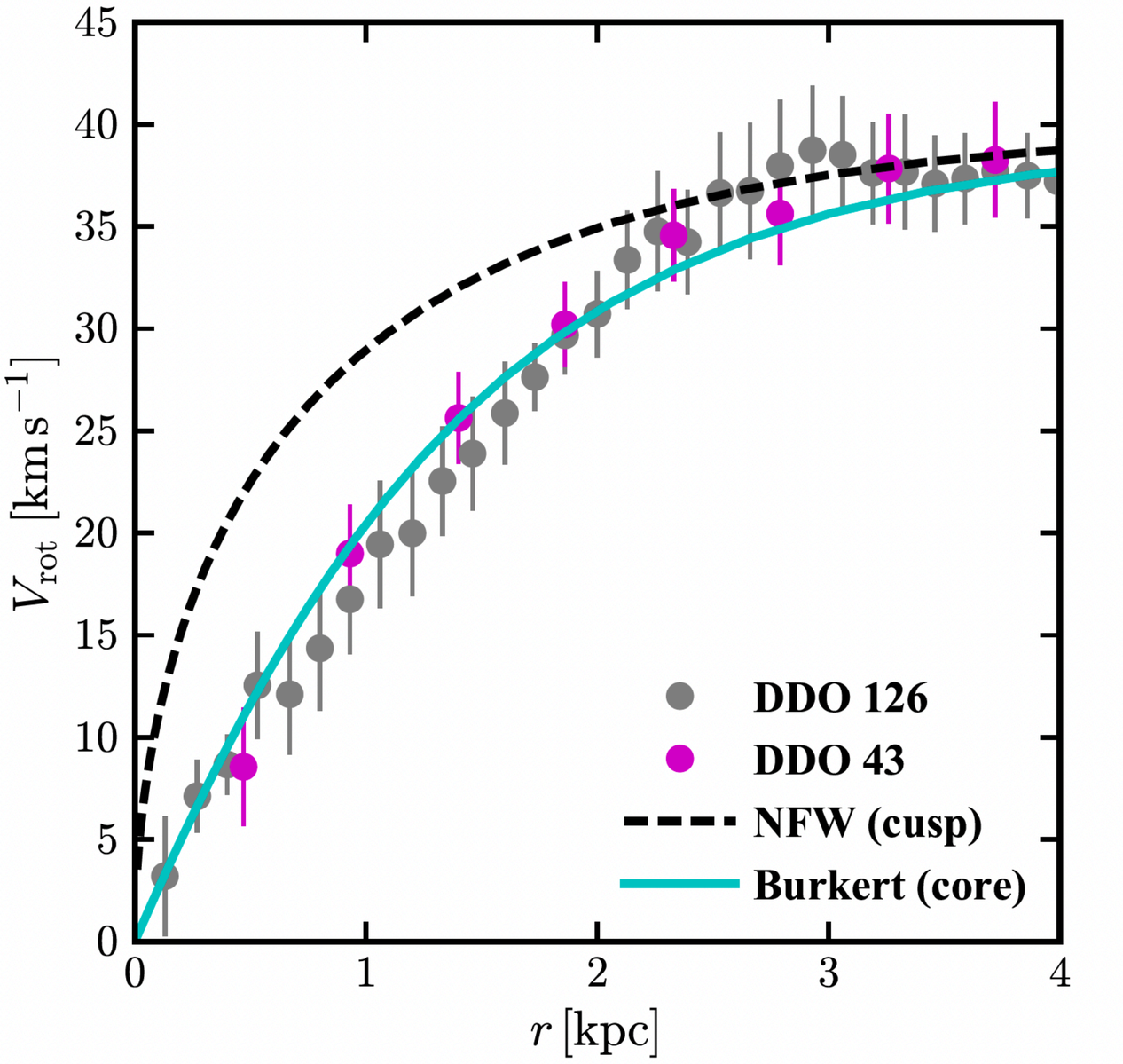


JSB & Boylan-Kolchin, ARAA, 2017



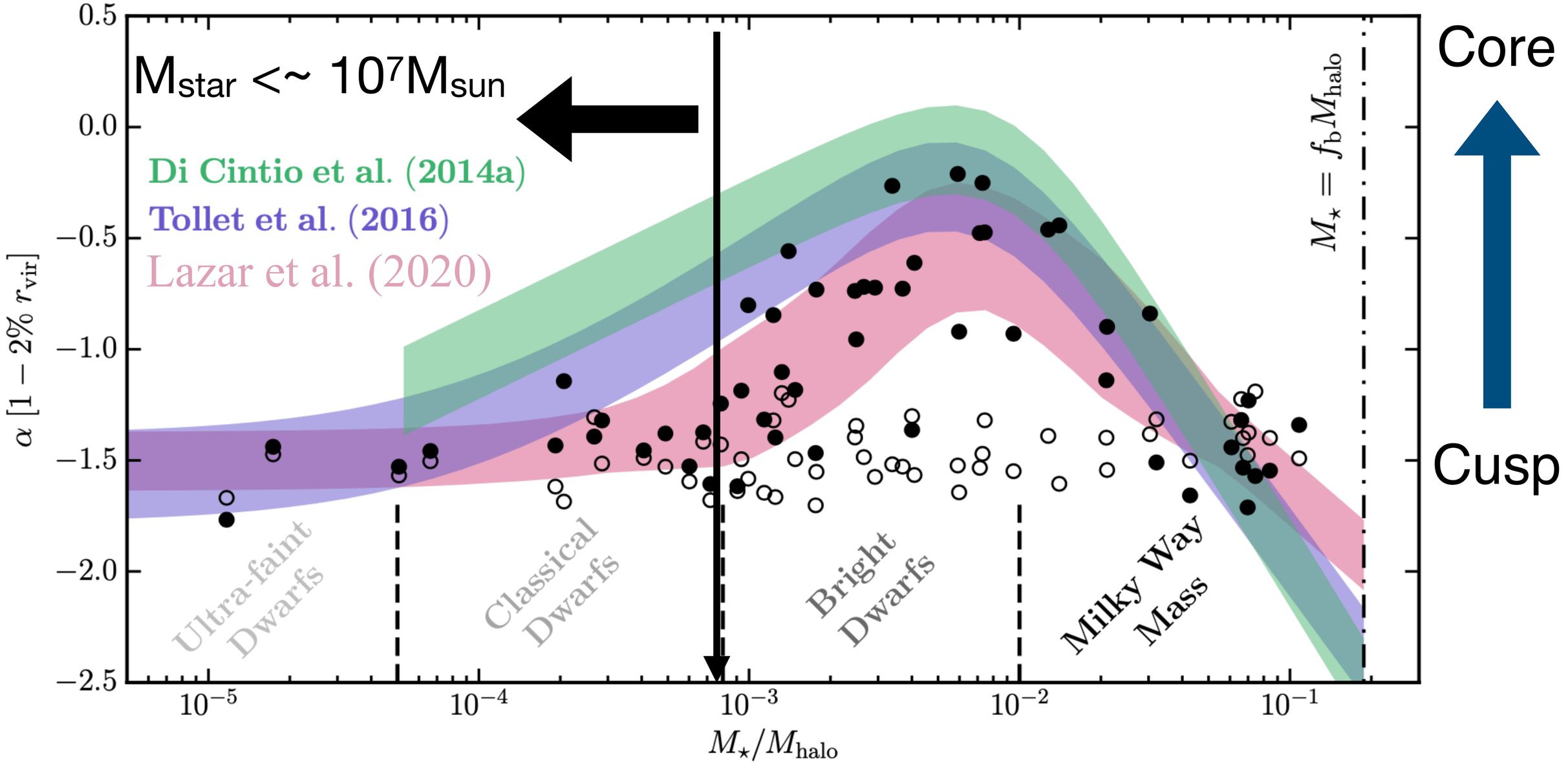
Low mass galaxies are the most dark-matter dominated galaxies in the universe

Ideal laboratories for the nature of dark matter
- current census is in crowded/local group environment



Cusp/Core problem in small galaxies

Feedback cannot make cores in lowest mass galaxies

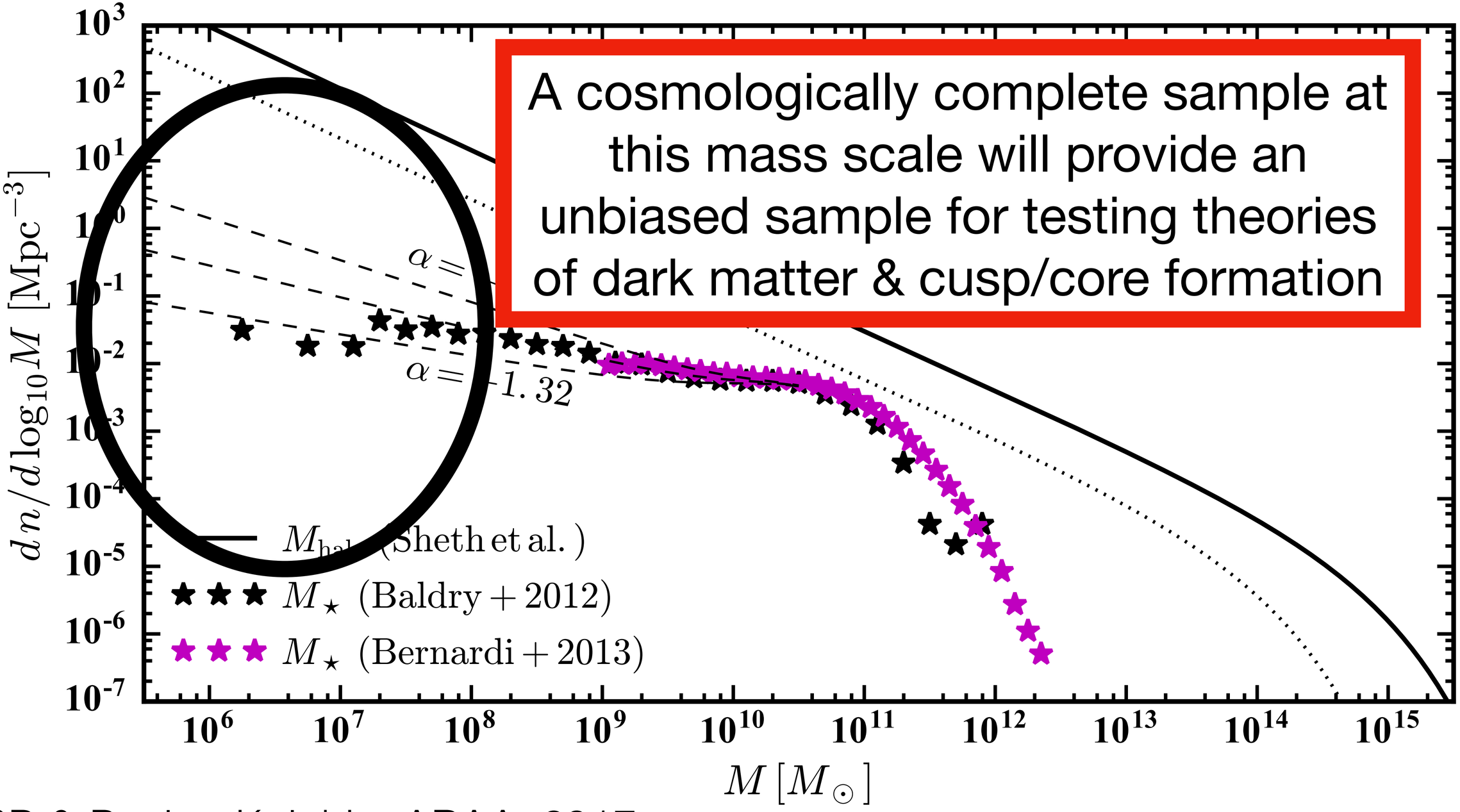


Core

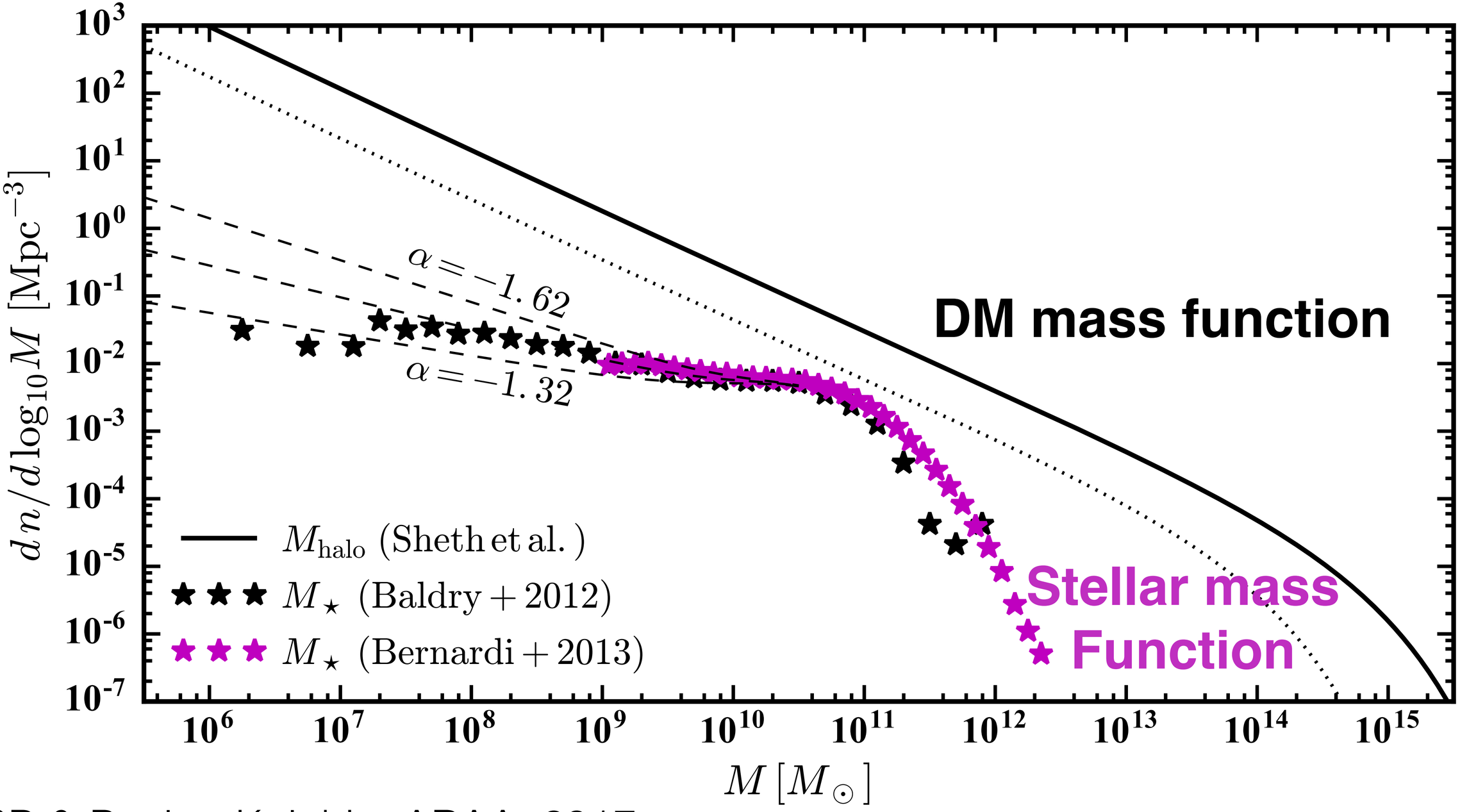
Cusp

Lazar, JSB et al. 2020

see also Governato+12,Brooks & Zolotov 12, Read+16, etc.



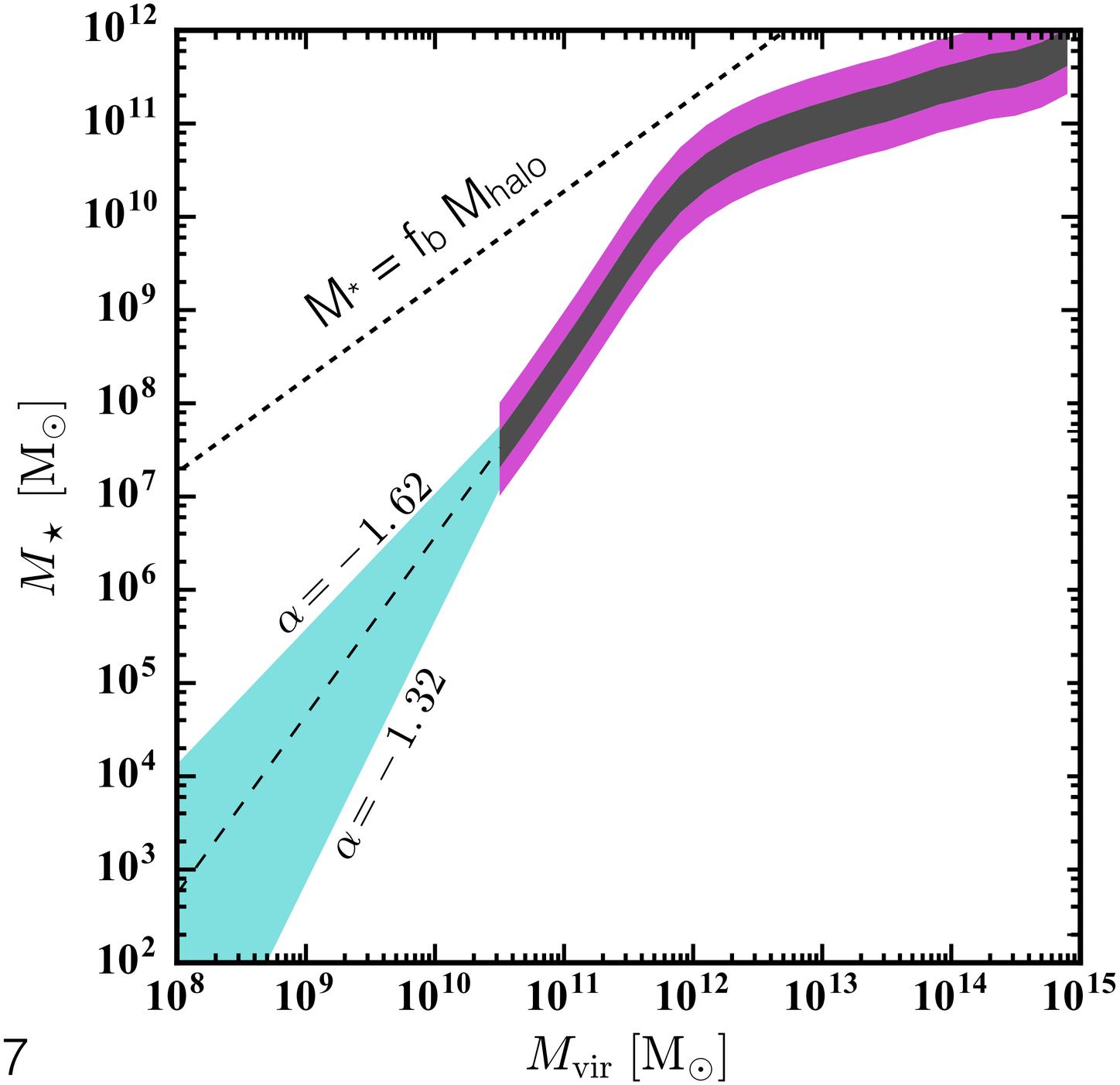
JSB & Boylan-Kolchin, ARAA, 2017



JSB & Boylan-Kolchin, ARAA, 2017

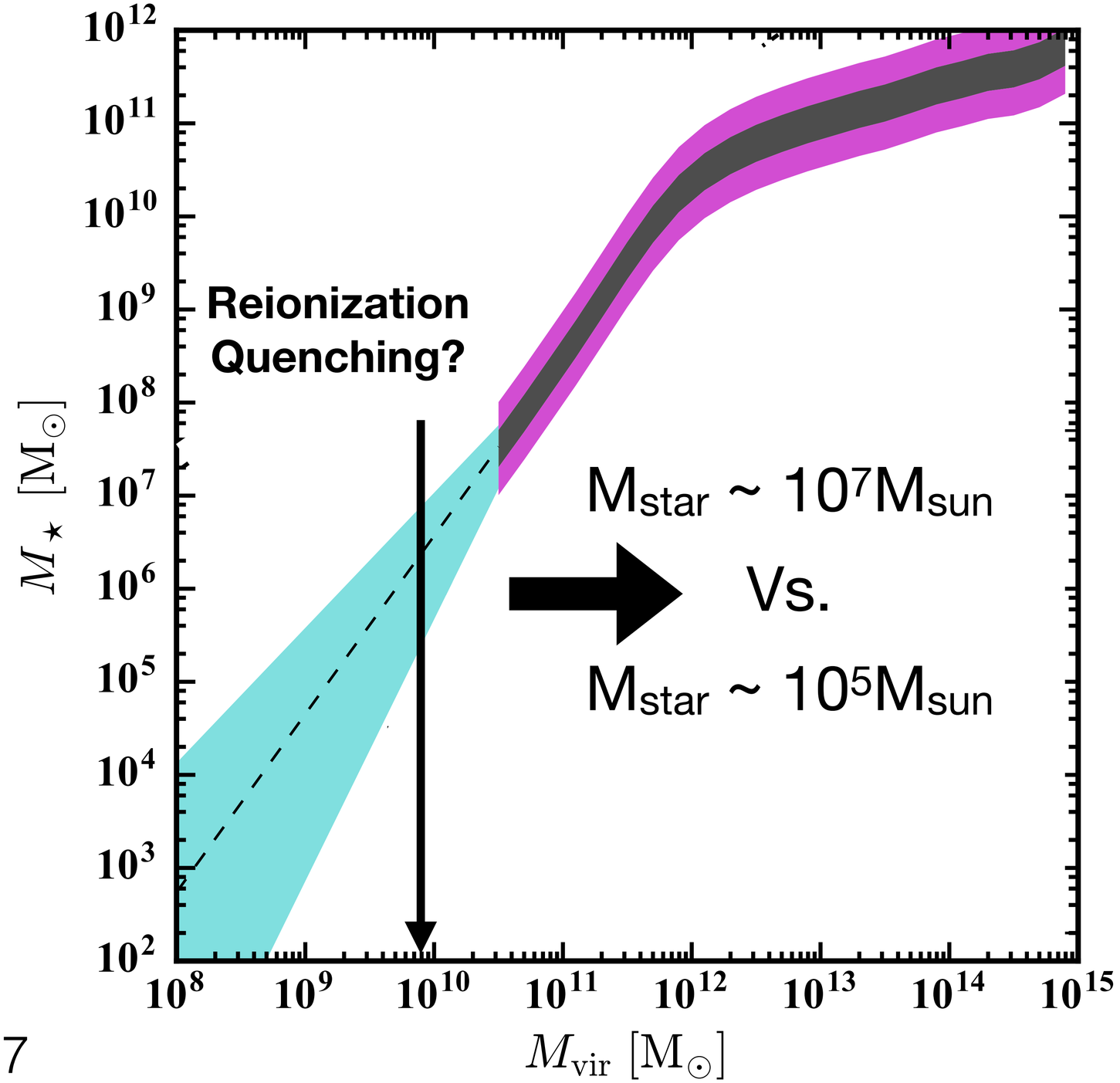
Unknown stellar-mass vs halo mass relation at small scales

UVEX will help settle this relation down to $M_{star} \sim 10^6 M_{sun}$

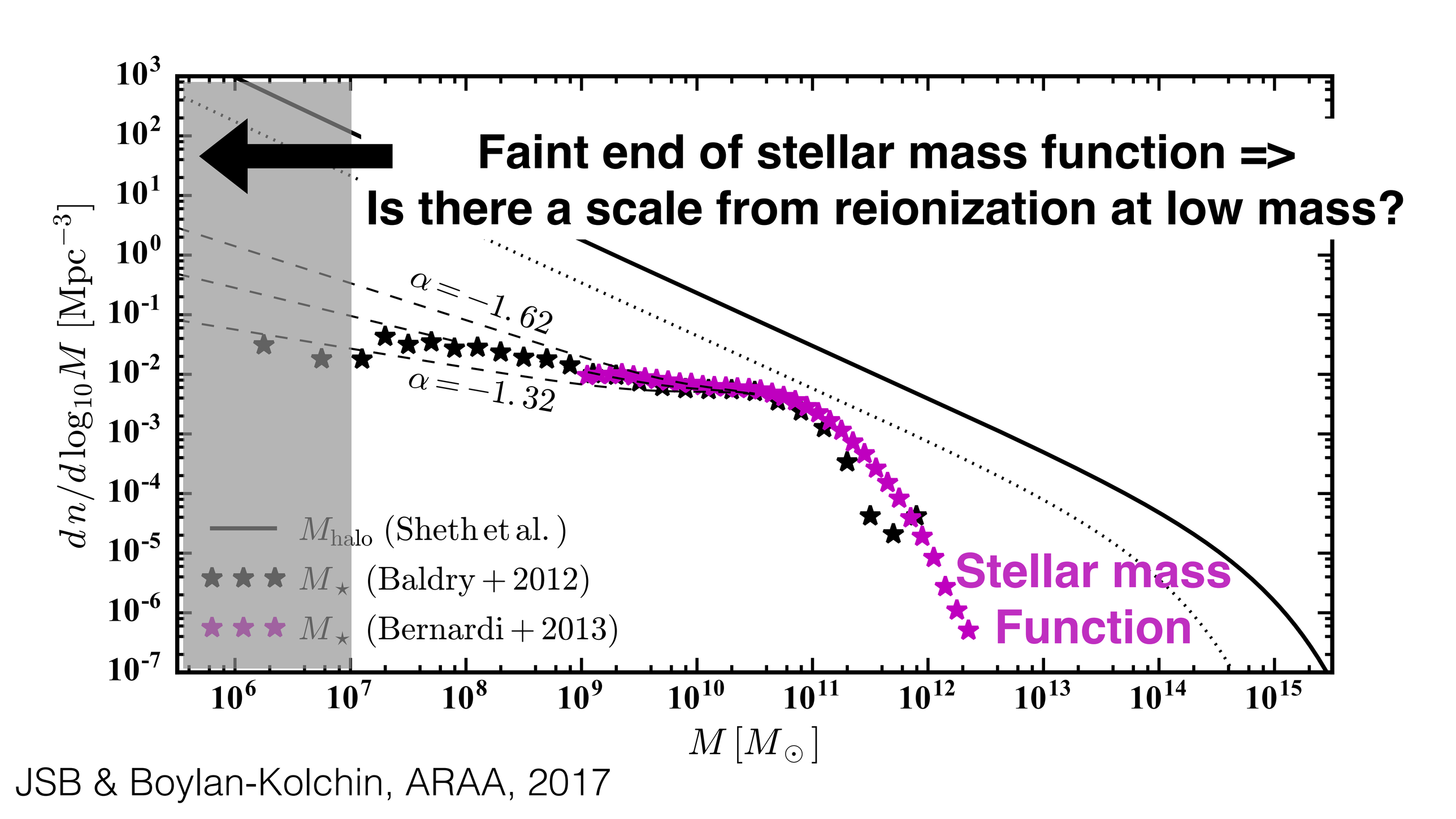


JSB & Boylan-Kolchin, ARAA, 2017

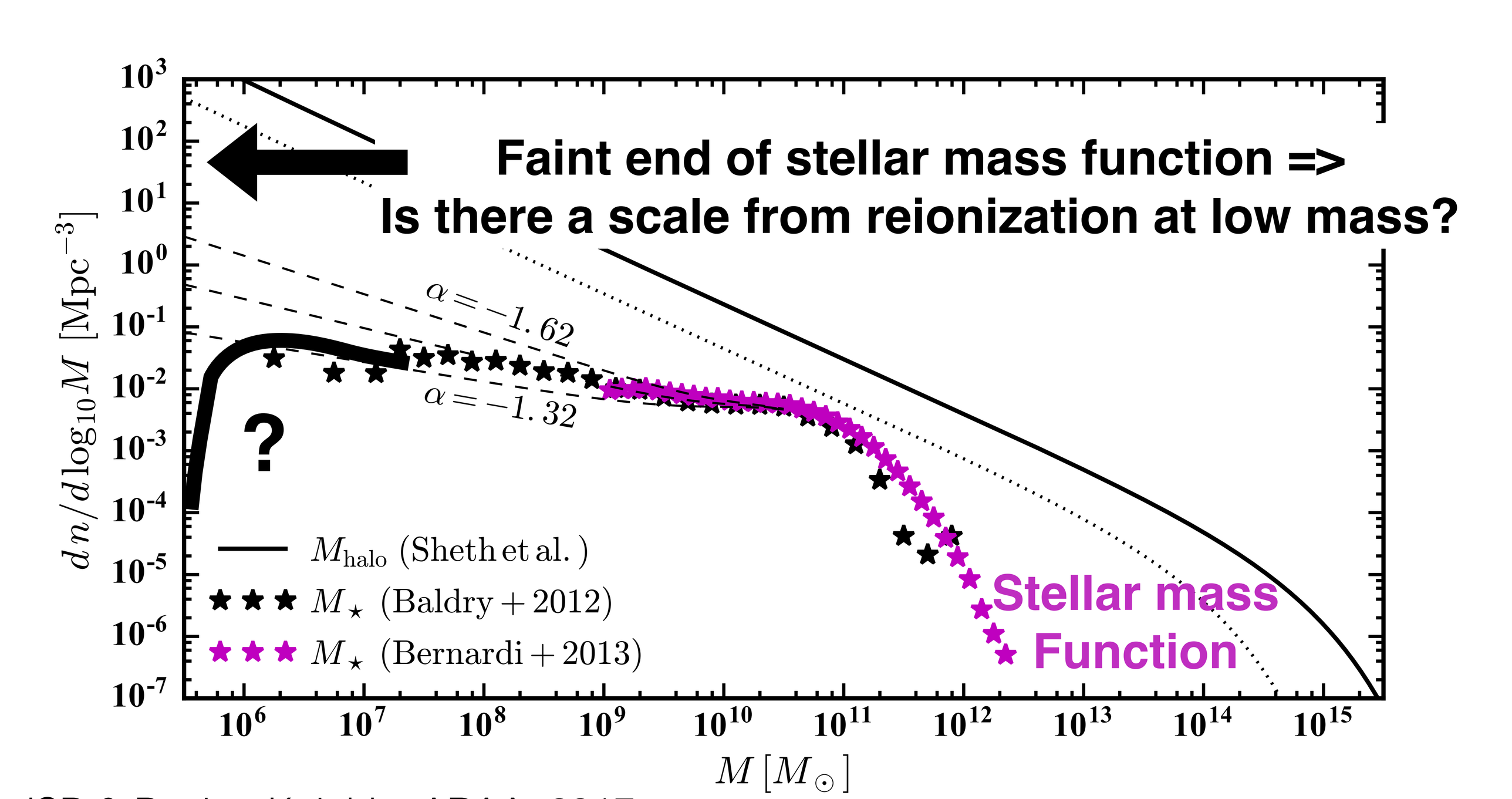
Very interesting physics at the ~ $10^6 M_{sun}$ scale



JSB & Boylan-Kolchin, ARAA, 2017

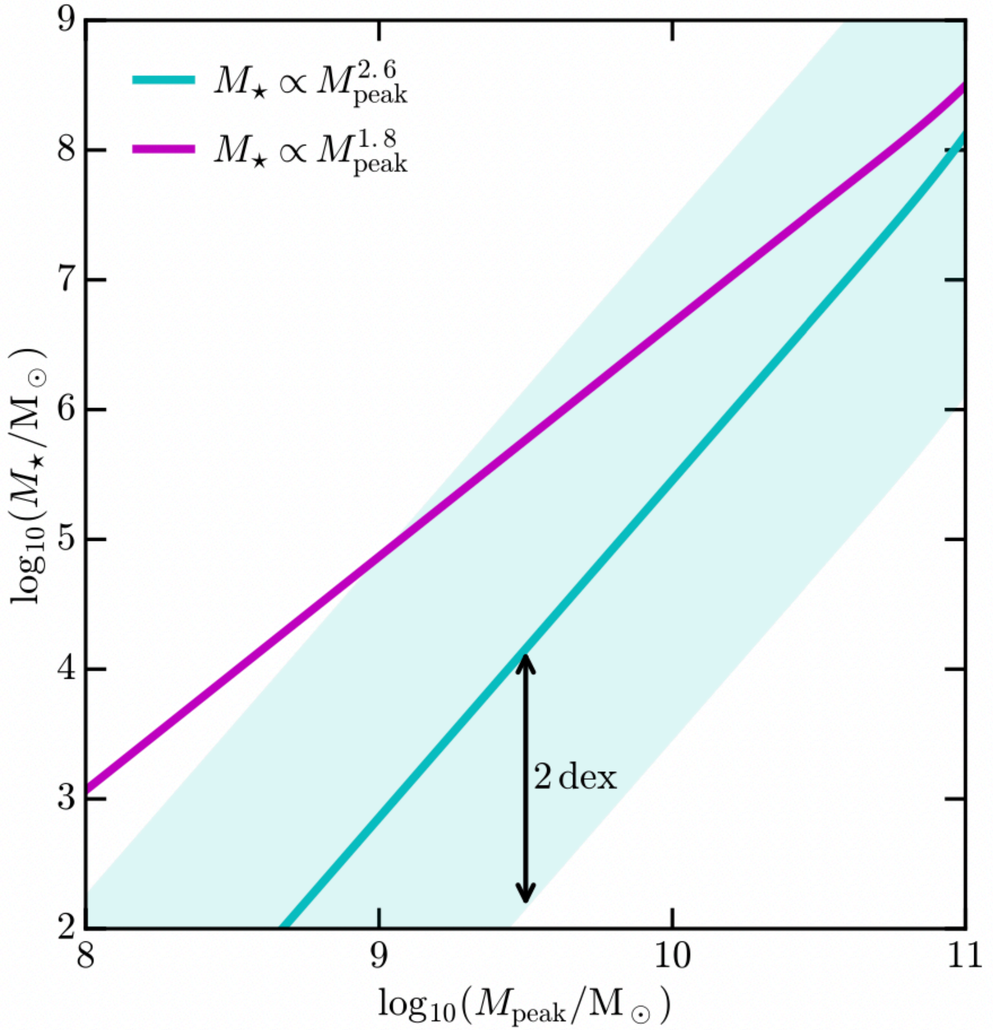


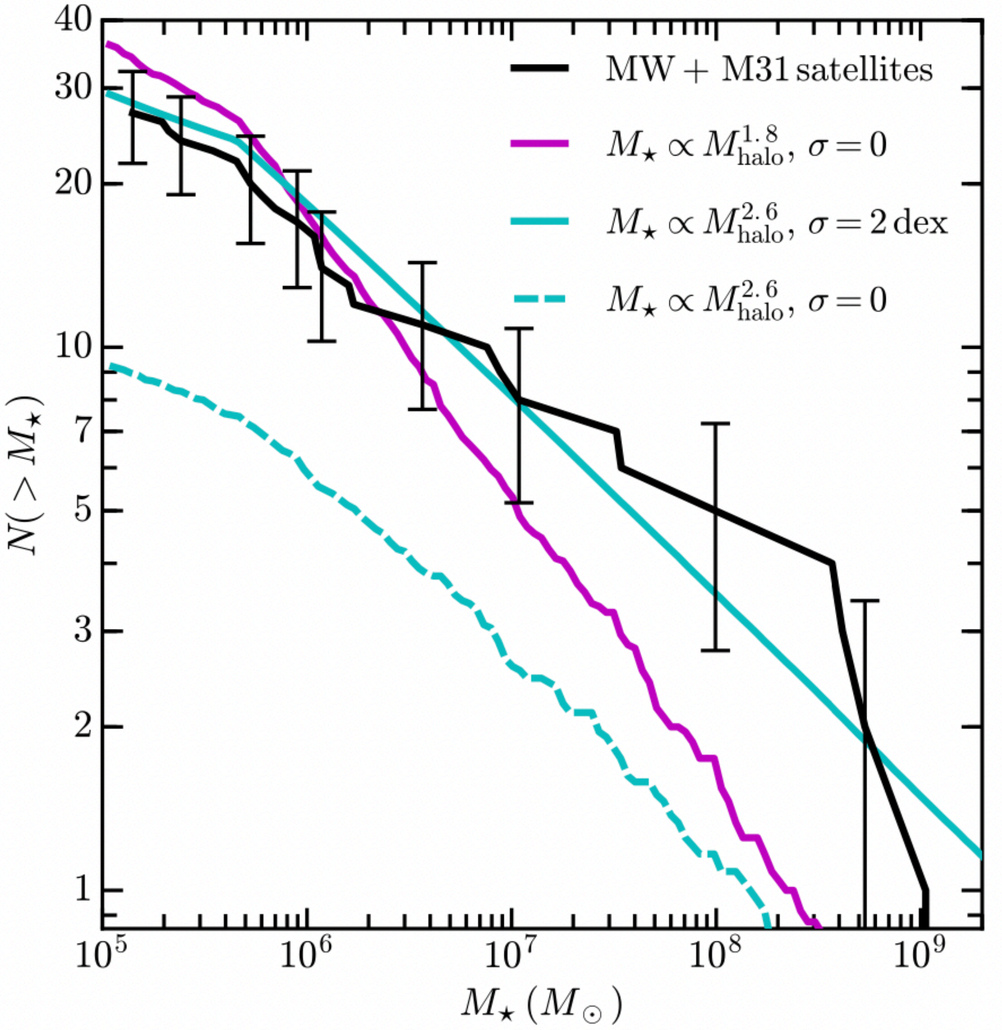
JSB & Boylan-Kolchin, ARAA, 2017



JSB & Boylan-Kolchin, ARAA, 2017

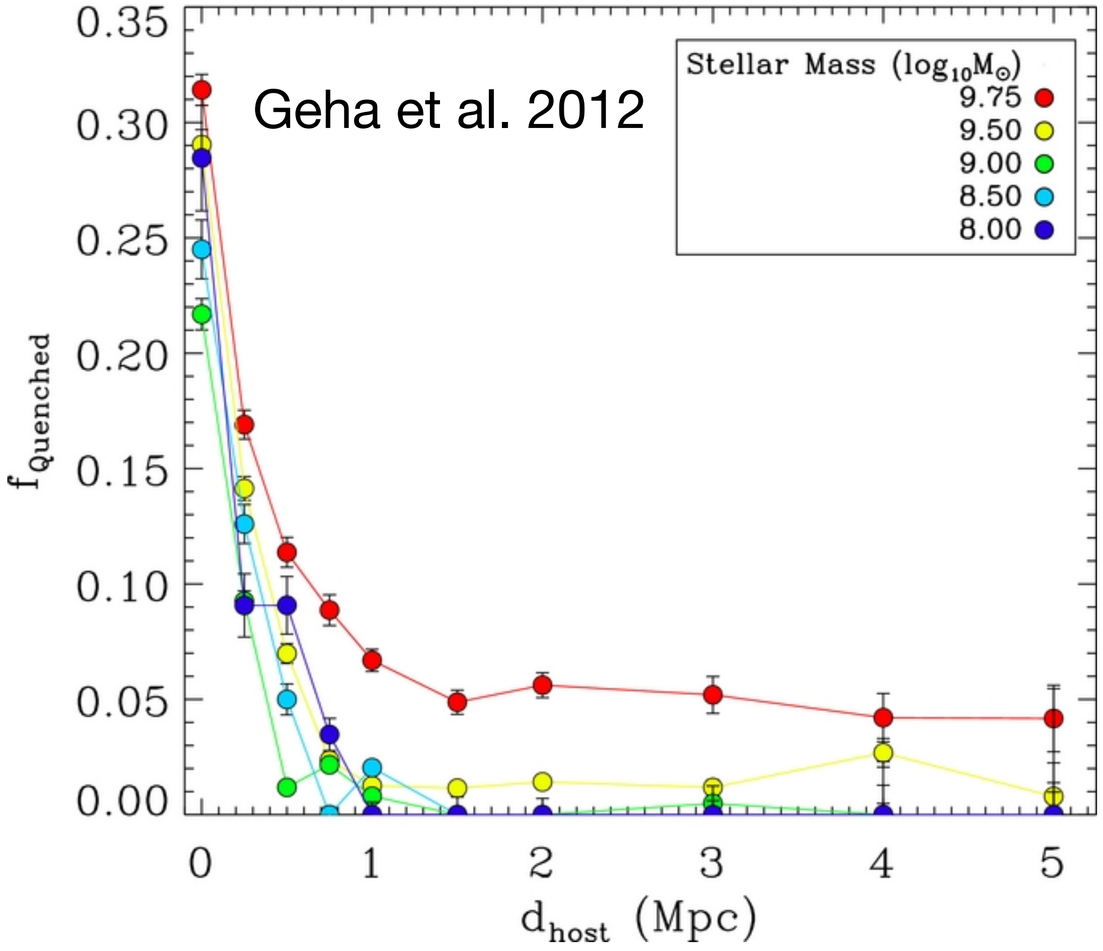
What is the scatter in the stellar-mass to halo-mass relation at small scales?



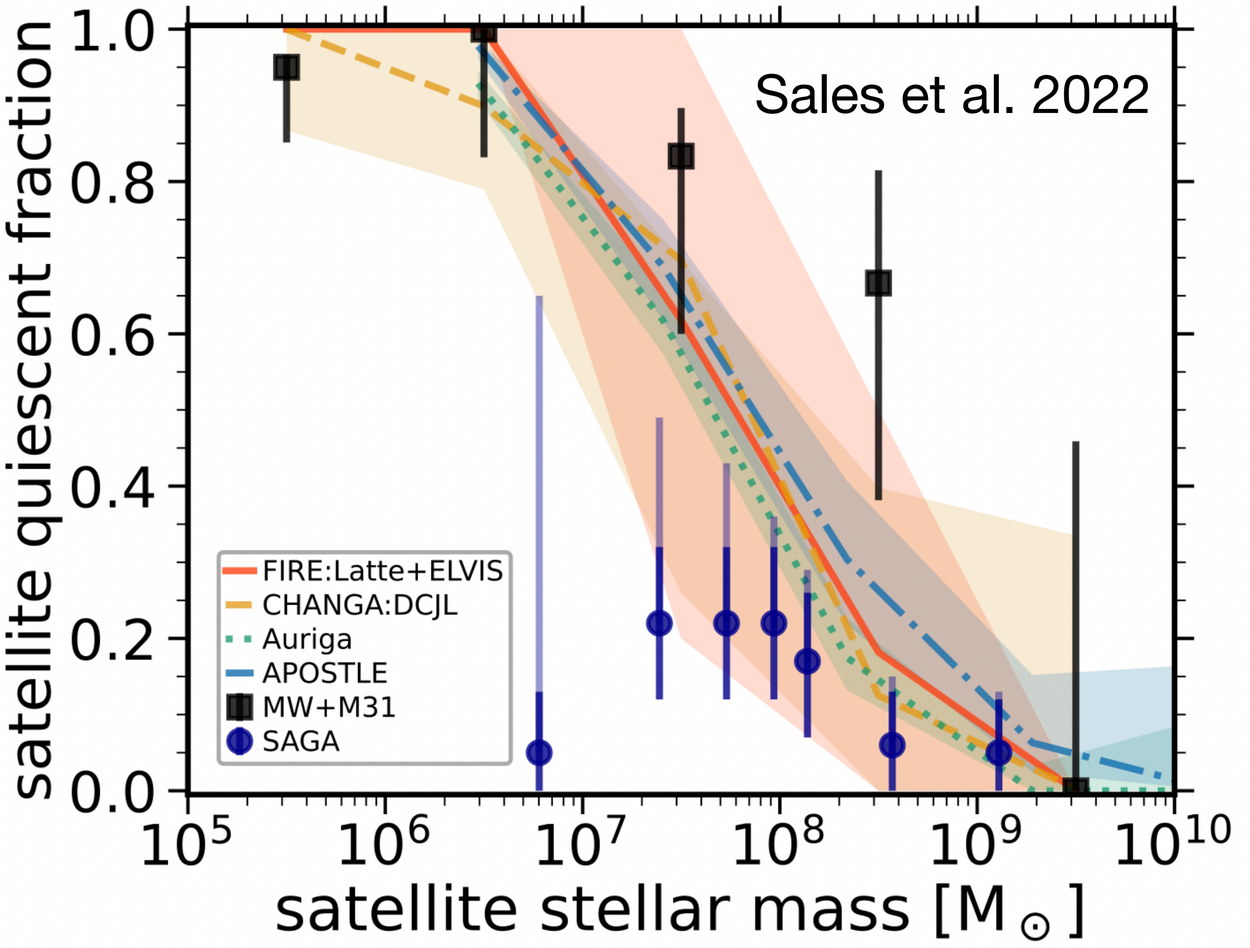


Garrison-Kimmel et al. 2017

Are any M_{star} ~ $10^7 M_{sun}$ galaxies quenched in the field?



How does satellite quenched fraction vary with mass?



Did JWST Break the Universe?

nature

https://doi.org/10.1038/s415

Accelerated Article Preview

A population of red candidate massive galaxies ~600 Myr after the Big Bang

Ivo Labbé, Pieter van Dokkum, Erica Nelson, Rachel Bezanson, Katherine A. Suess, Joel Leja, Gabriel Brammer, Katherine Whitaker, Elijah Mathews, Mauro Stefanon & Bingjie Wang

Nature (2023) | Cite this article

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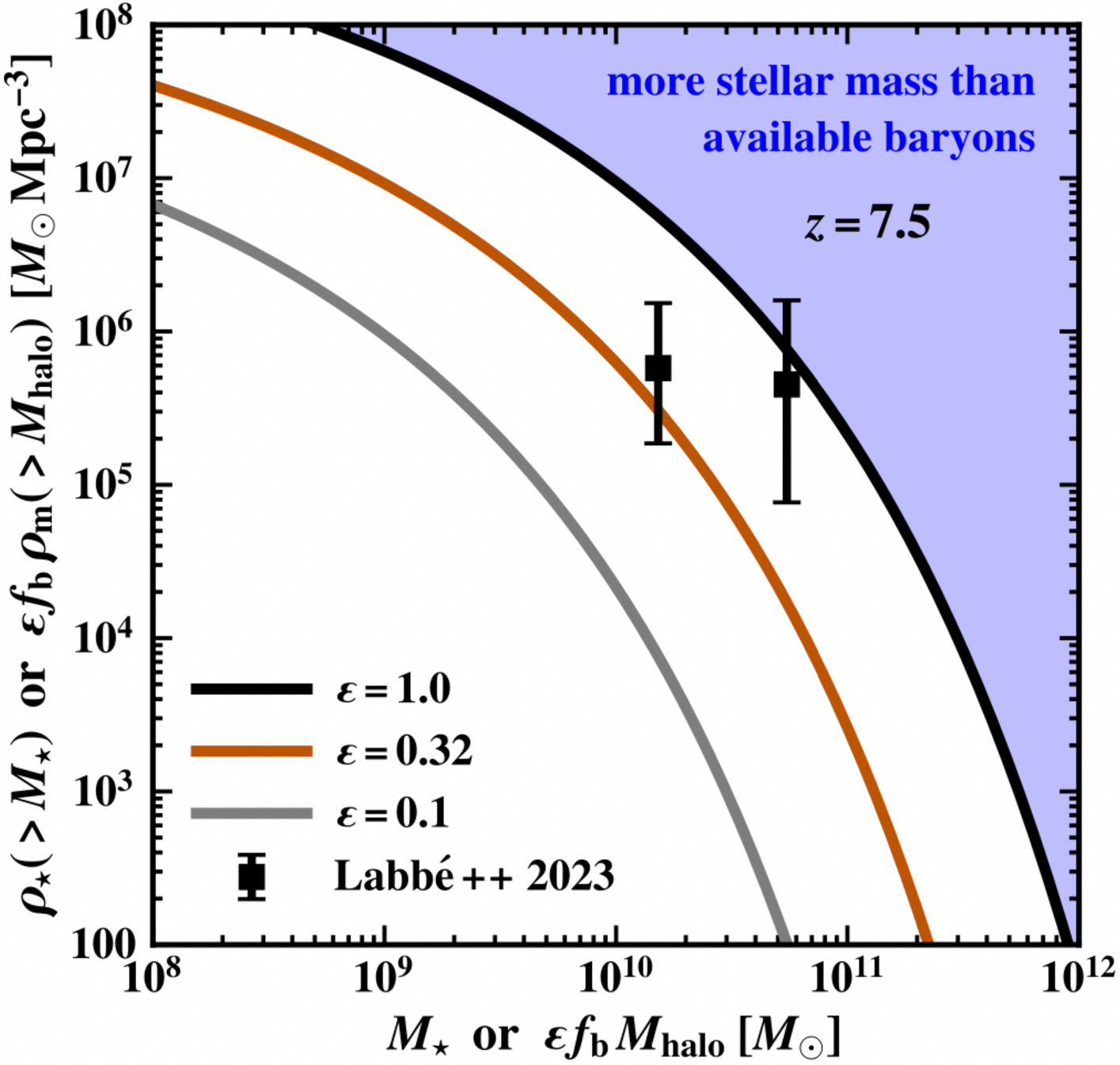
COSMOS

Ancient galaxies, so massive that they break modern cosmology, observed with JWST

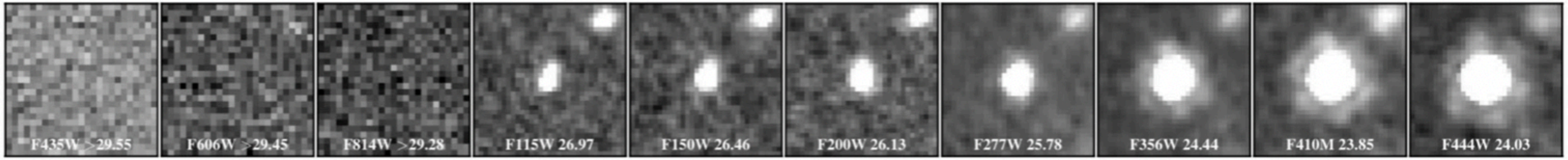
"too big to make sense of our current understanding of the universe"

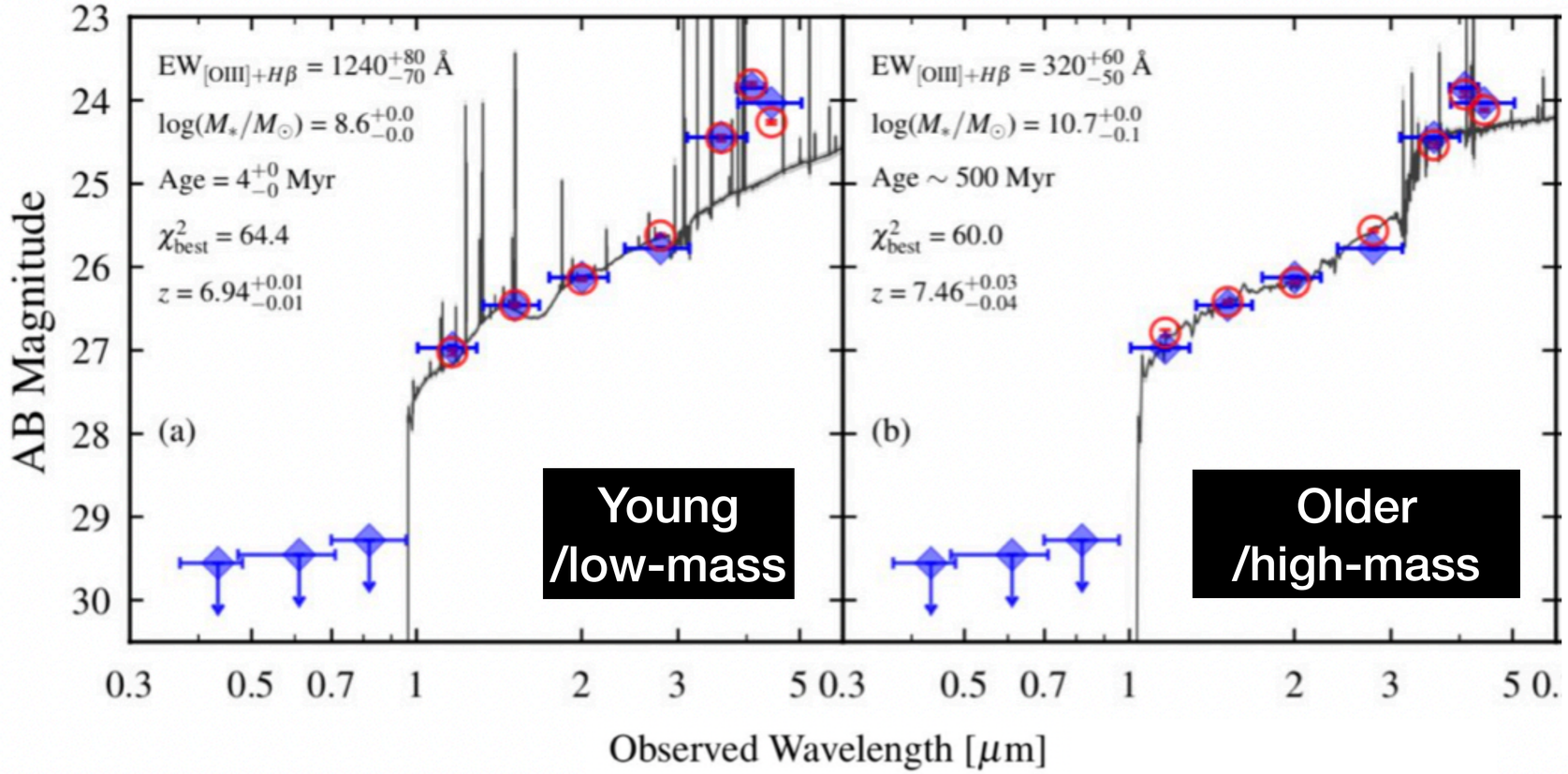
Lower stellar masses would make these detections much easier to understand…



Boylan-Kolchin 2023

Labbe sample as analyzed by Endsley et al. 2022





=> no need for extreme masses, ~10^{11} $M_\odot$, in contrast to Labbe et al.

Understanding expectations for nebular emission from similar galaxies at low-z is vital…

"strongly prefer a solution where the SED is dominated by a very young (≈4 Myr) stellar population yielding strong nebular line emission" ([OIII]+Hβ EW) >1500 Å

UVEX will provide a cosmologically-complete sample of galaxies down to the critical ~ $10^6 M_{sun}$ stellar mass scale

How does reionization affect galaxy formation?

What is the relationship between stars & dark matter in the most dark-matter dominated systems?

Are any field dwarfs quenched above the mass-scale of reionization quenching?