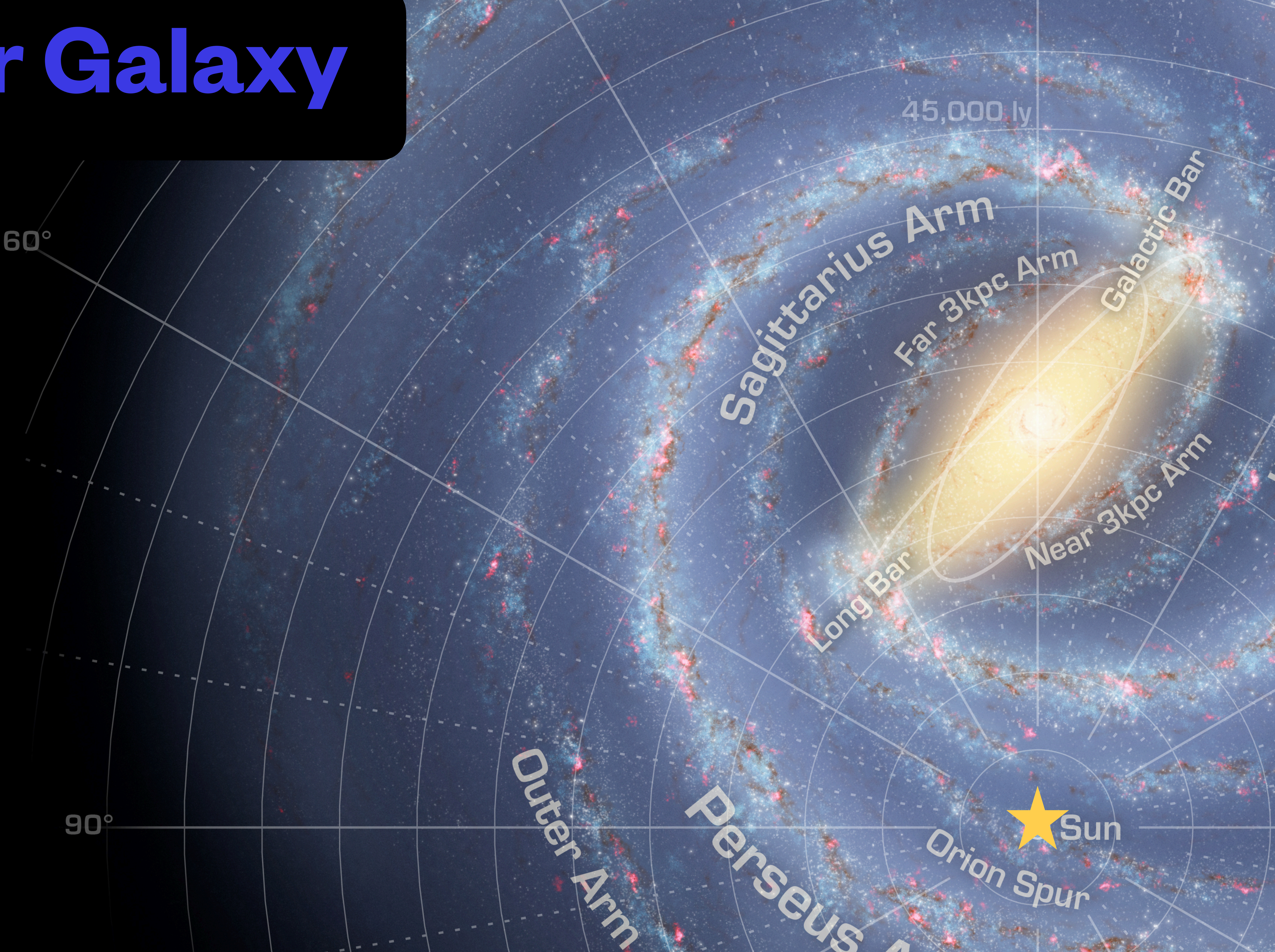
The Galactic Halo's Contribution to Inner Galaxy Stellar Populations

Maddie Lucey (UPenn)

The Inner Galaxy

The Inner Galaxy



The Inner Galaxy

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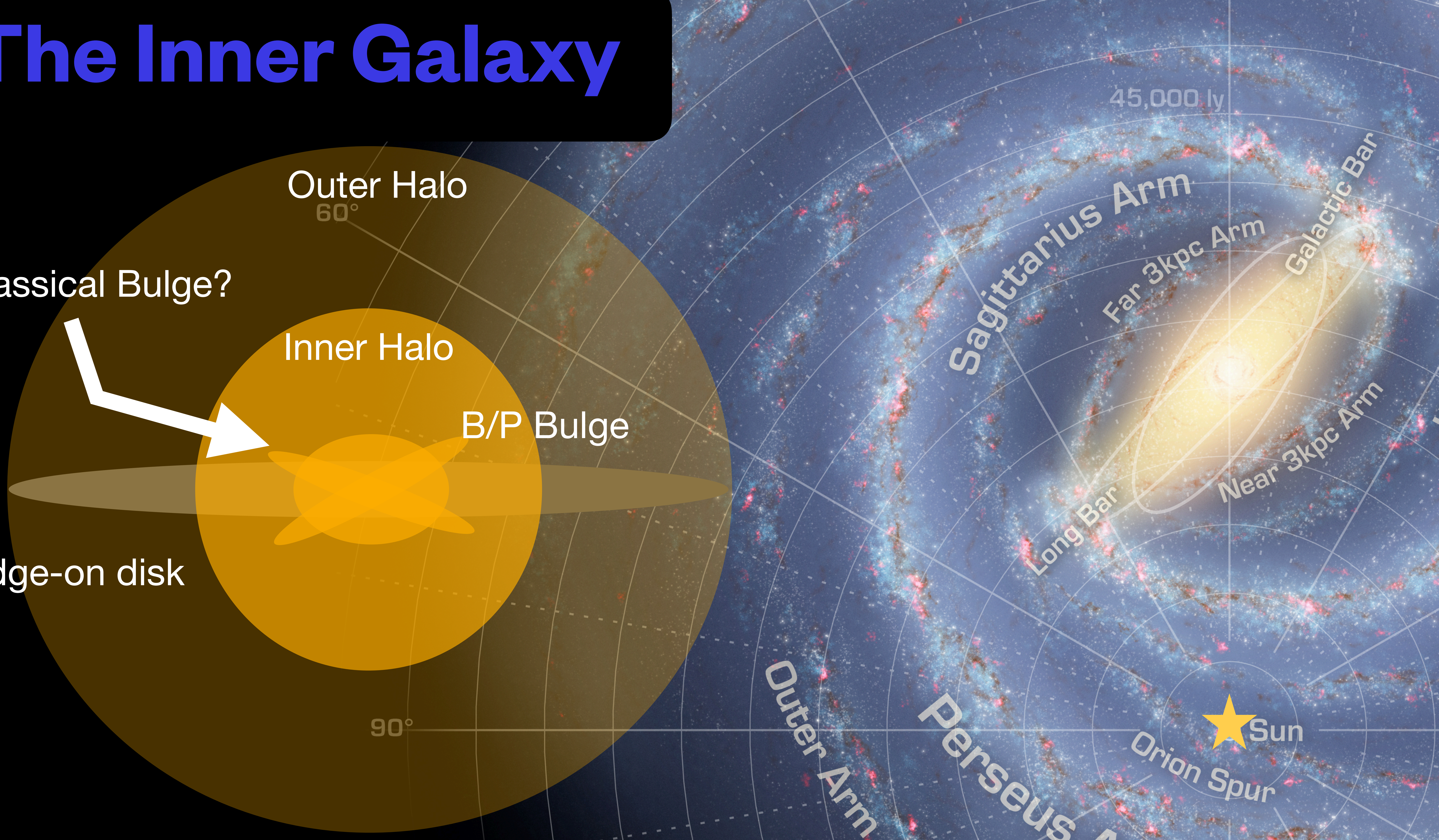
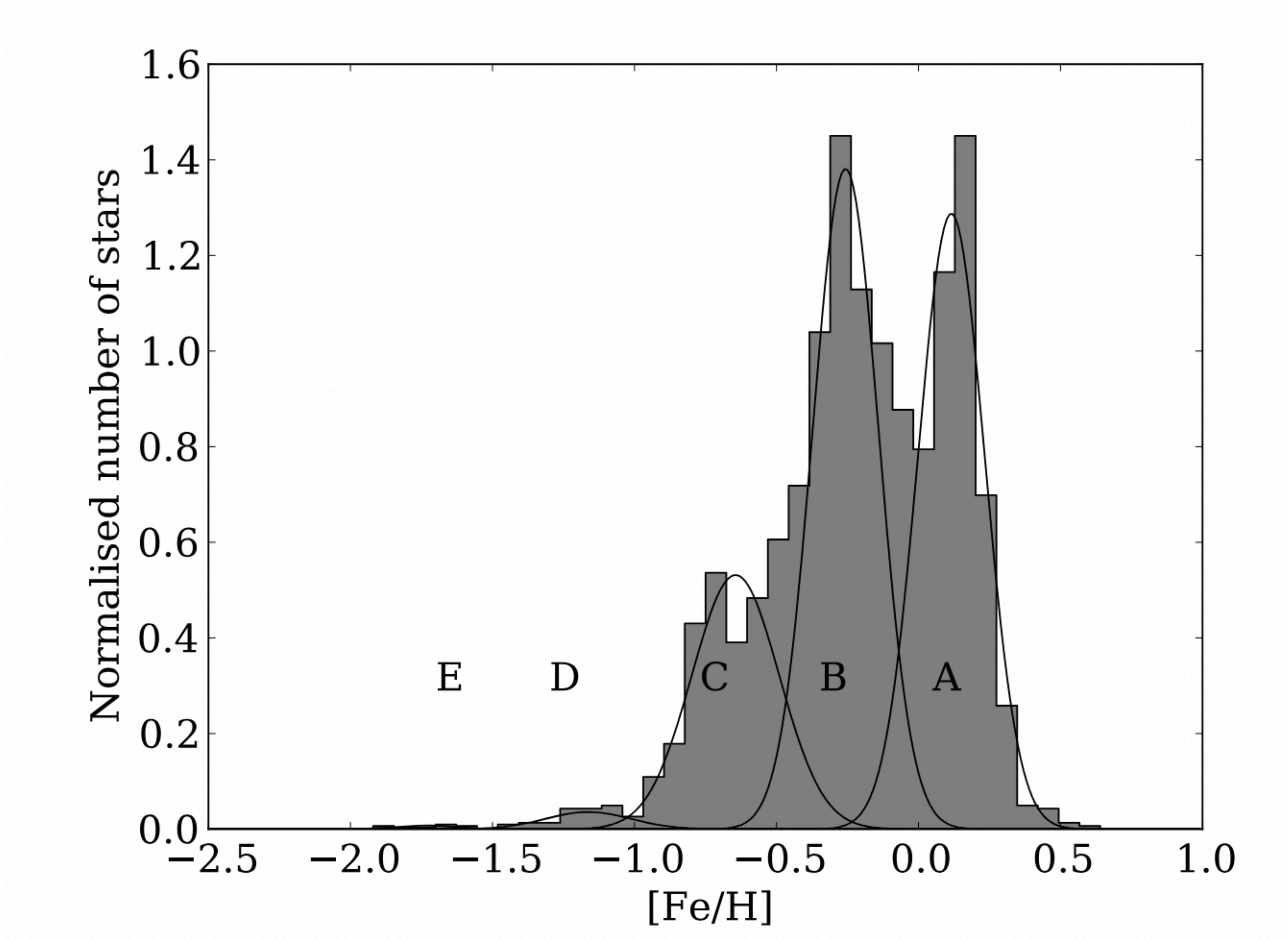
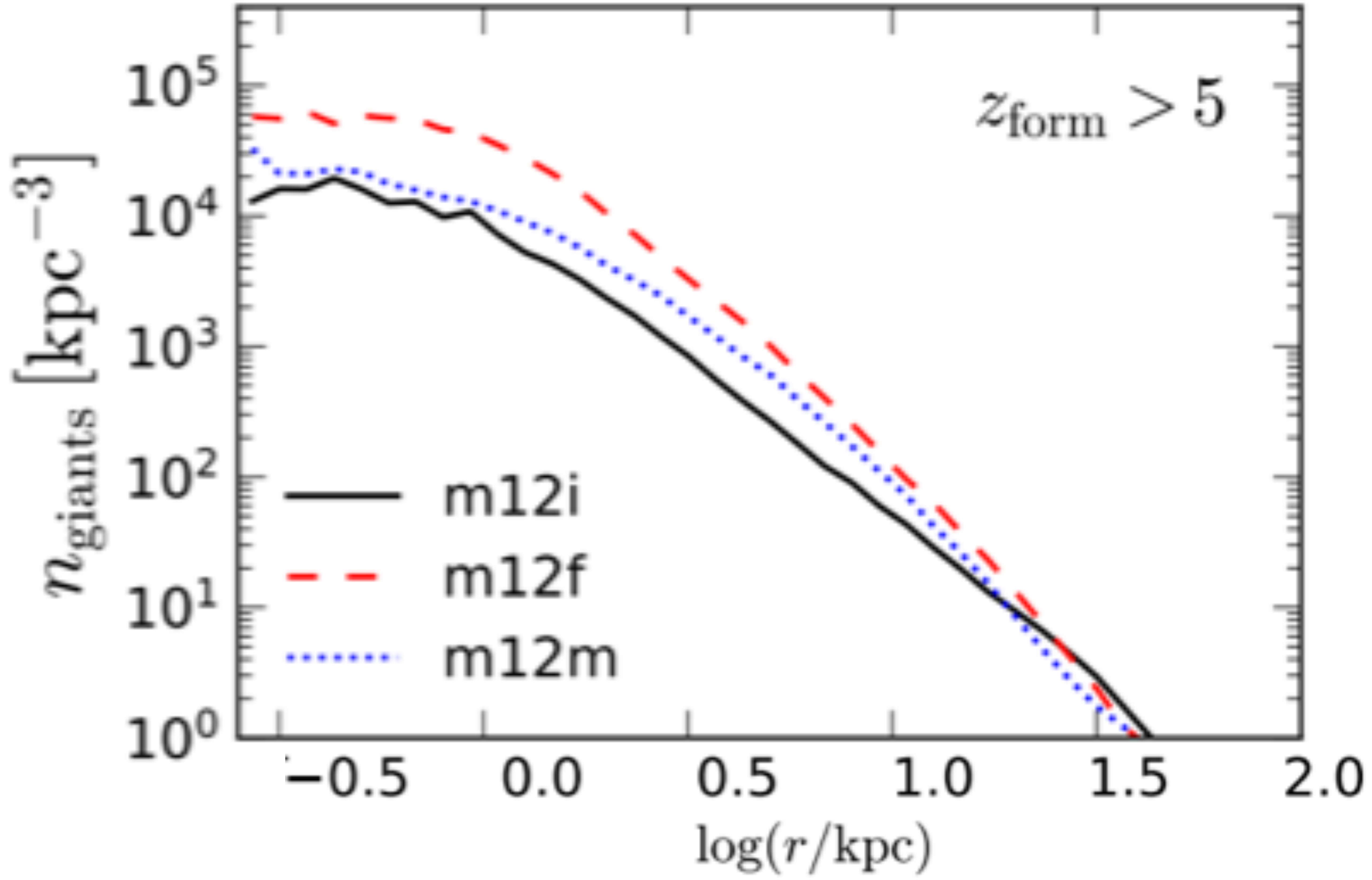


Metal-poor component is <5% of total stellar mass



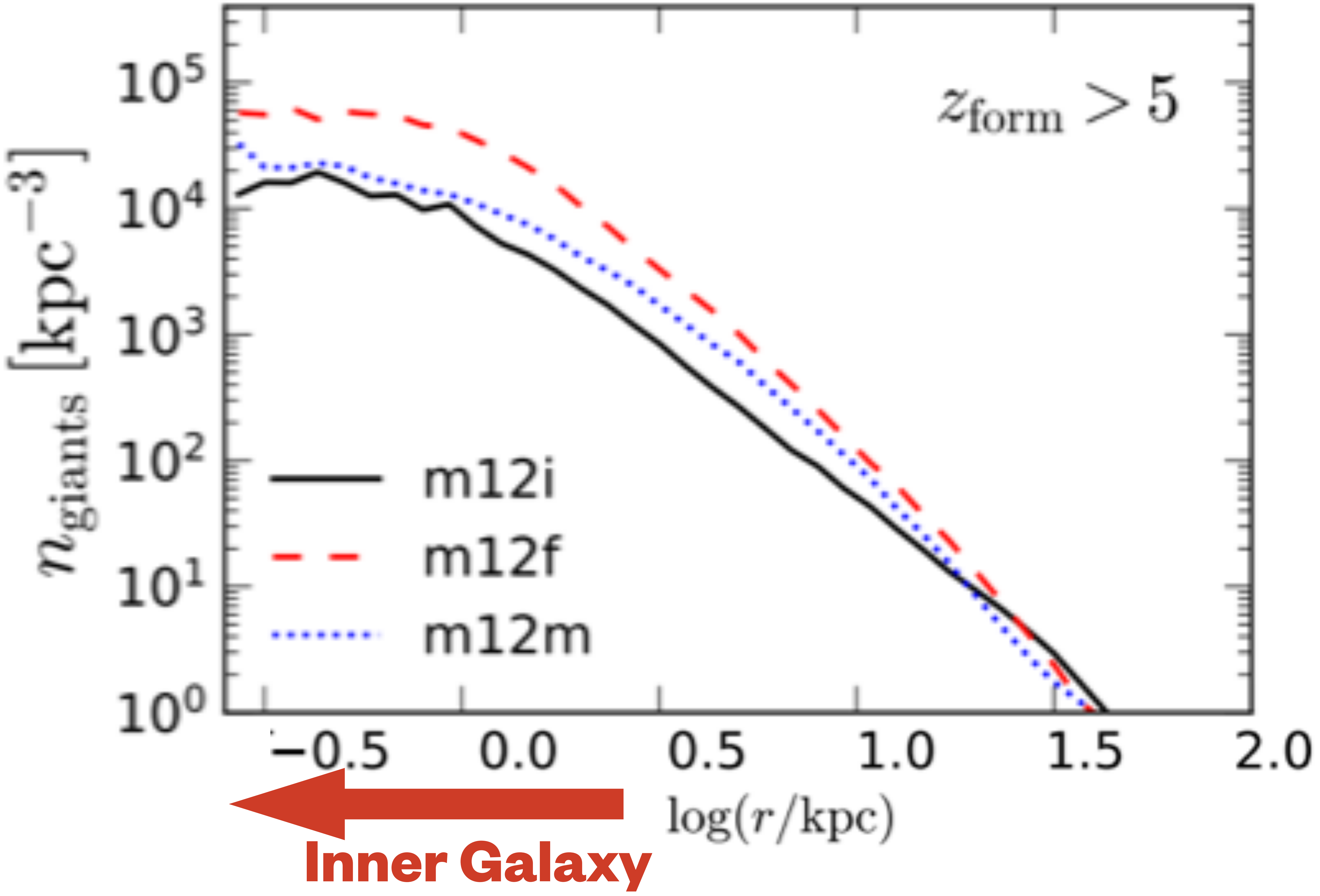
Ness+2013

Inner Galaxy is the new frontier for near-field cosmology



El-Badry+2018; FIRE simulations

Inner Galaxy is the new frontier for near-field cosmology



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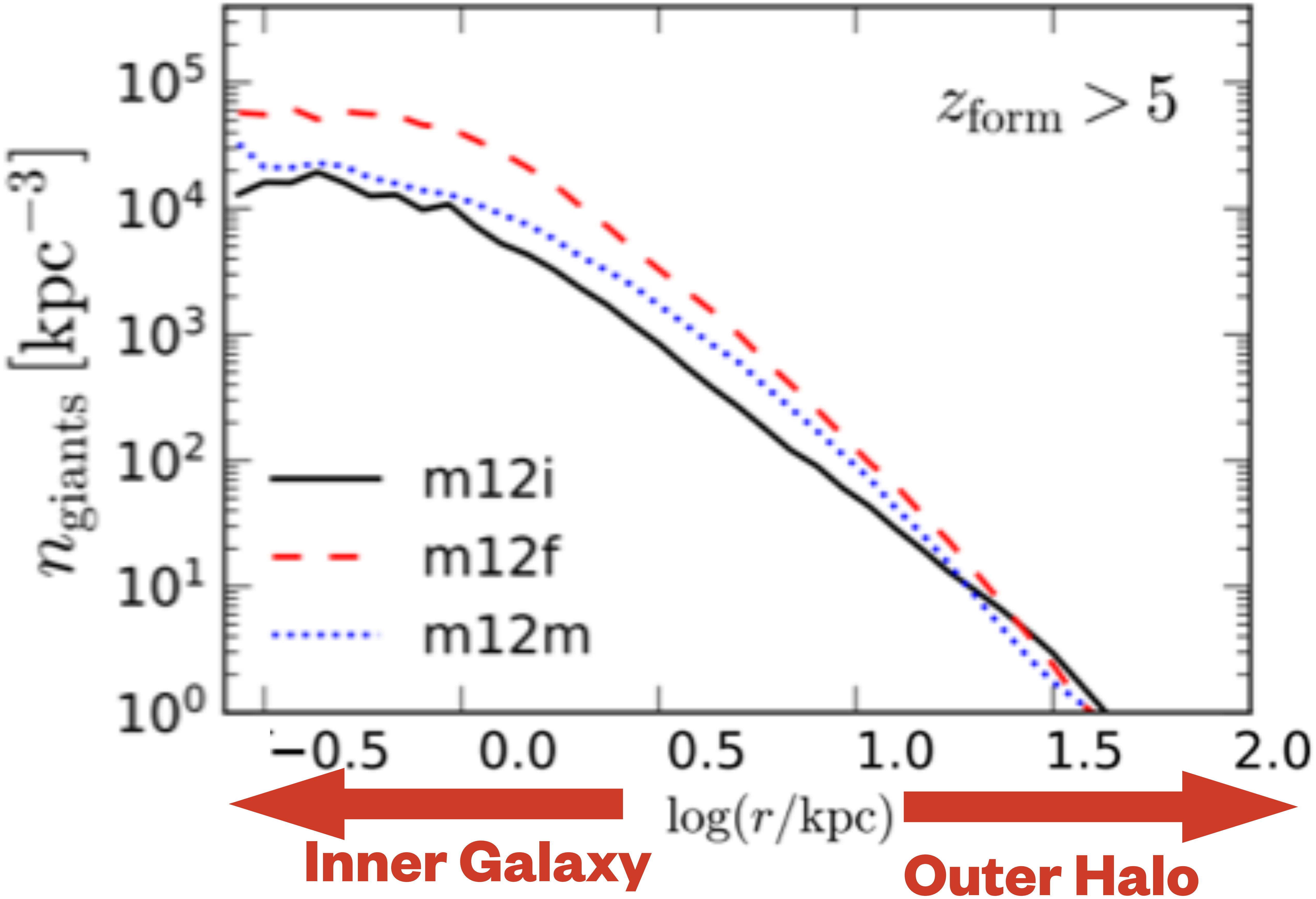

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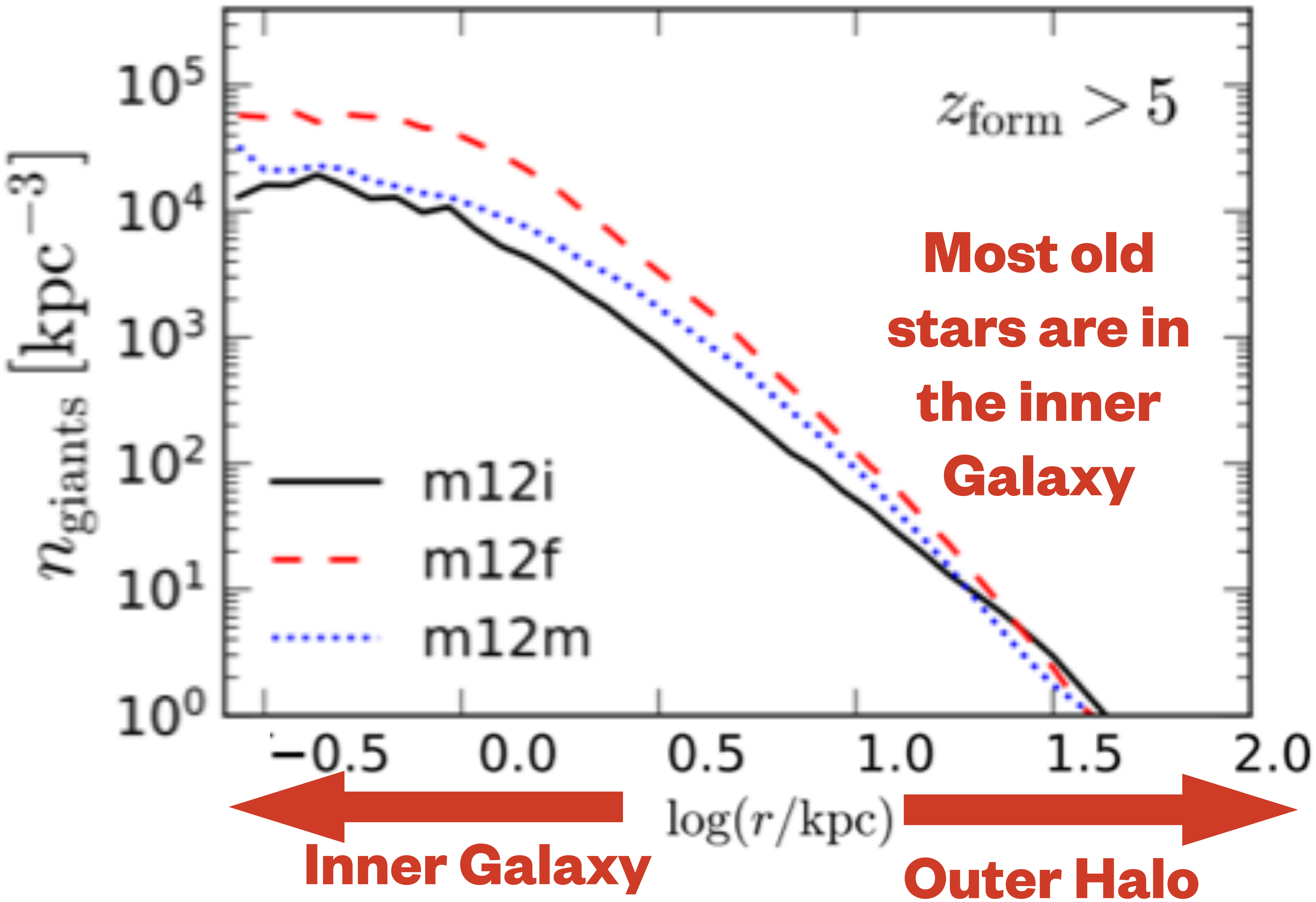

El-Badry+2018; FIRE simulations

The COMBS Survey: Chemical Origins of Metal-poor Bulge Stars

COMBS I:

Detailed chemical abundances of 26 metal-poor bulge stars using high resolution UVES spectra

Lucey+2019

COMBS II:

Dynamics and metallicity estimates of ~500 stars to determine bulge membership

Lucey+2021

COMBS III:

Chemical abundances of ~500 metal-poor bulge stars with mid-resolution GIRAFFE spectra

Lucey+2022a

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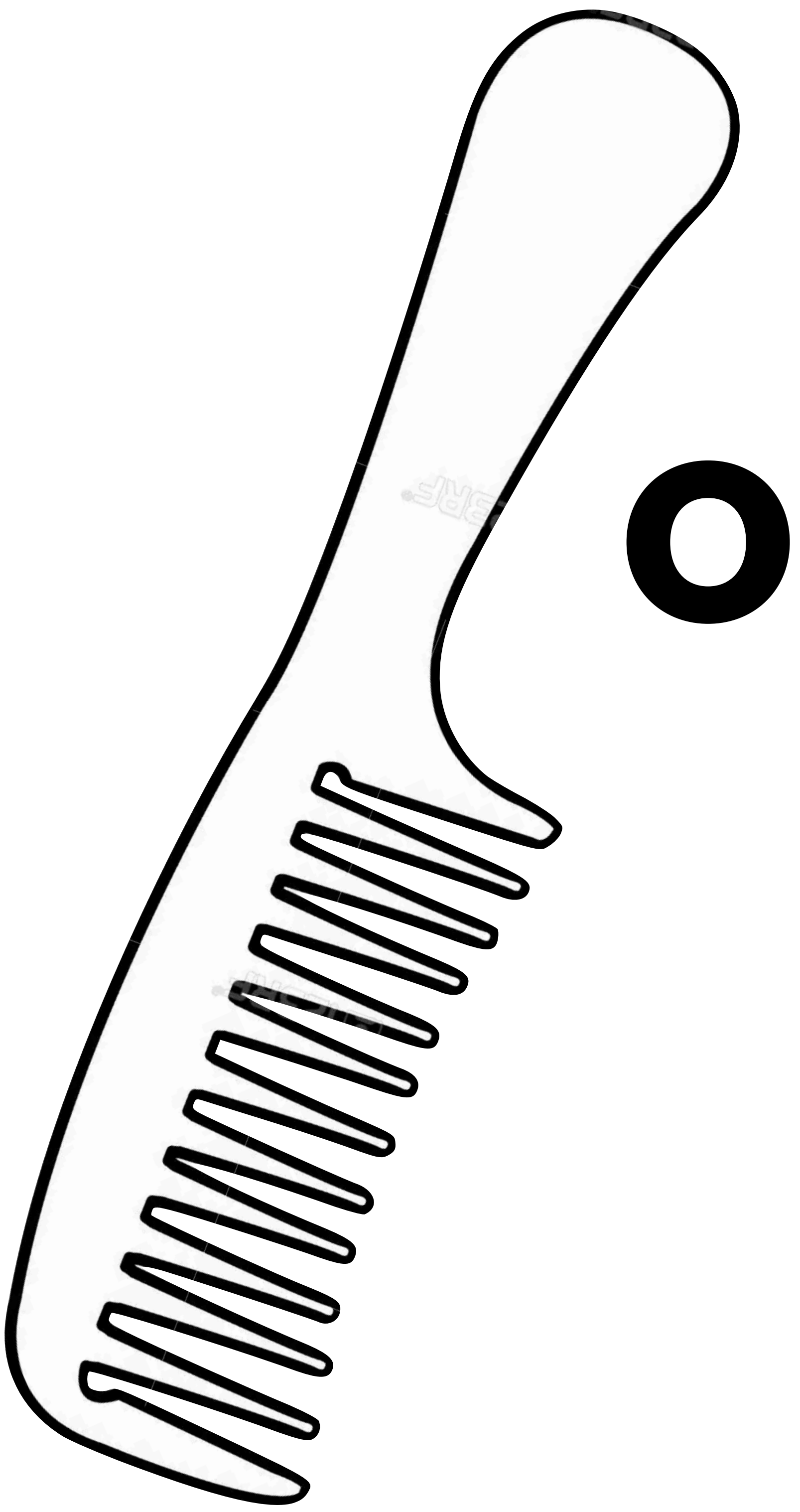
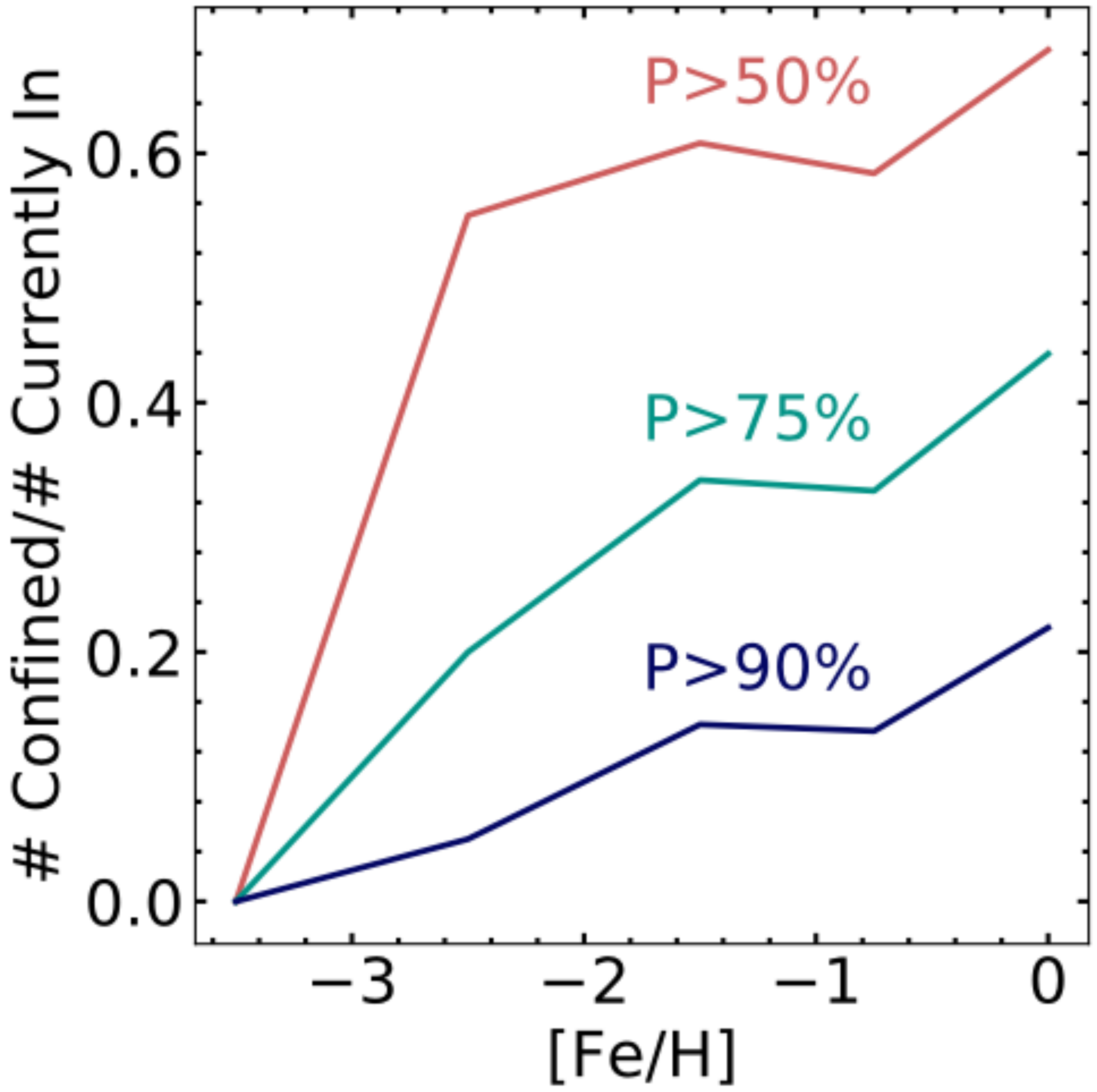
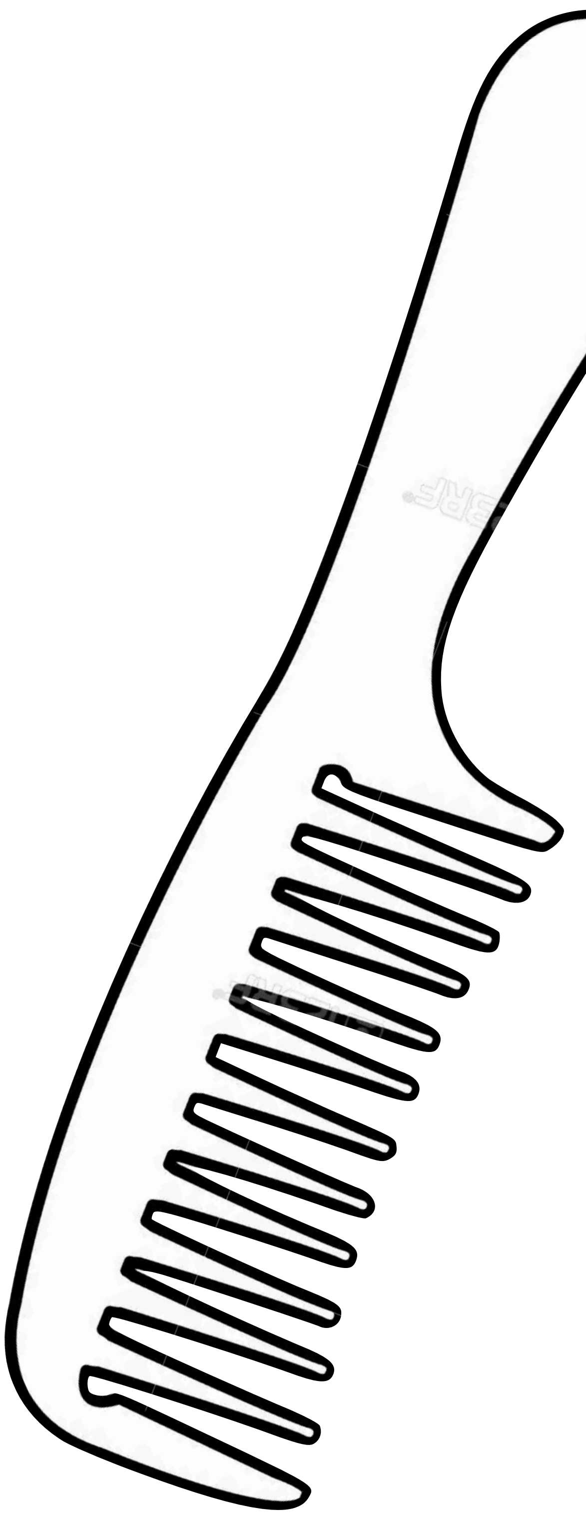


COMBS II Orbit Simulations

Bayesian
Probabilistic
Analysis



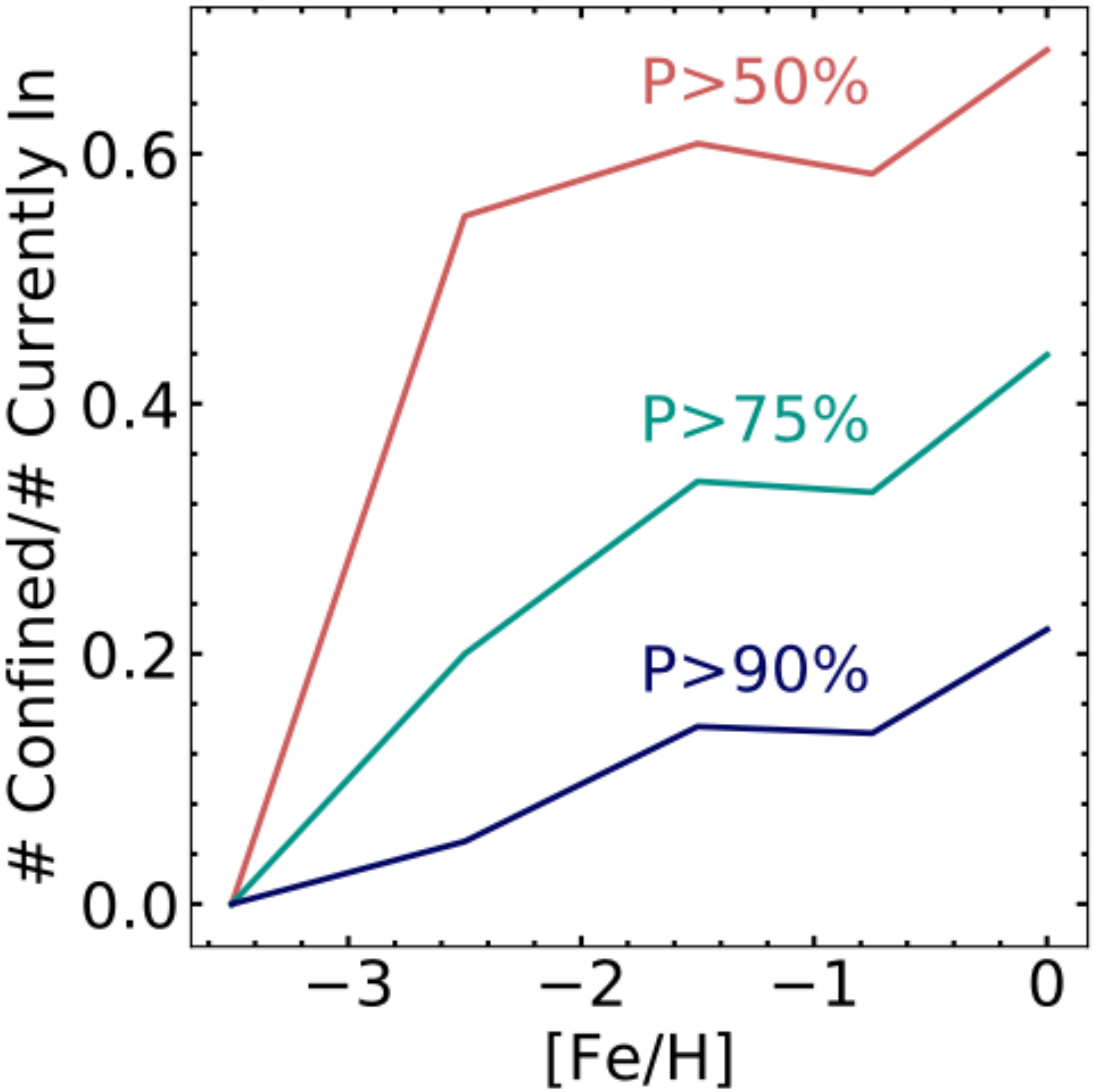
Lucey+2021



COMBS II
Orbit Simulations

Bayesian
Probabilistic
Analysis

Alice Burington-Luna
NSF Graduate
Research Fellow
University of
Chicago



Lucey+2021

How much halo do we expect in the inner Galaxy, and what does it mean?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and what does it mean?
Look to Cosmological Zoom-in Simulations…..

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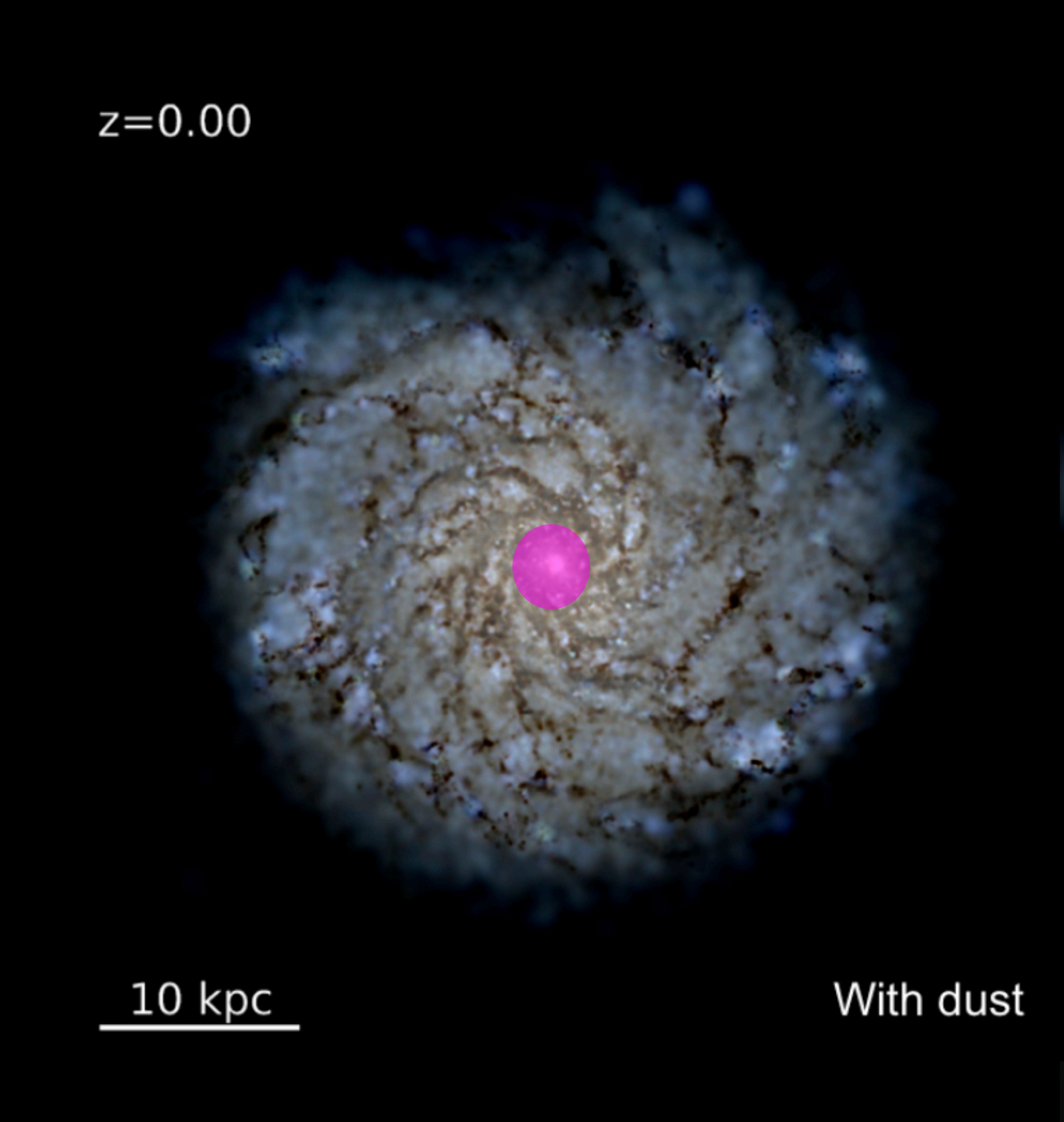
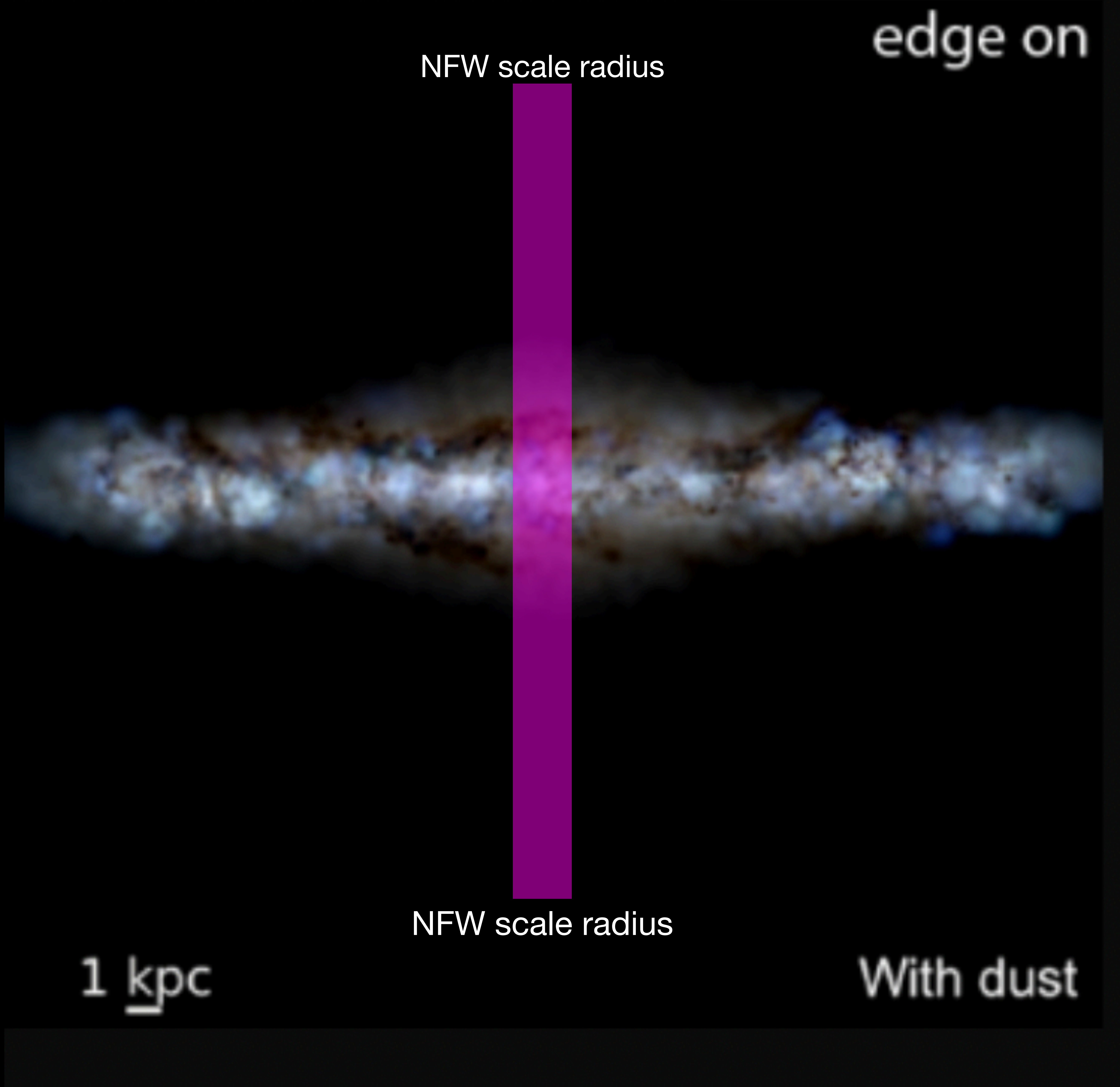
Look to Cosmological Zoom-in Simulations…..

Specifically,
FIRE-2 and Auriga

How to define the inner halo….



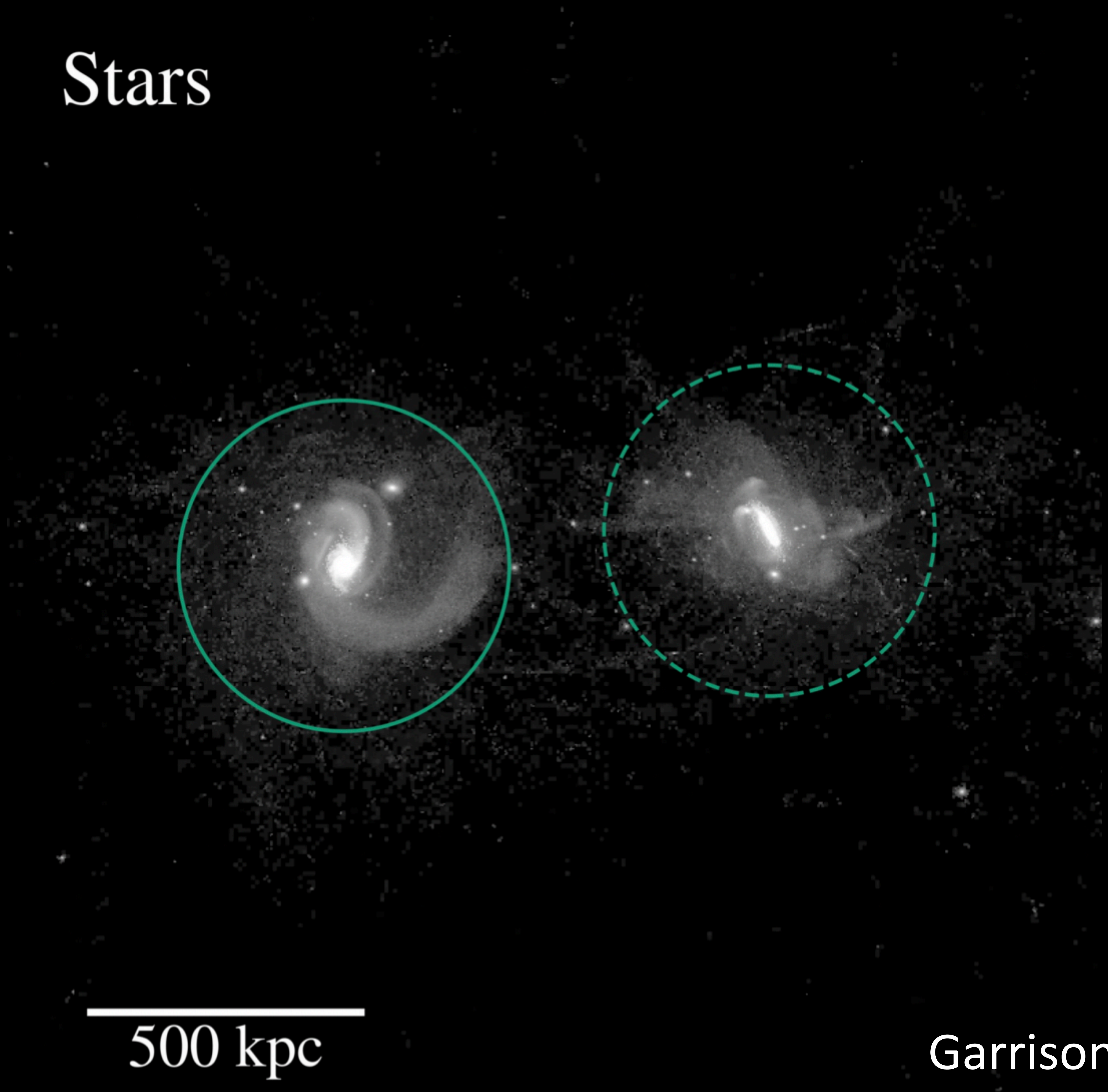


Cosmological Zoom-in Simulations…..

1. FIRE-2 Isolated
   7 galaxies

2. FIRE-2 Pairs
   3 set of pairs
   6 galaxies

3. Auriga
   7 galaxies

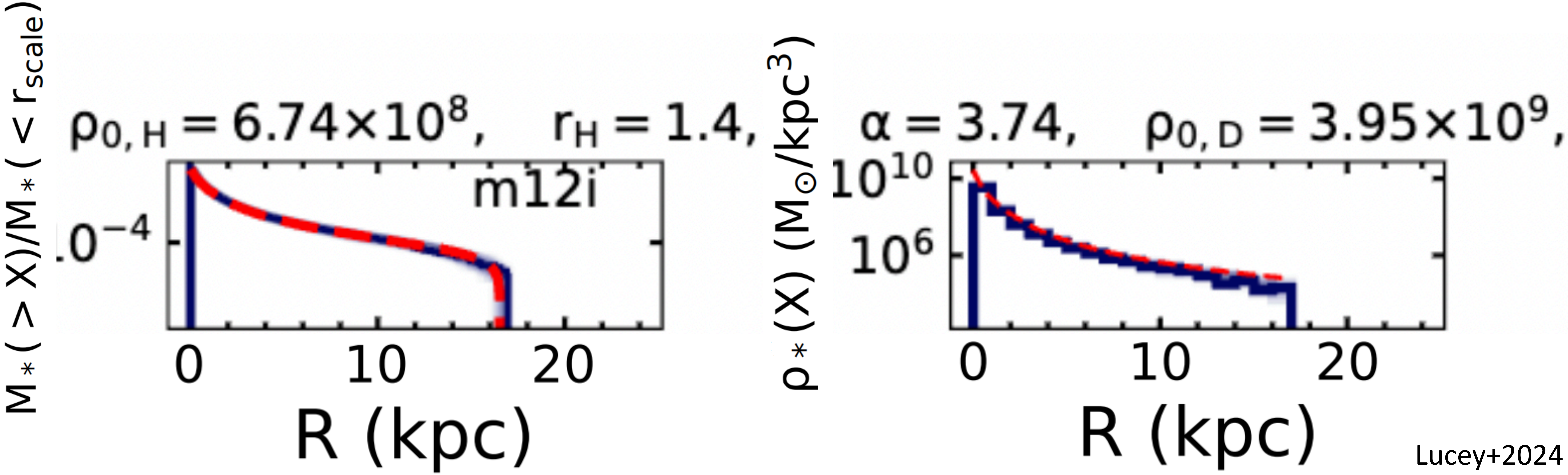


Garrison-Kimmel+2019

Simulation(s)	Year	Code	Technique	SMBH Feedback	M_{DM} [$M_\odot$]	M_{baryon} [$M_\odot$]
Auriga L3	2017	AREPO	zoom	yes	5×10^4	6×10^3
FIRE-2 Suite	2017	GIZMO	zoom	no	3.5×10^4	7.1×10^3

Parameterization of stellar density profile

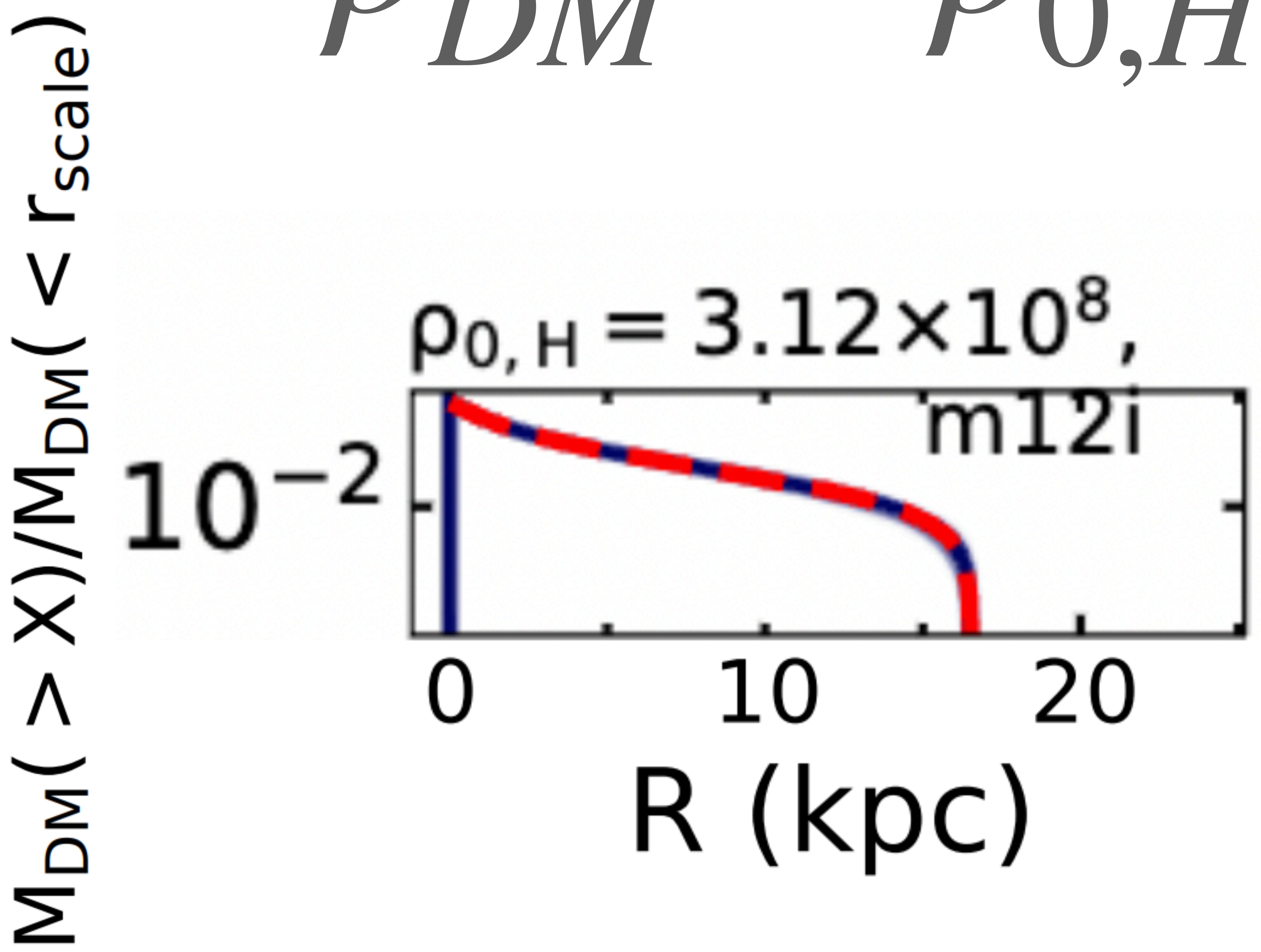
$$\rho_* = \rho_{0,D} e^{-r/r_D} + \rho_{0,H}/(1 + (r/r_H)^{\alpha})$$

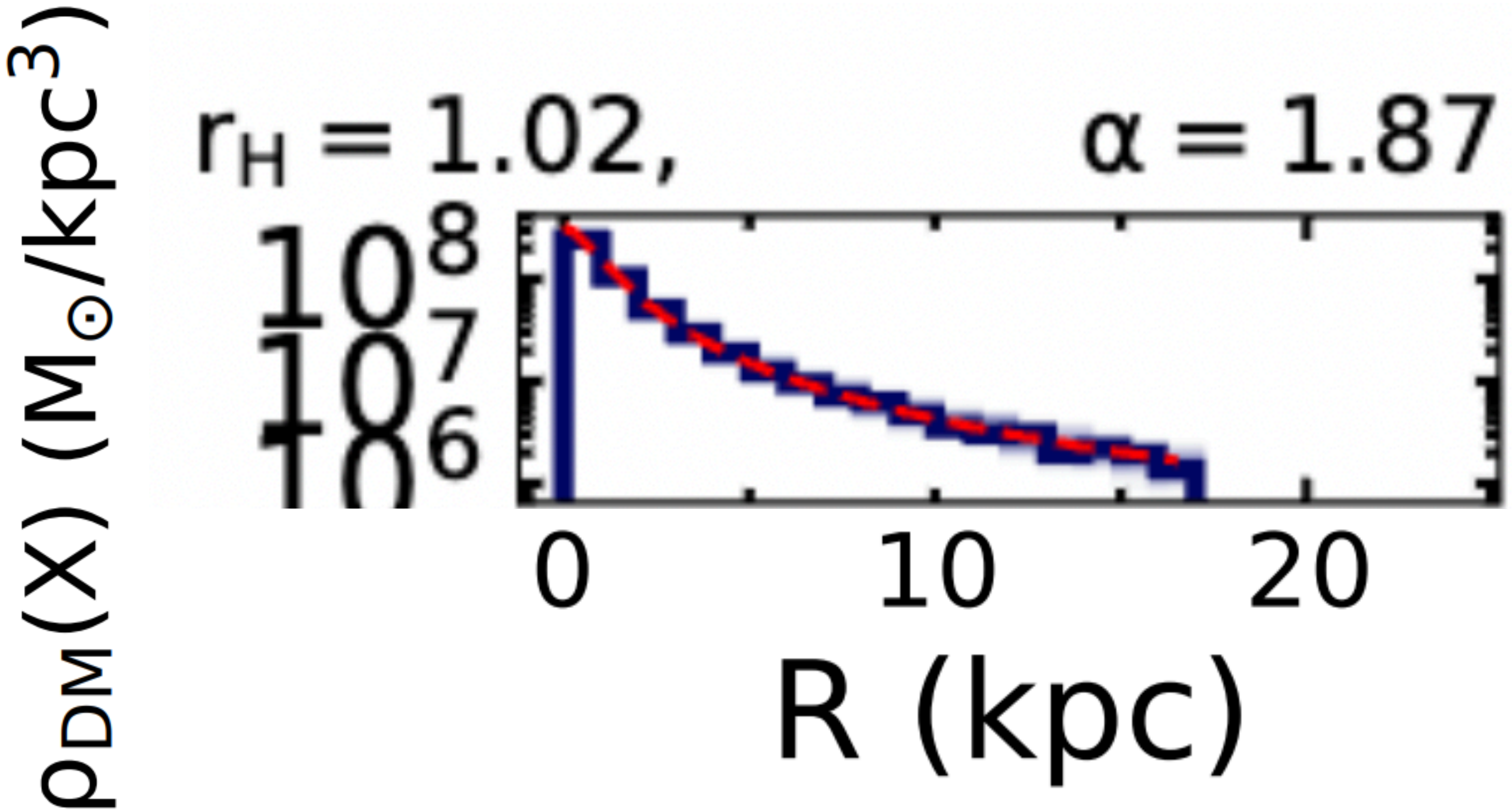


Lucey+2024

Parameterization of dark matter density profile

$$\rho_{DM} = \rho_{0,H}/(1 + (r/r_H)^{\alpha})$$



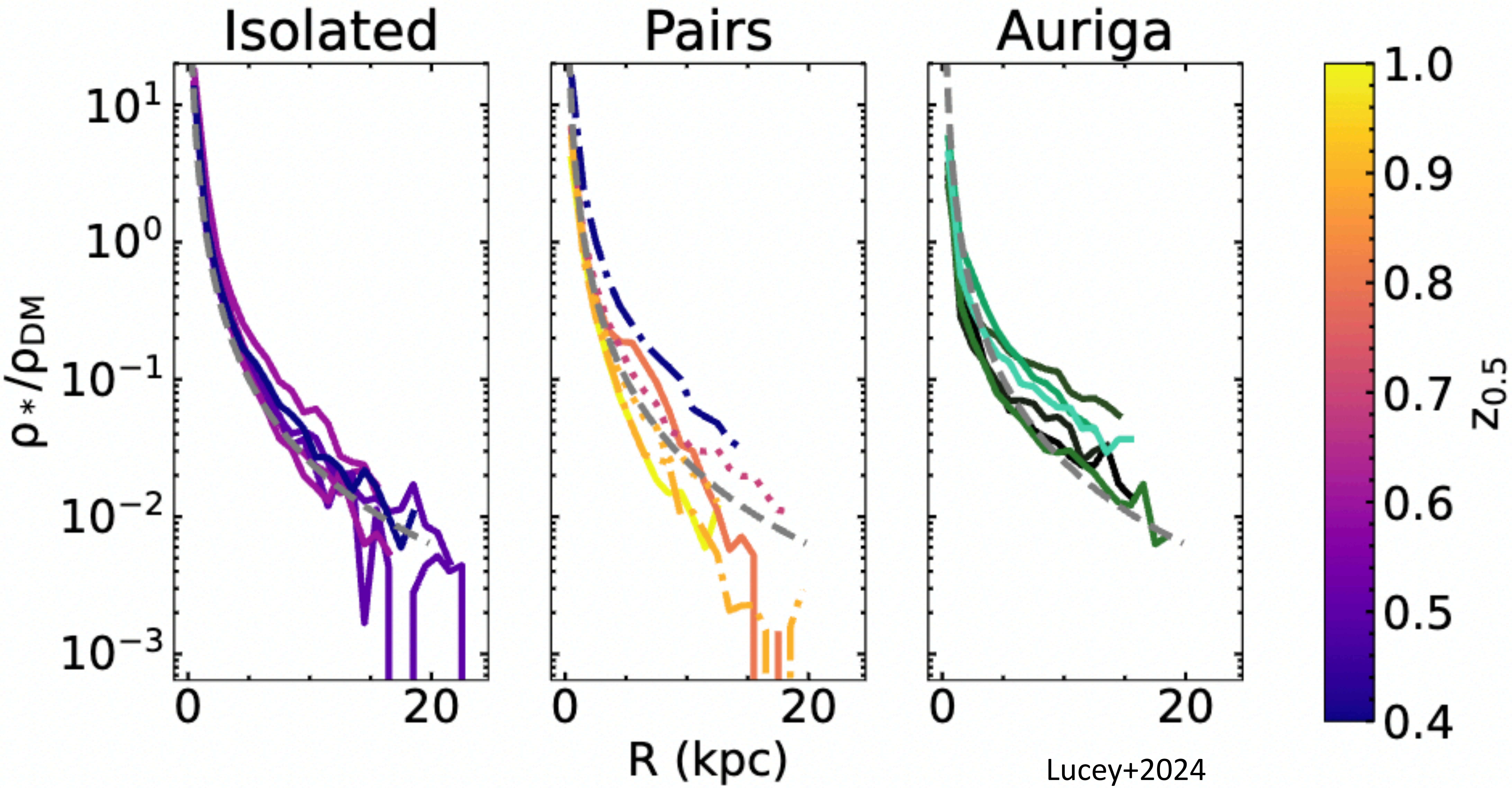


Lucey+2024

Strongest correlation is with the dark matter profile

Lucey+2024

Ratio of stellar to dark matter mass falls off as $1/R^2$



Lucey+2024

Summary of Conclusions

Inner Galaxy Metal-Poor stars inform earliest epochs of Milky Way formation

Most very metal-poor stars in the inner Galaxy are actually just halo interlopers

Lucey+2021

Inner minor-axis stellar density profile is uncorrelated with accretion history but instead follows the dark matter potential well

Lucey+2024