

Exploring the Local Volume in Simulations: Results from the ELVIS Suite

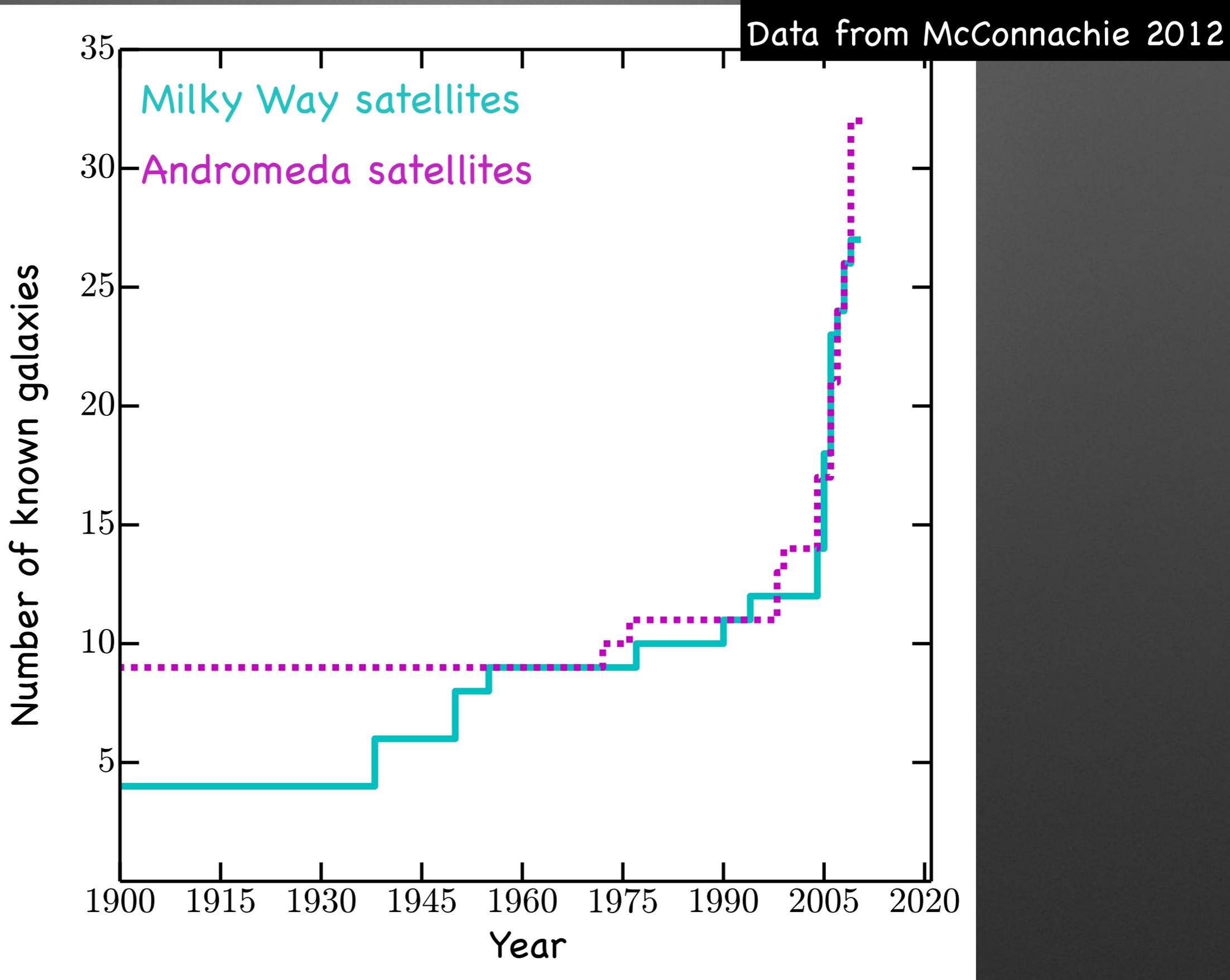
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University of California, Irvine

with: Mike Boylan-Kolchin,
James Bullock, and Kyle Lee

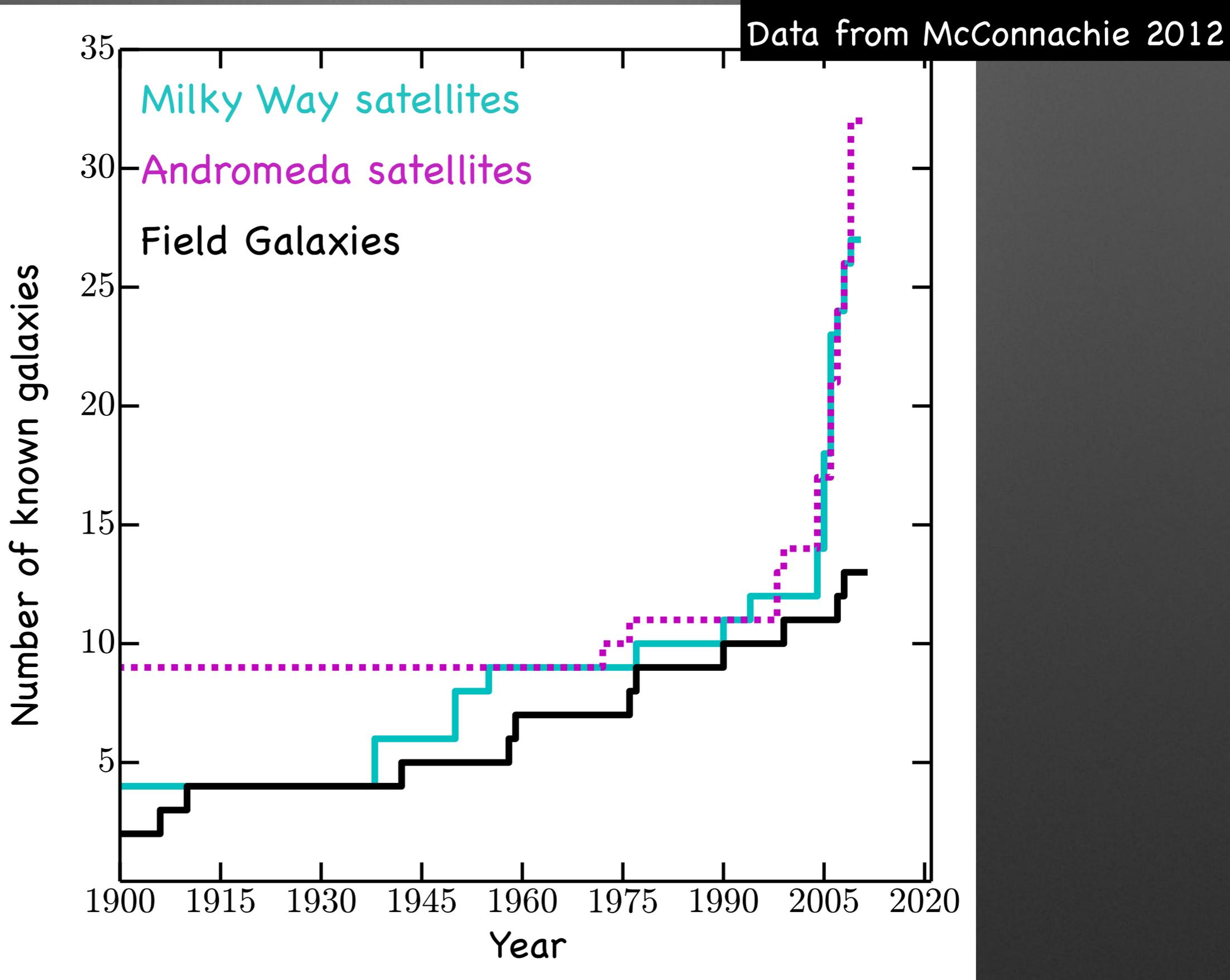


Leibniz-Institut für
Astrophysik Potsdam

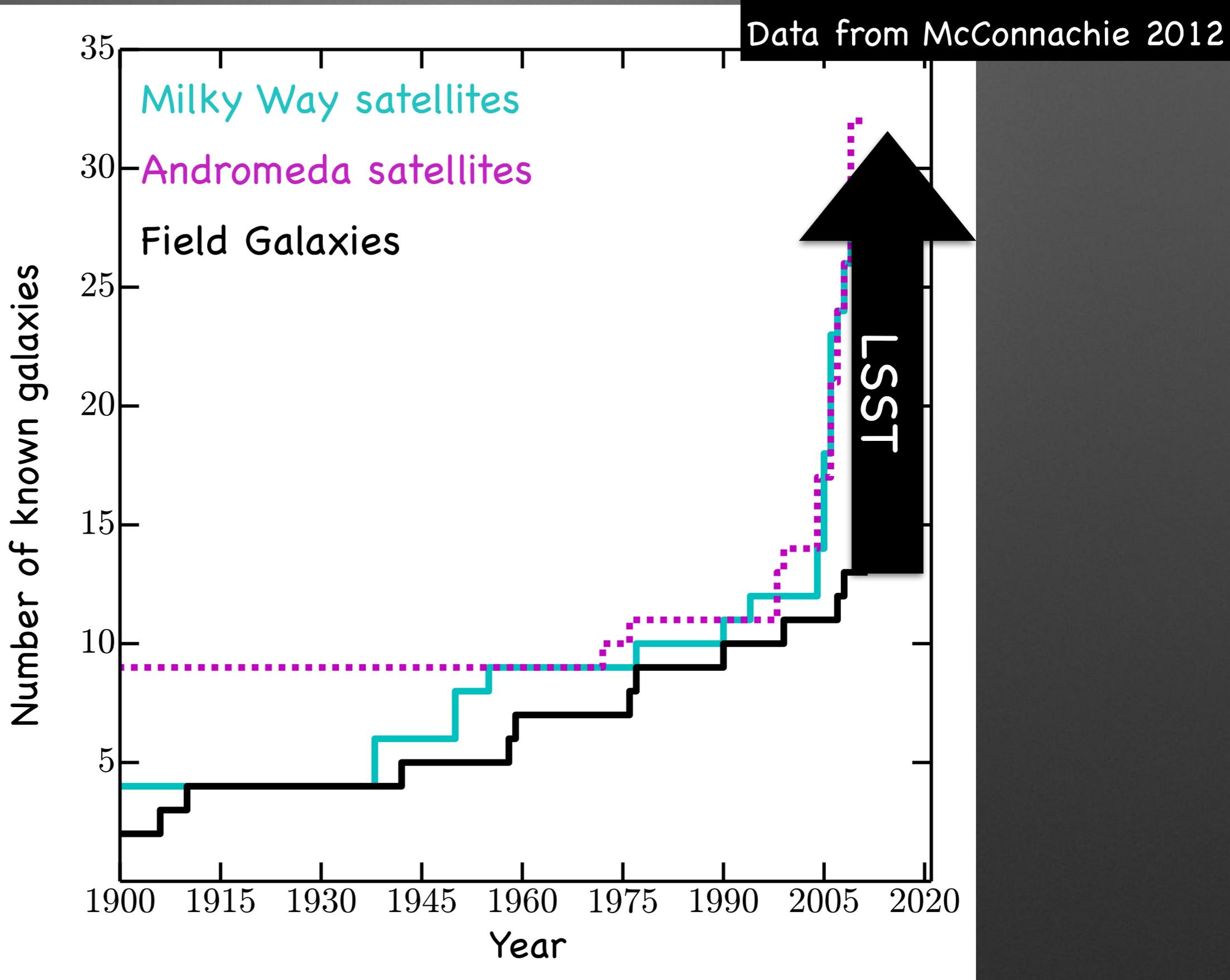
The increasingly-less-Local Group



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The increasingly-less-Local Group



ELVIS: Exploring the Local Group

- ✦ **Twenty-four** paired halos in **LG-like** pairs
- ✦ **Twenty-four** mass-matched **isolated** analogues
- ✦ Spans the suggested parameter space for the LG

$$\text{e.g., } 1.02 \times 10^{12} M_{\text{sun}} \leq M_v \leq 2.86 \times 10^{12} M_{\text{sun}}$$

- ✦ Reliably identify halos expected to host the ultra-faint dwarf satellites ($M_{\text{peak}} = 6 \times 10^7 M_{\text{sun}}$)
- ✦ Up to **15 million** particles within R_v and up to **61 million** within uncontaminated regions, which are as large as **43 Mpc^3**

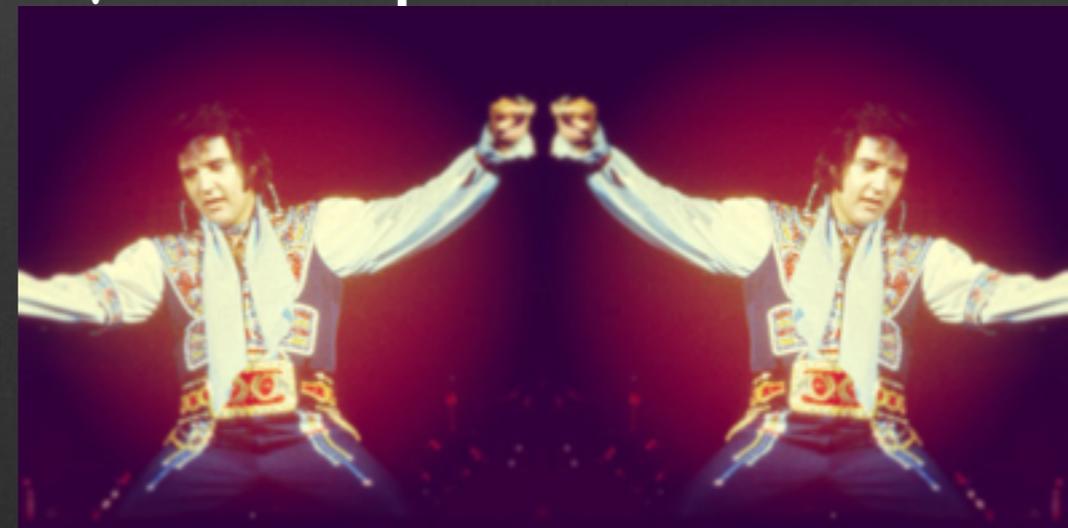


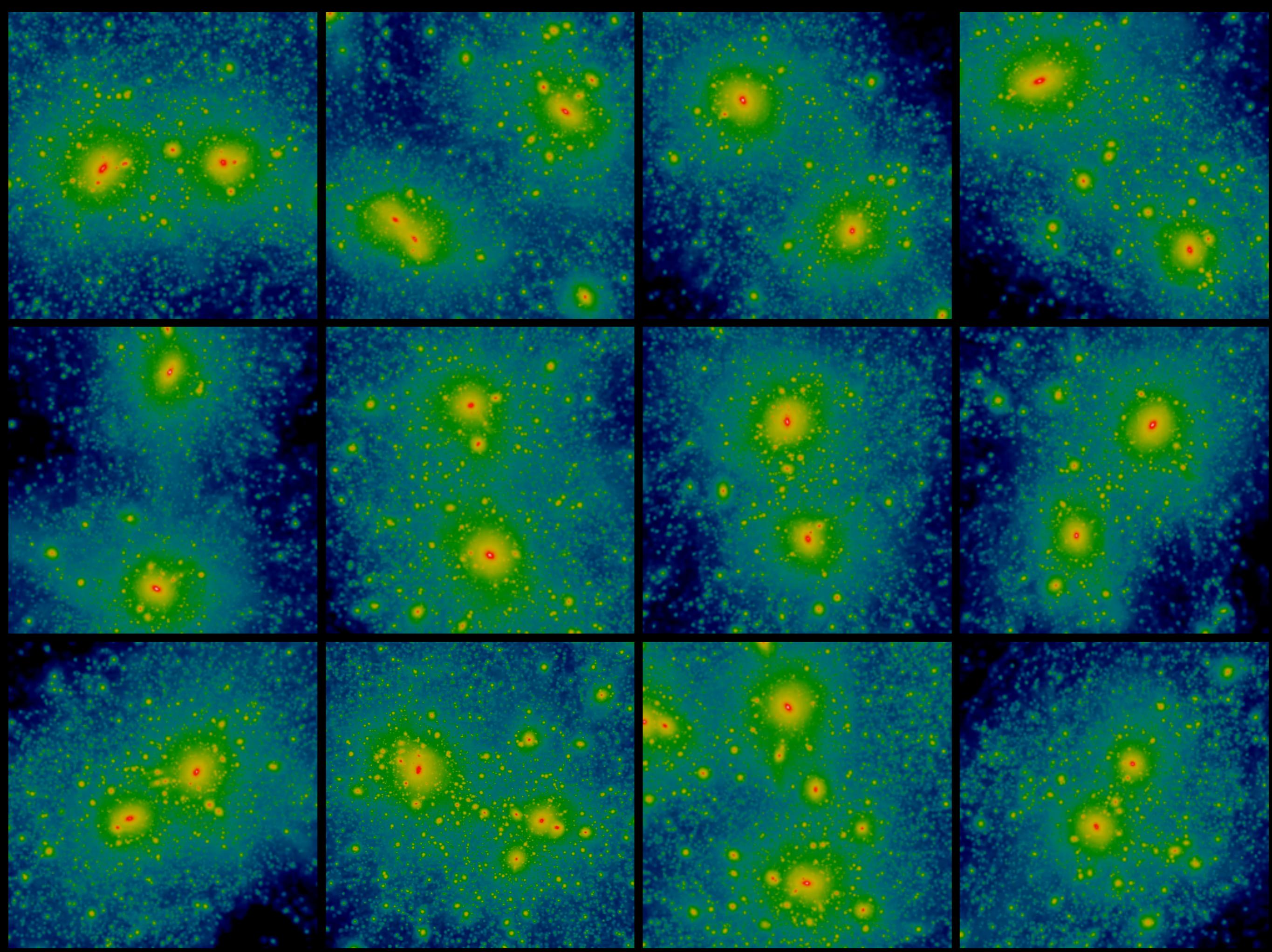
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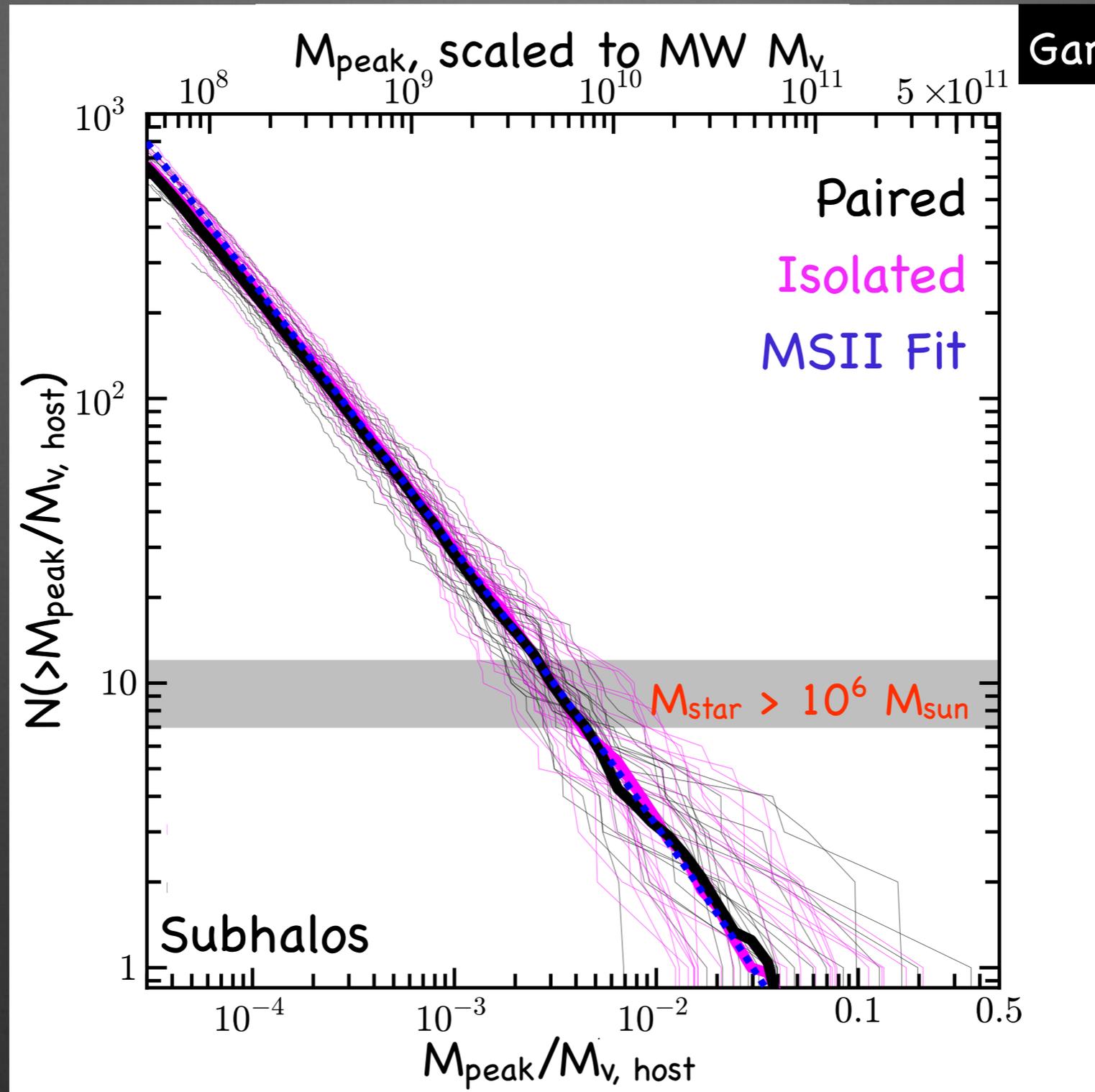
All of the ELVIS data are publicly available at
localgroup.ps.uci.edu/elvis/data.html

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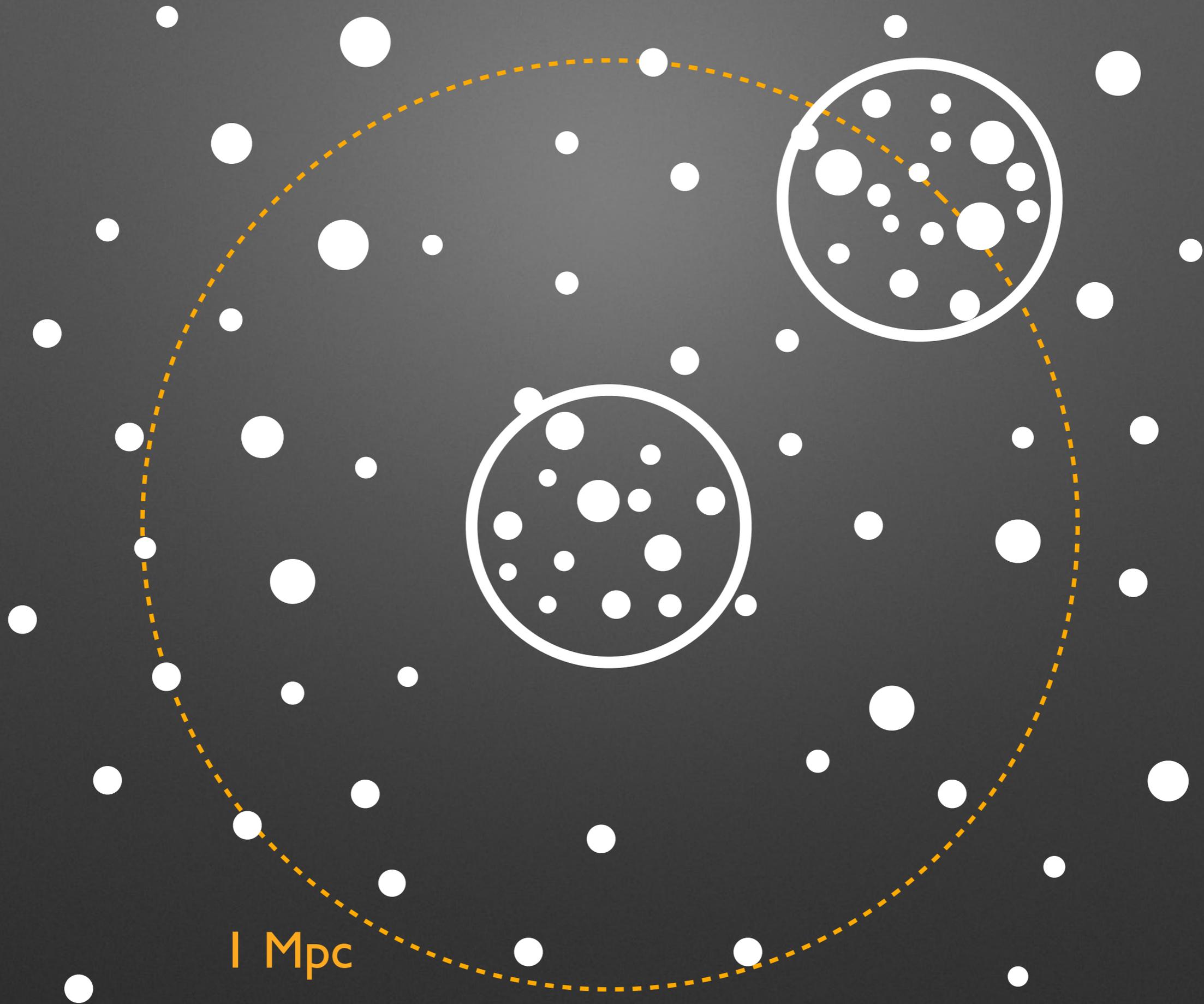




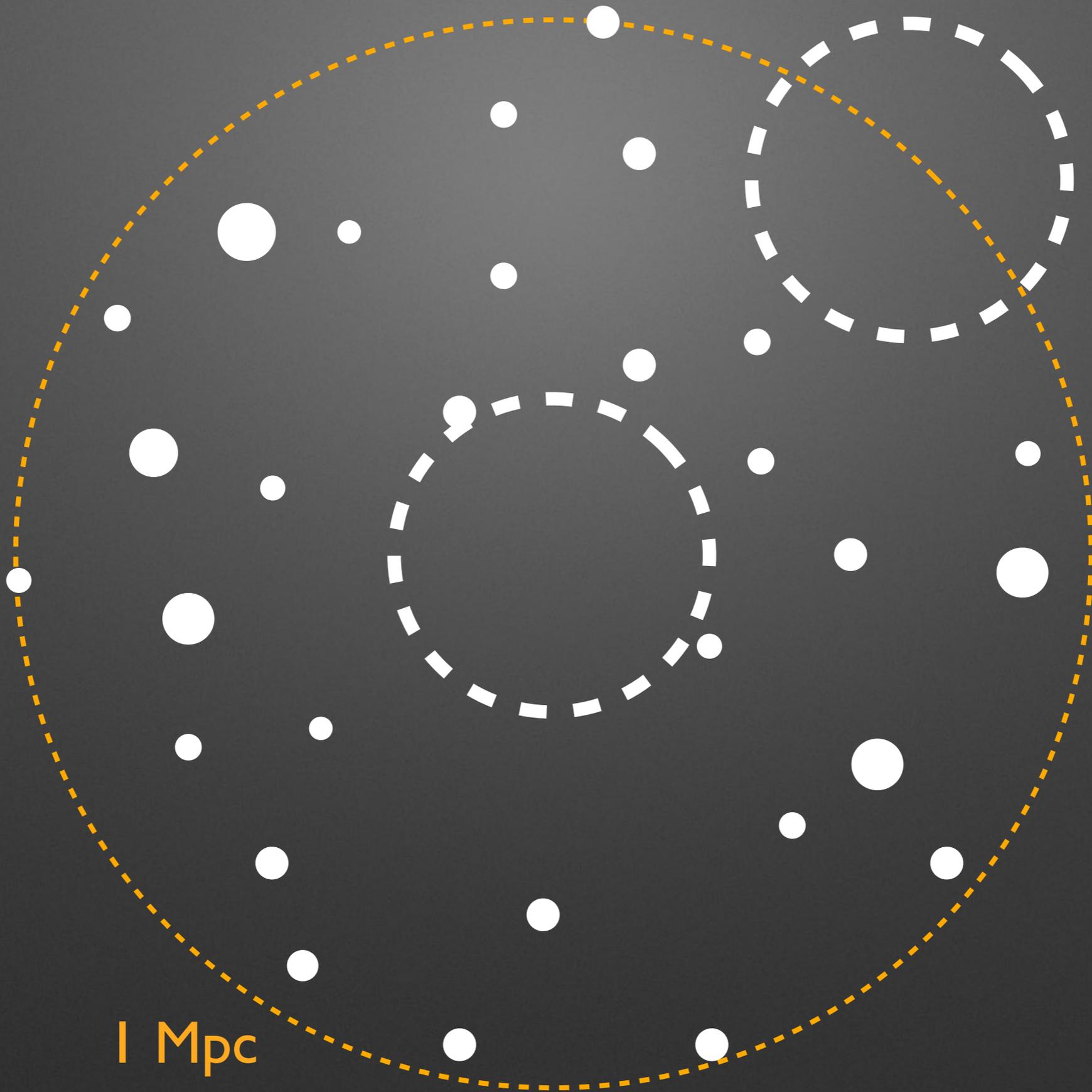
Subhalo mass functions in ELVIS



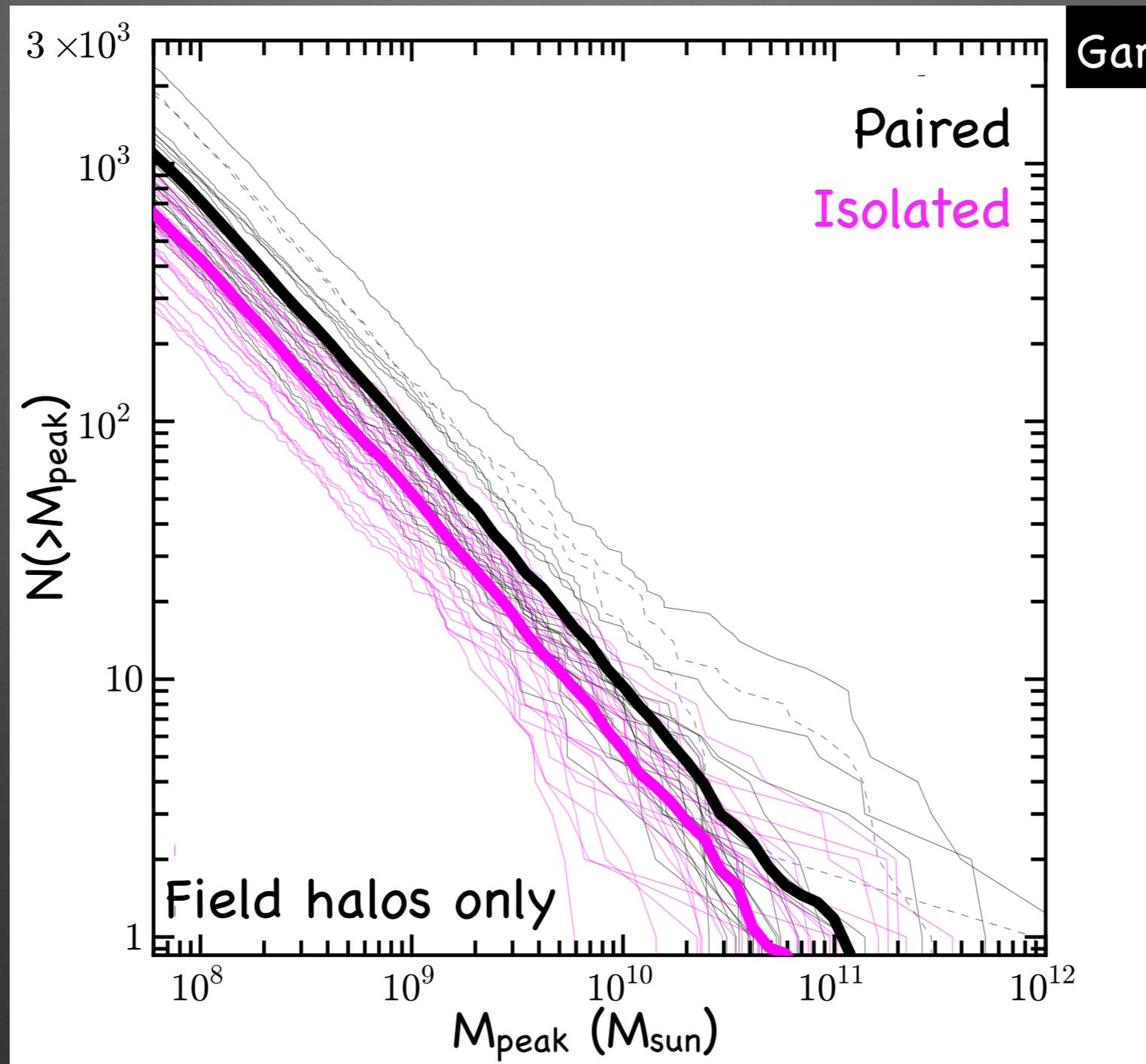
Normalized subhalo mass functions agree perfectly



1 Mpc

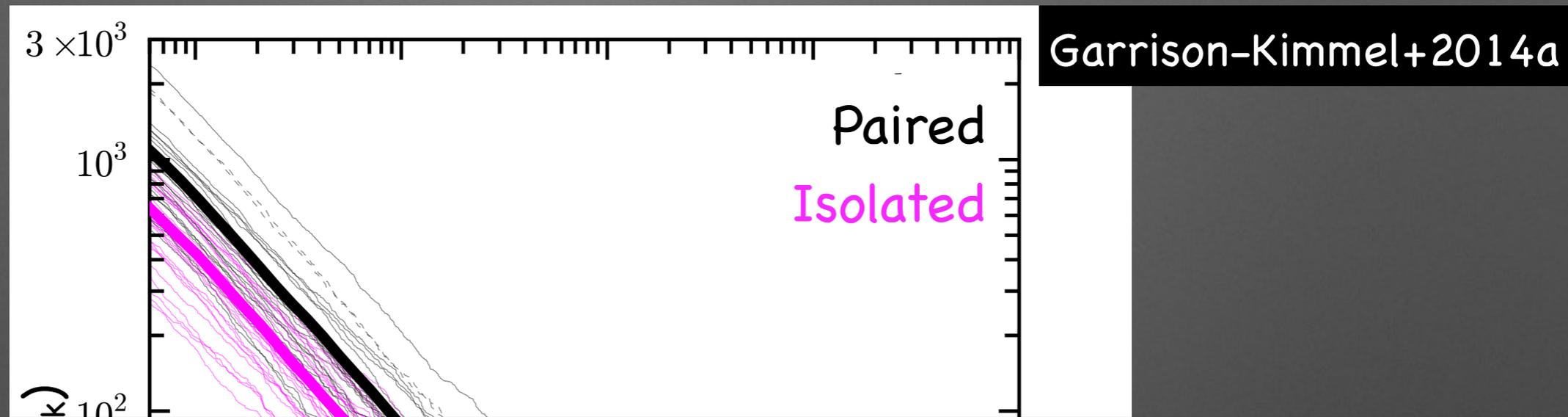


Field halo mass functions in ELVIS

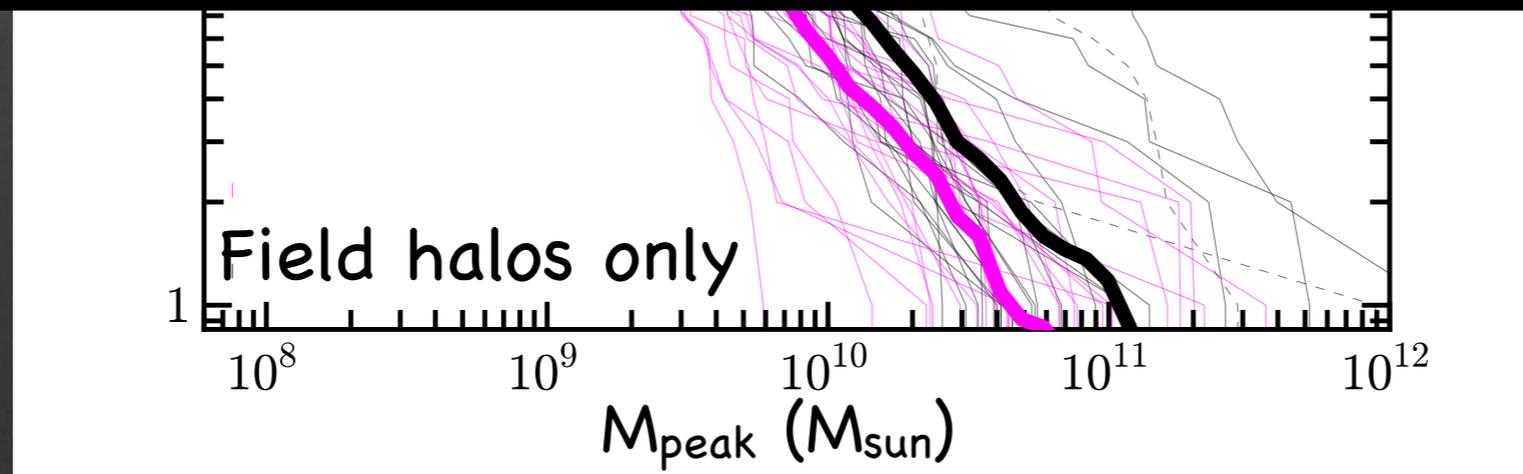


Fields surrounding (~ 1 Mpc) isolated MW-size halos contain about **80% fewer halos** at fixed mass

Field halo mass functions in ELVIS

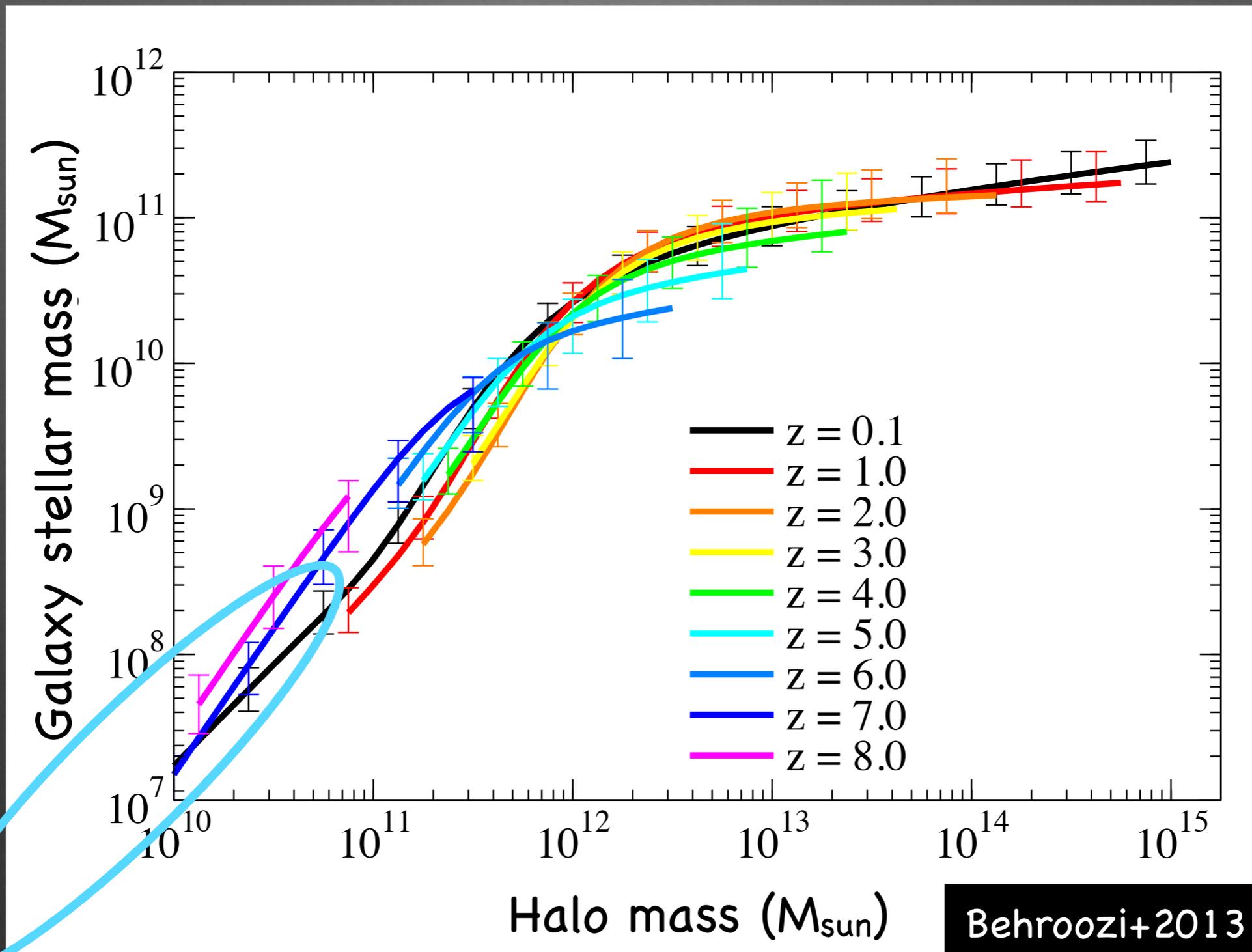


You **must** account for Andromeda to accurately predict abundance and kinematics of Local Field halos



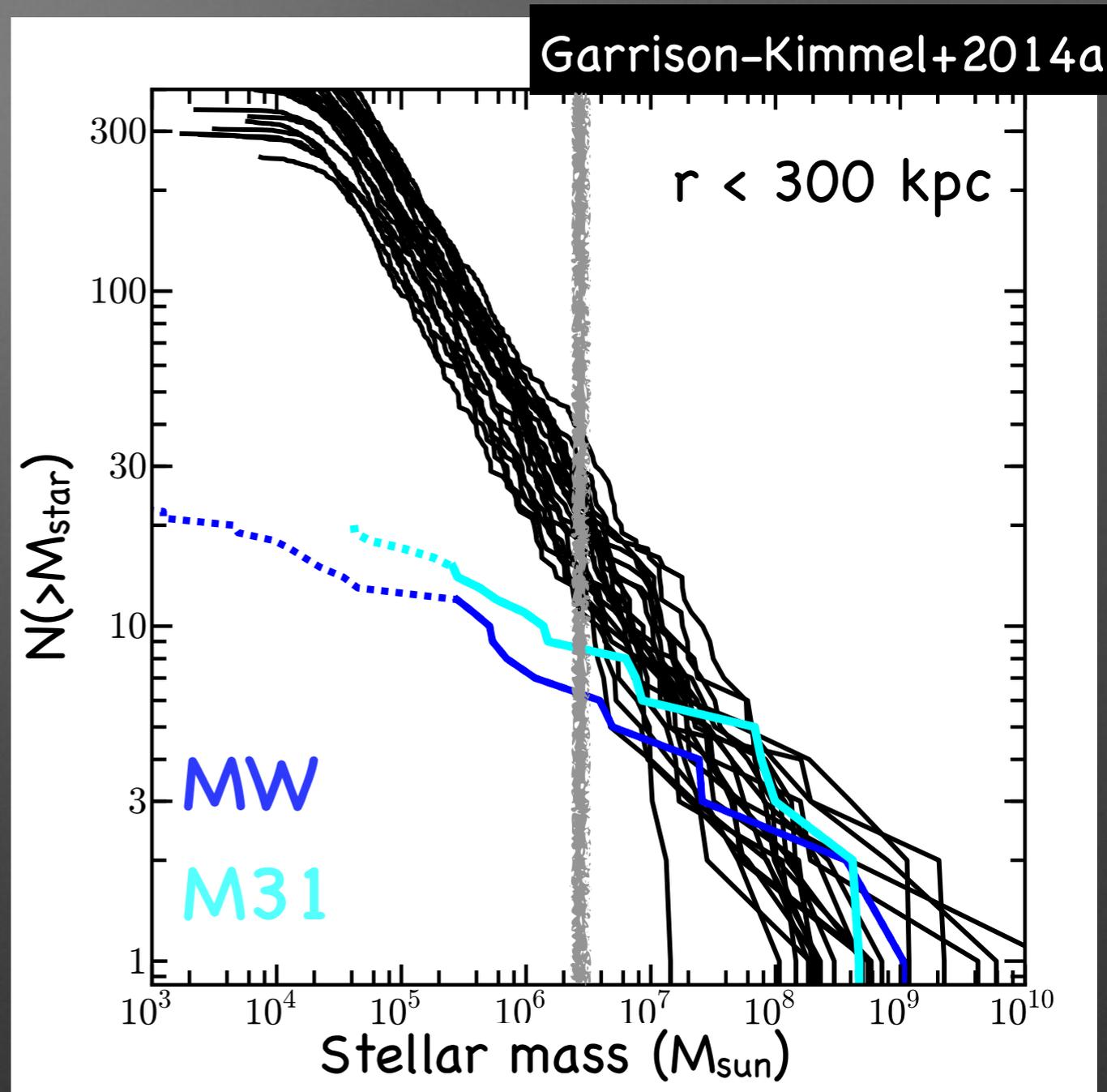
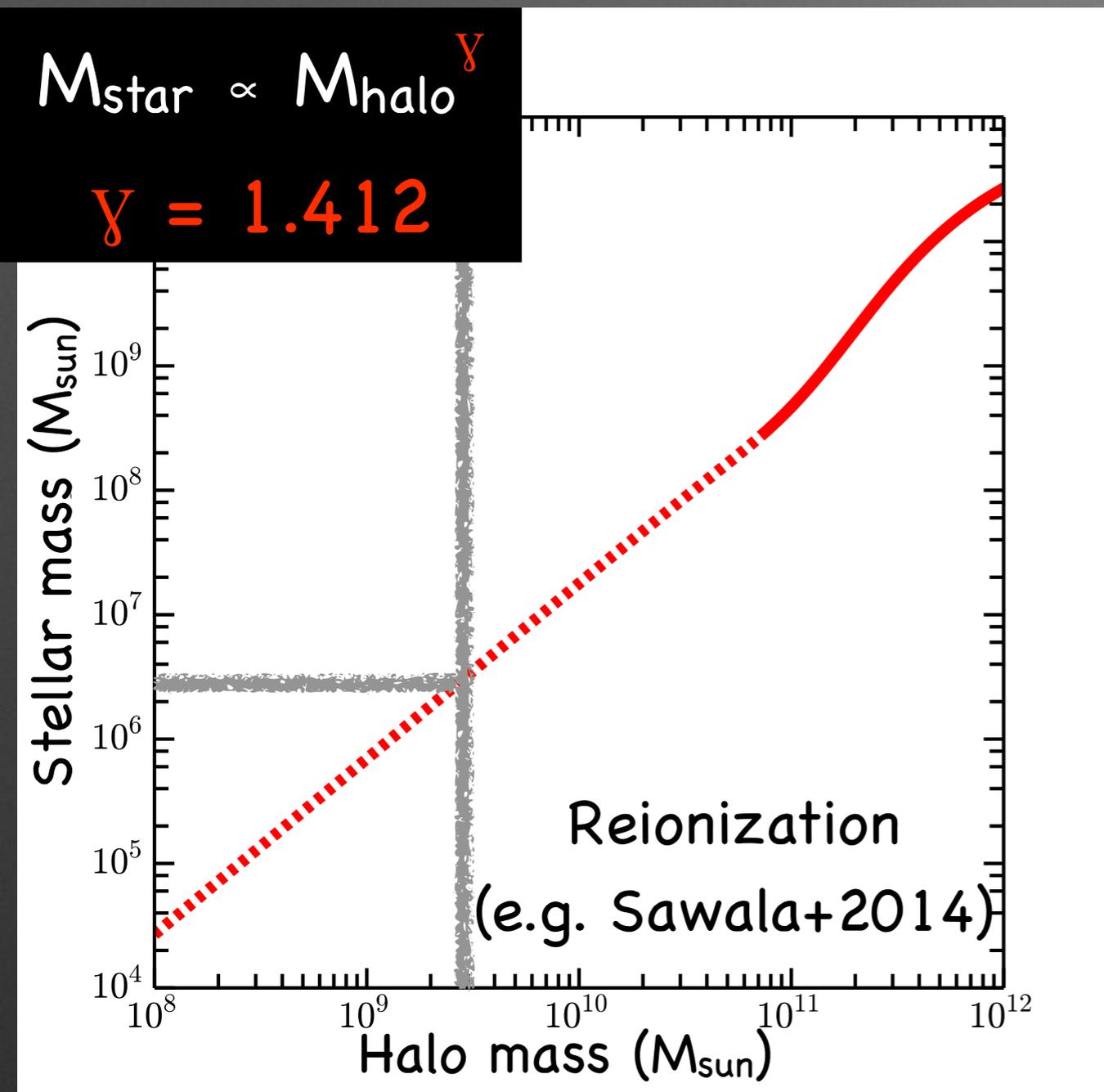
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Abundance Matching



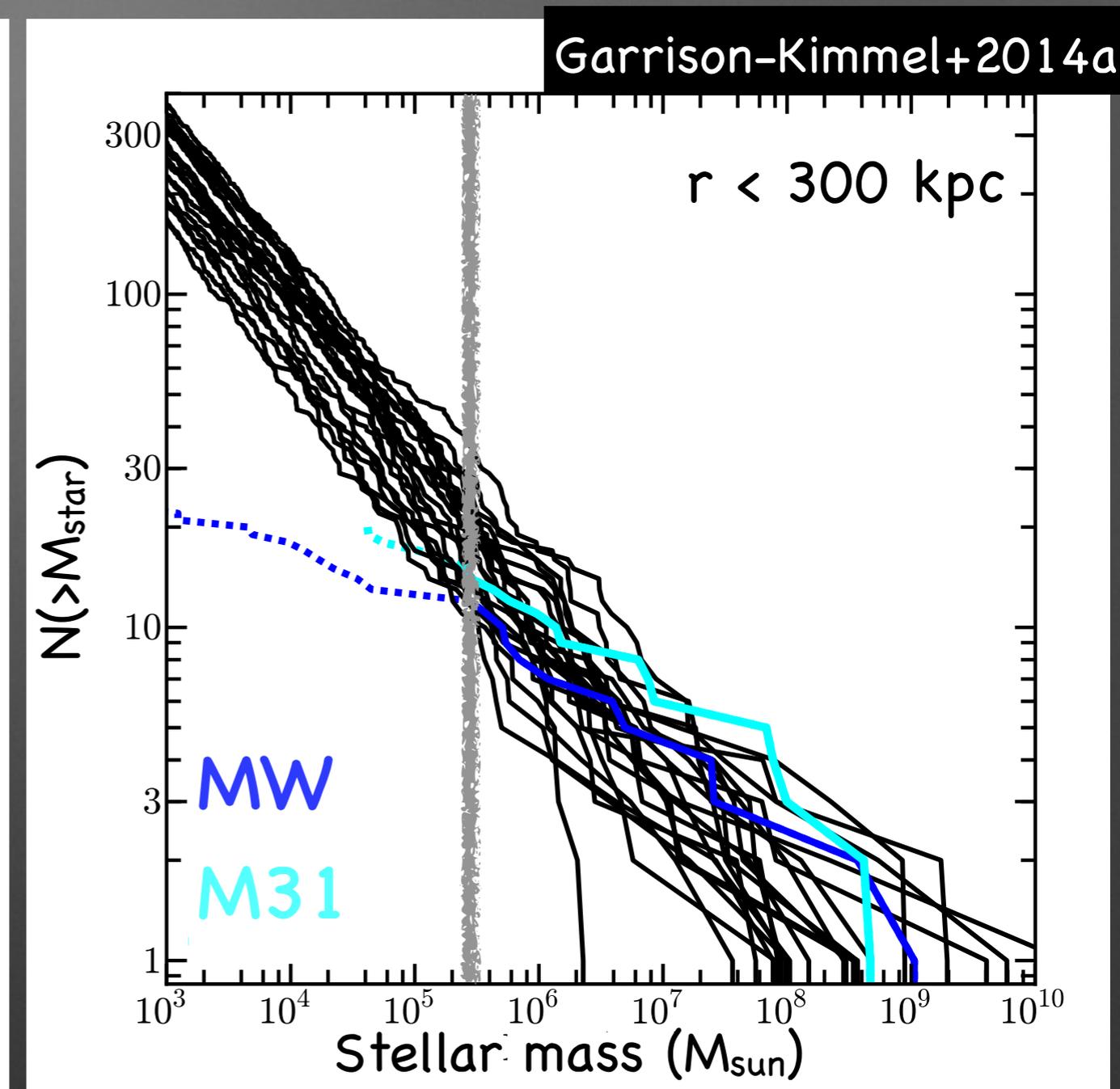
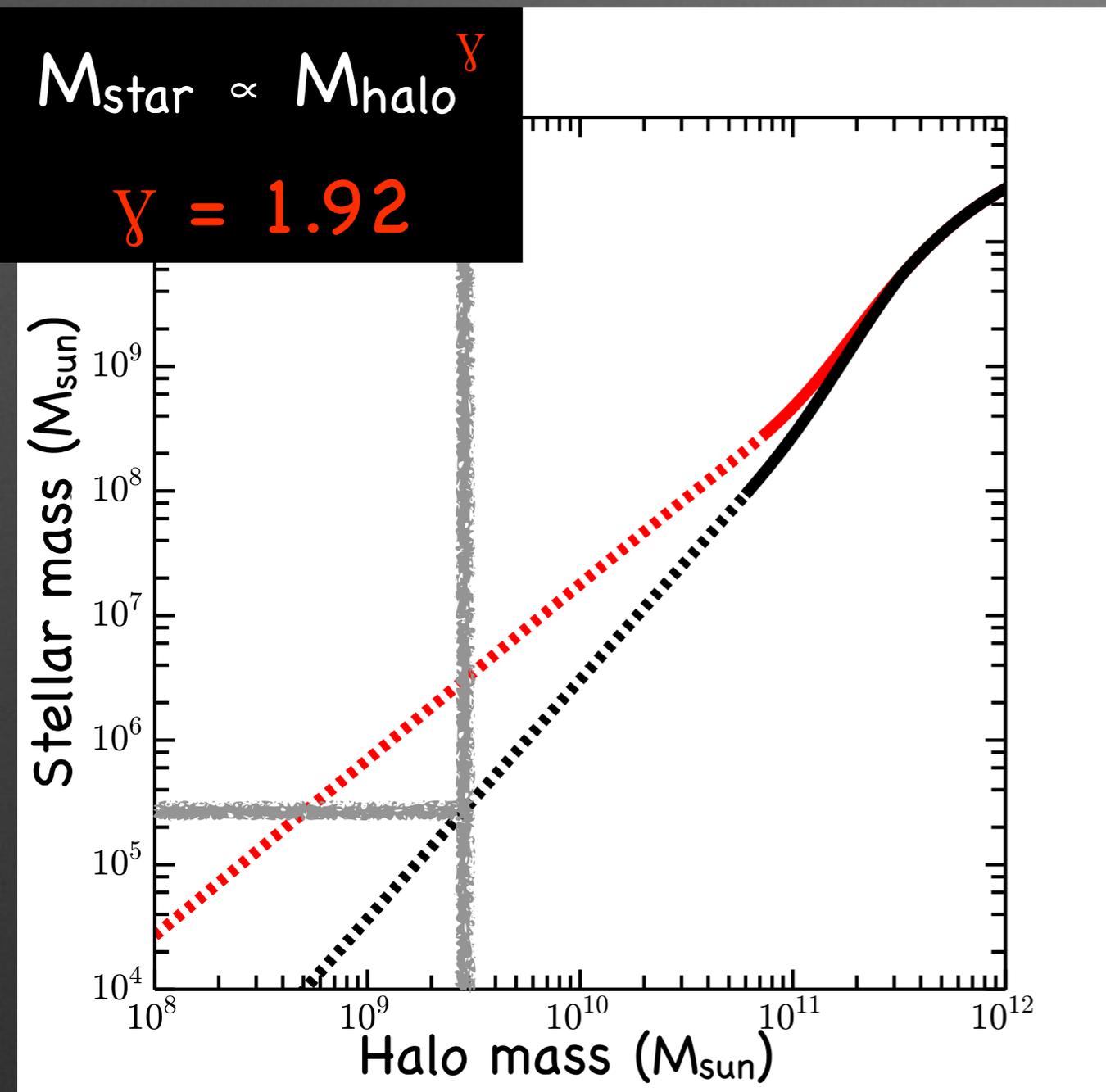
Probe the stellar mass function down to $M_{\text{star}} \sim 10^5 M_{\text{sun}}$
in order to test extrapolations of abundance matching

Testing AM extrapolations



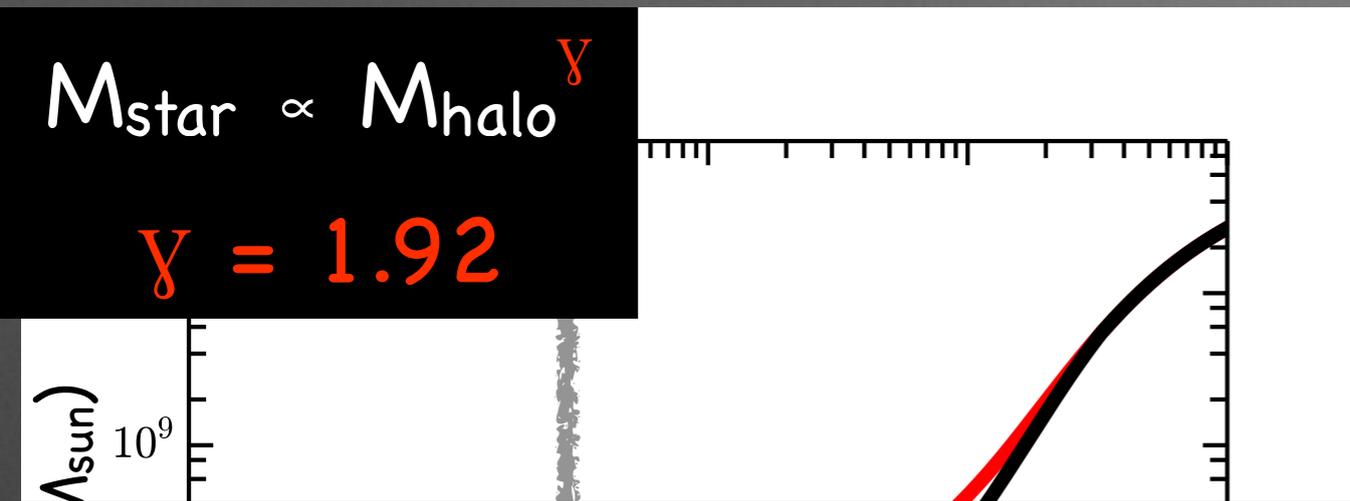
Behroozi+2013 abundance matching predicts too many low mass galaxies, even where observations are complete

Testing AM extrapolations

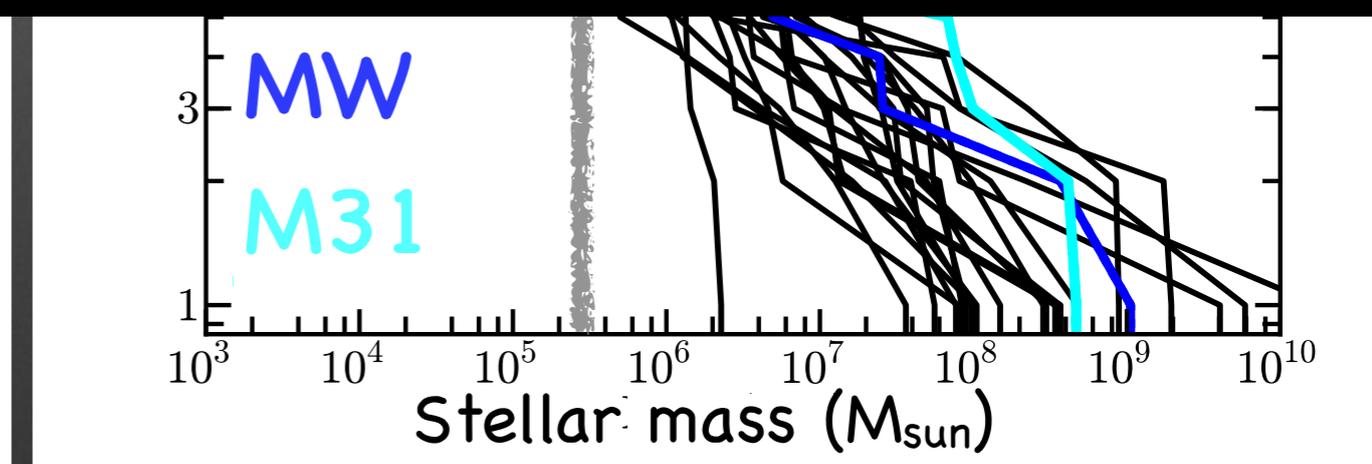
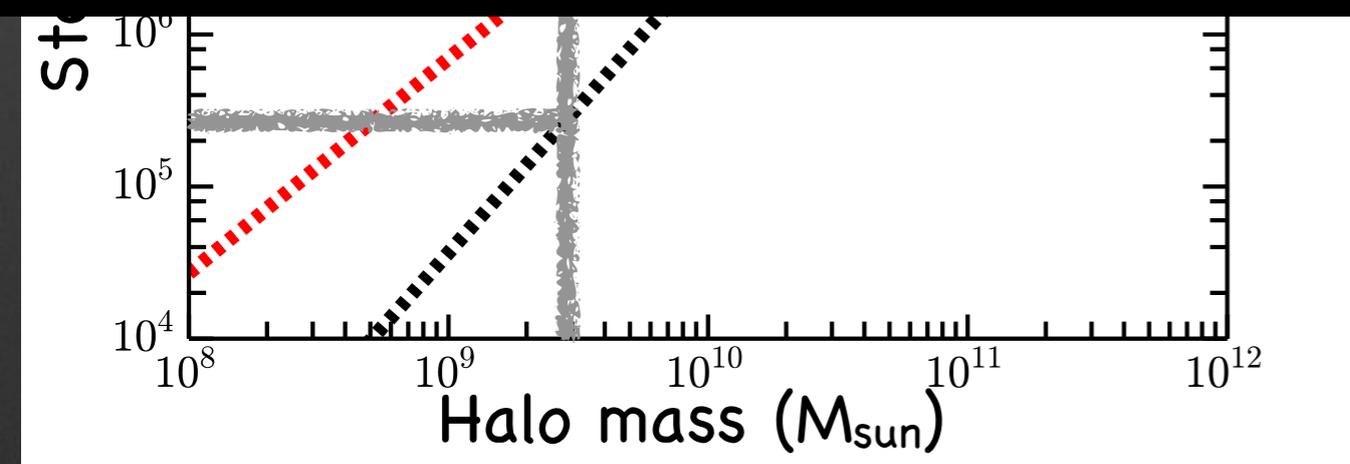


Modified Behroozi+2013 using a shallower low-mass slope (Baldry+2012) agrees well

Testing AM extrapolations

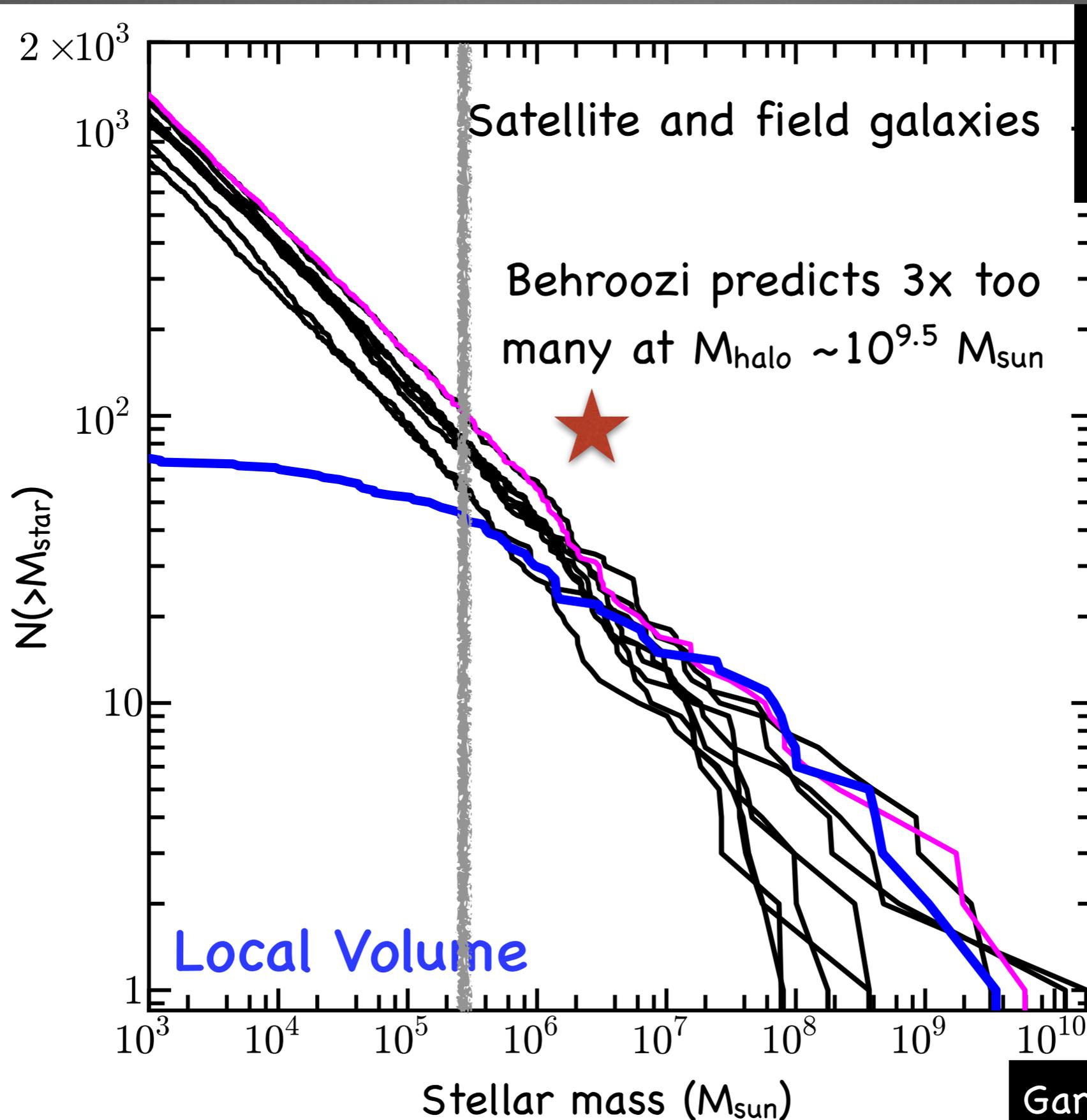


NOTE: Adding scatter requires an $M_{\text{star}}-M_{\text{halo}}$ relation that falls off even more rapidly at low M_{halo}



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Predicting LSST discoveries

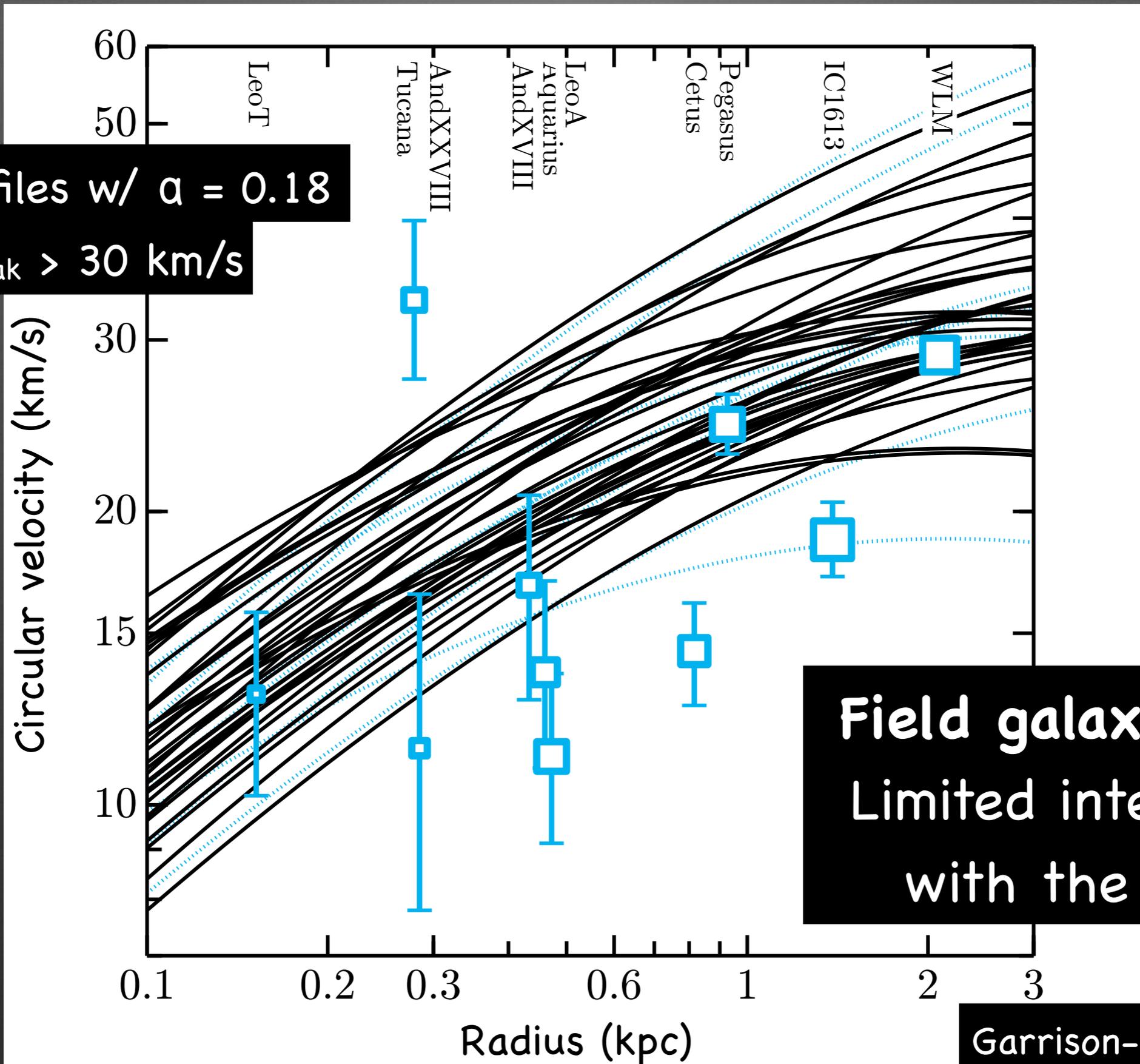


$$M_{\text{star}} \propto M_{\text{halo}}^{\gamma}$$

$\gamma = 1.92$

Too-big-to-fail in the ELVIS fields

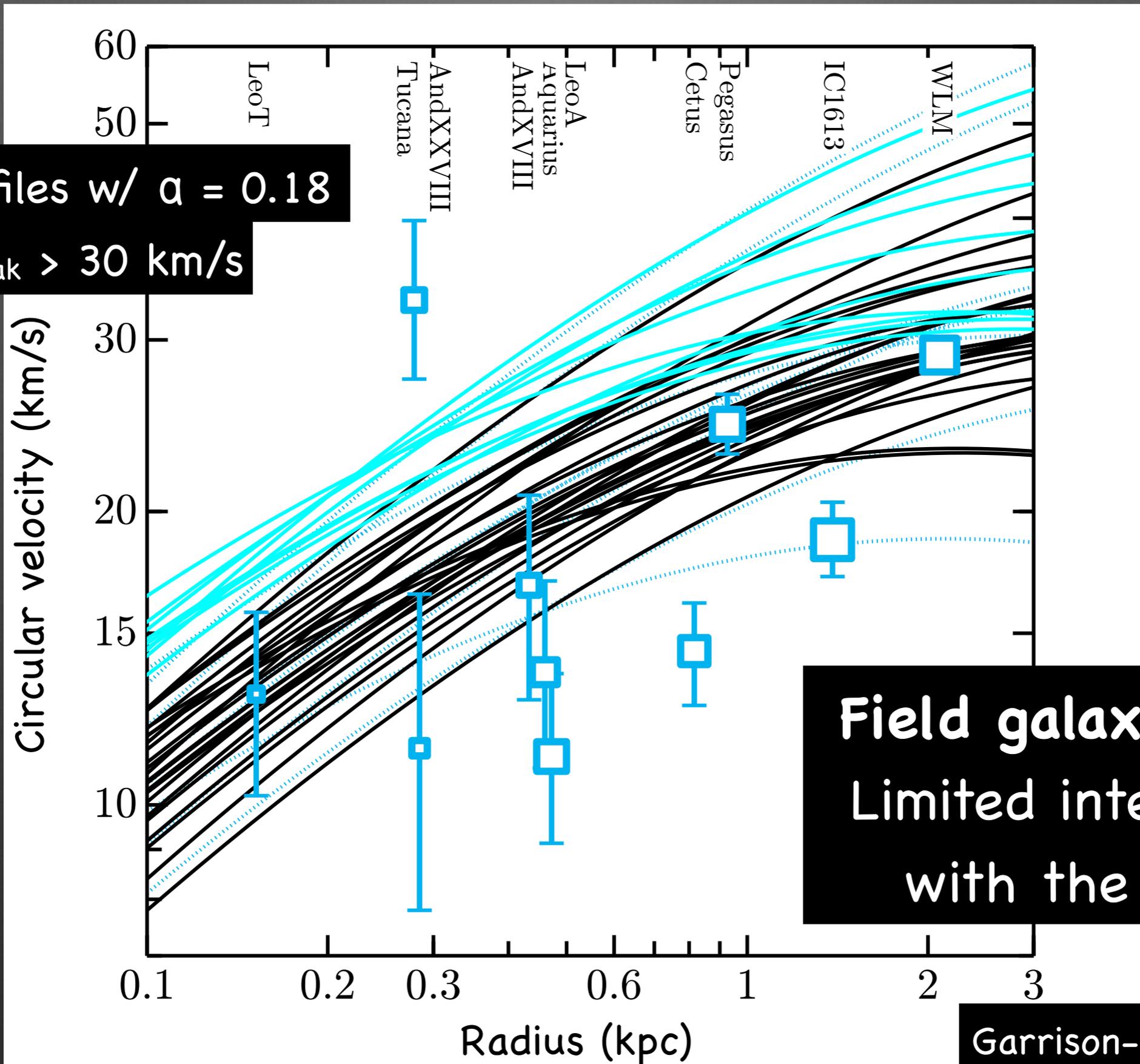
Einasto profiles w/ $\alpha = 0.18$
All with $V_{\text{peak}} > 30$ km/s



Field galaxies only:
Limited interactions
with the giants

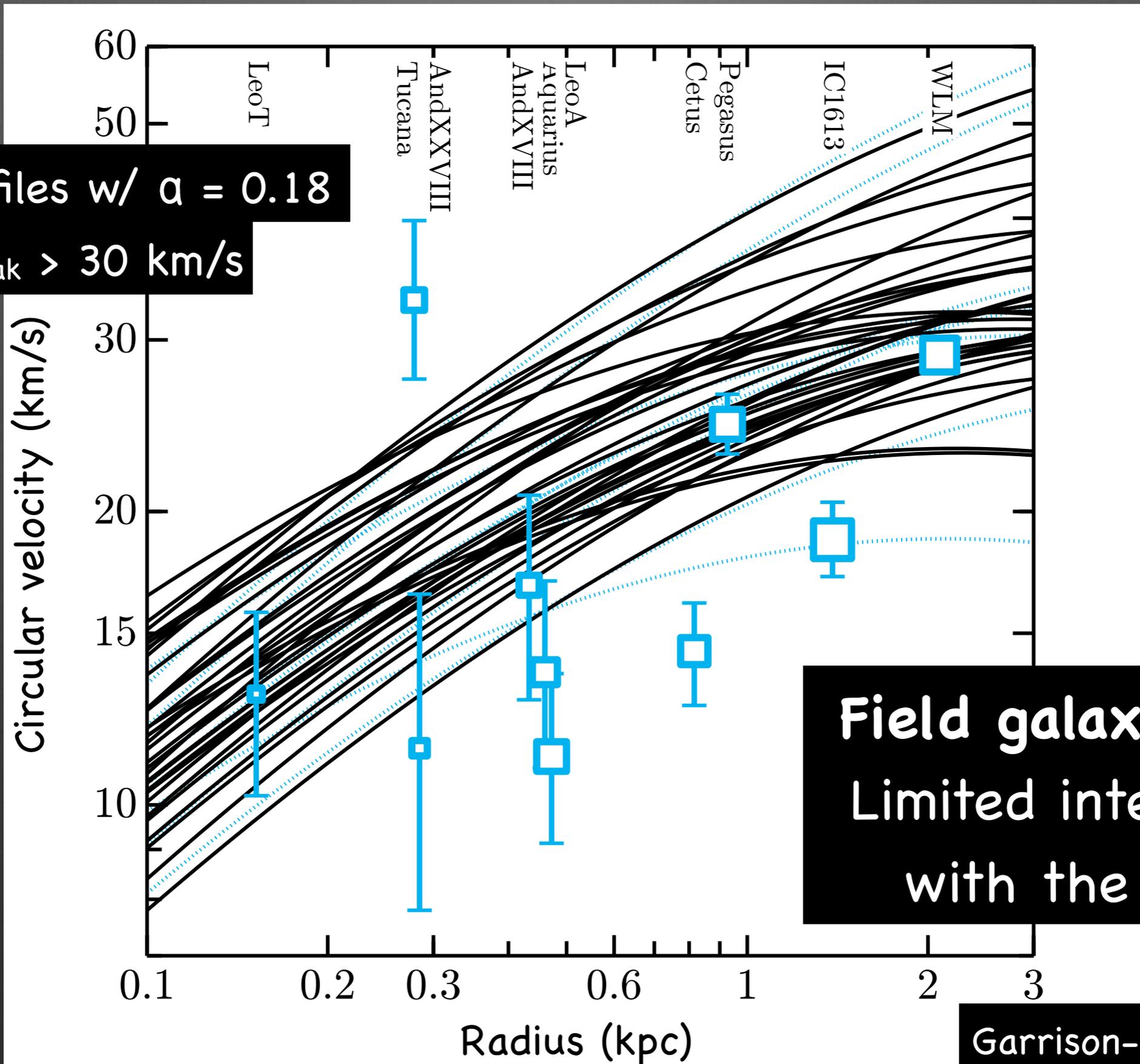
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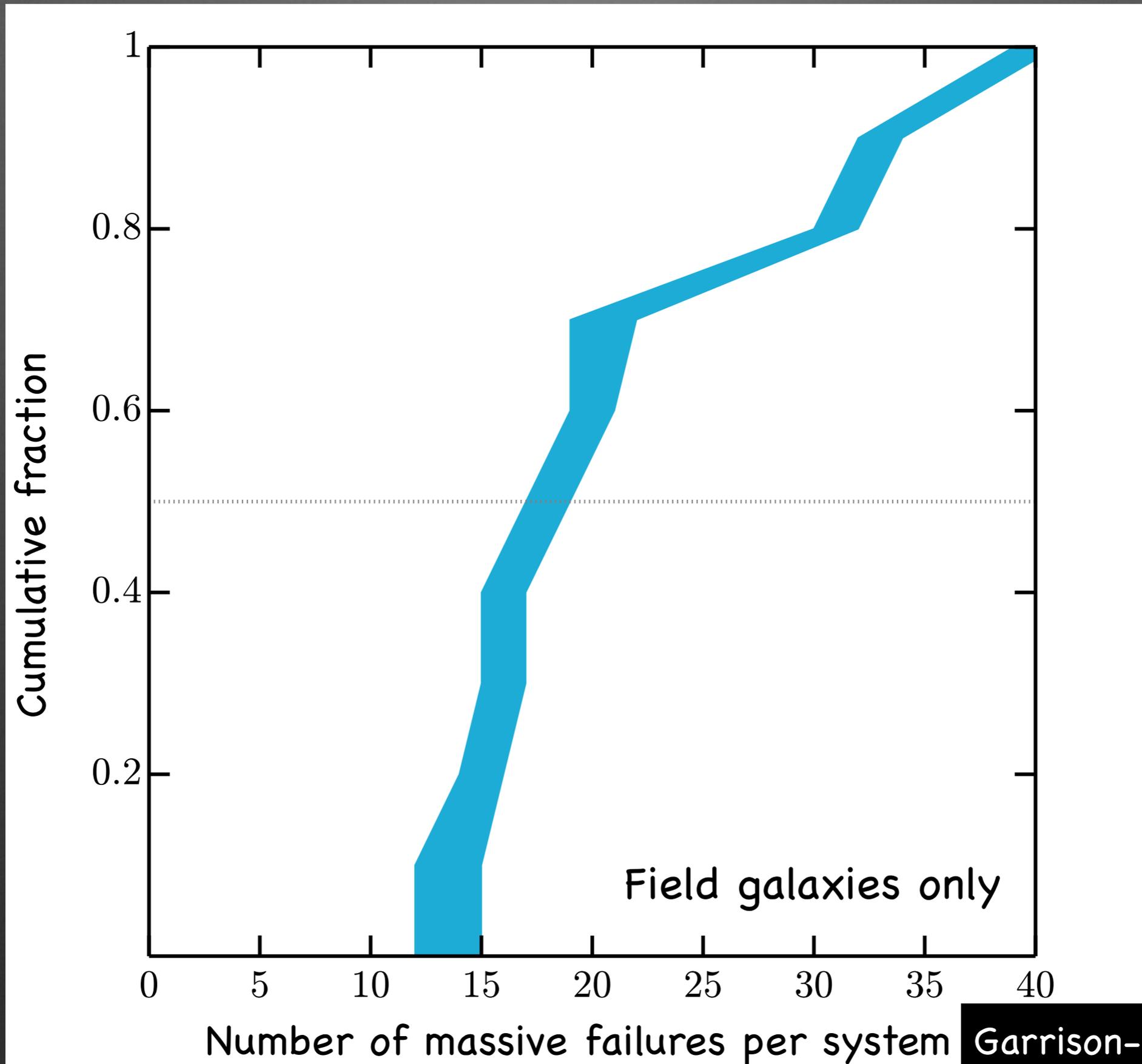


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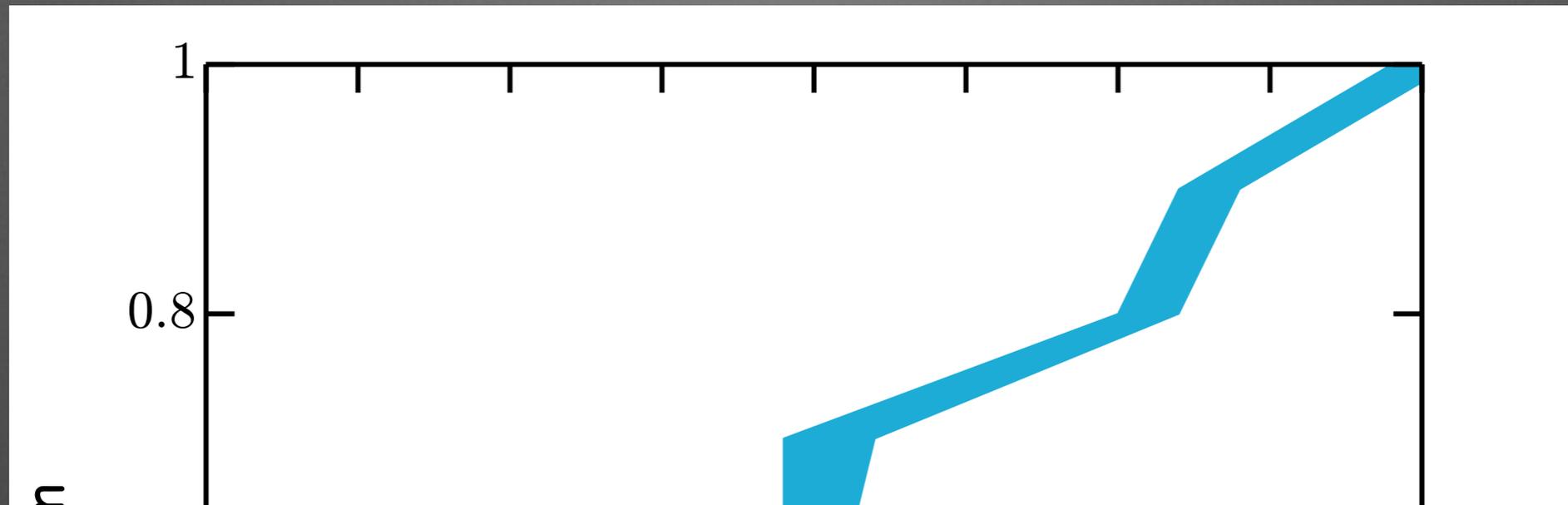
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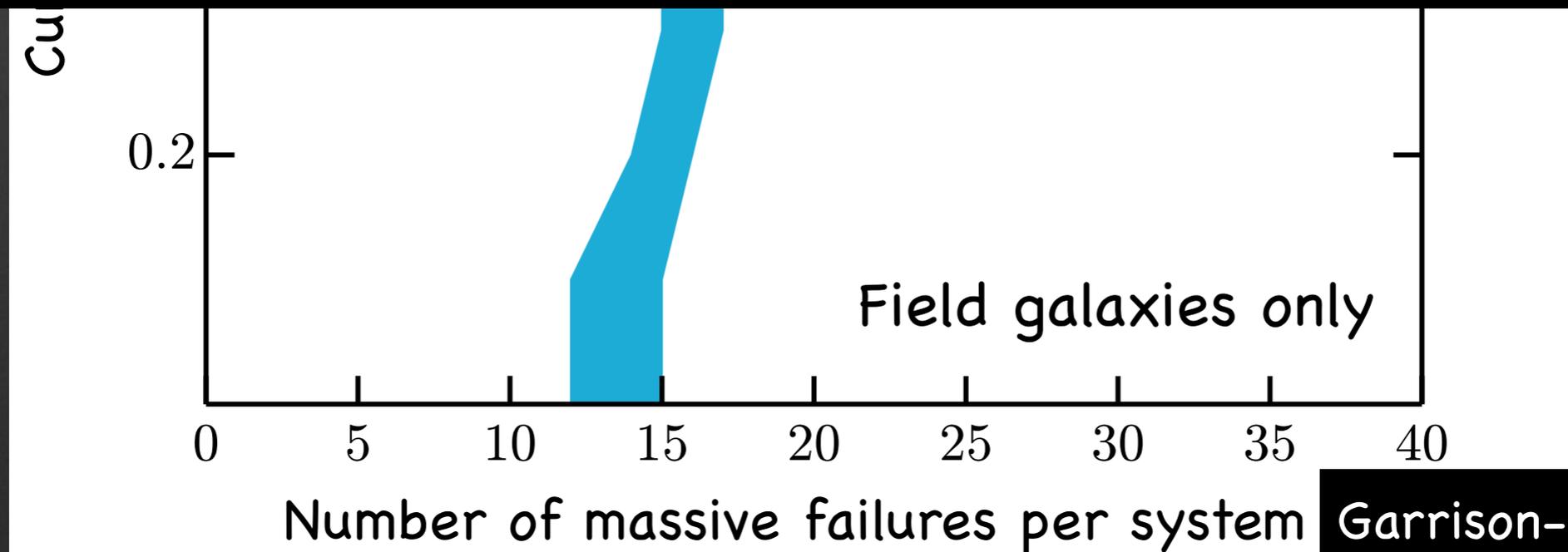
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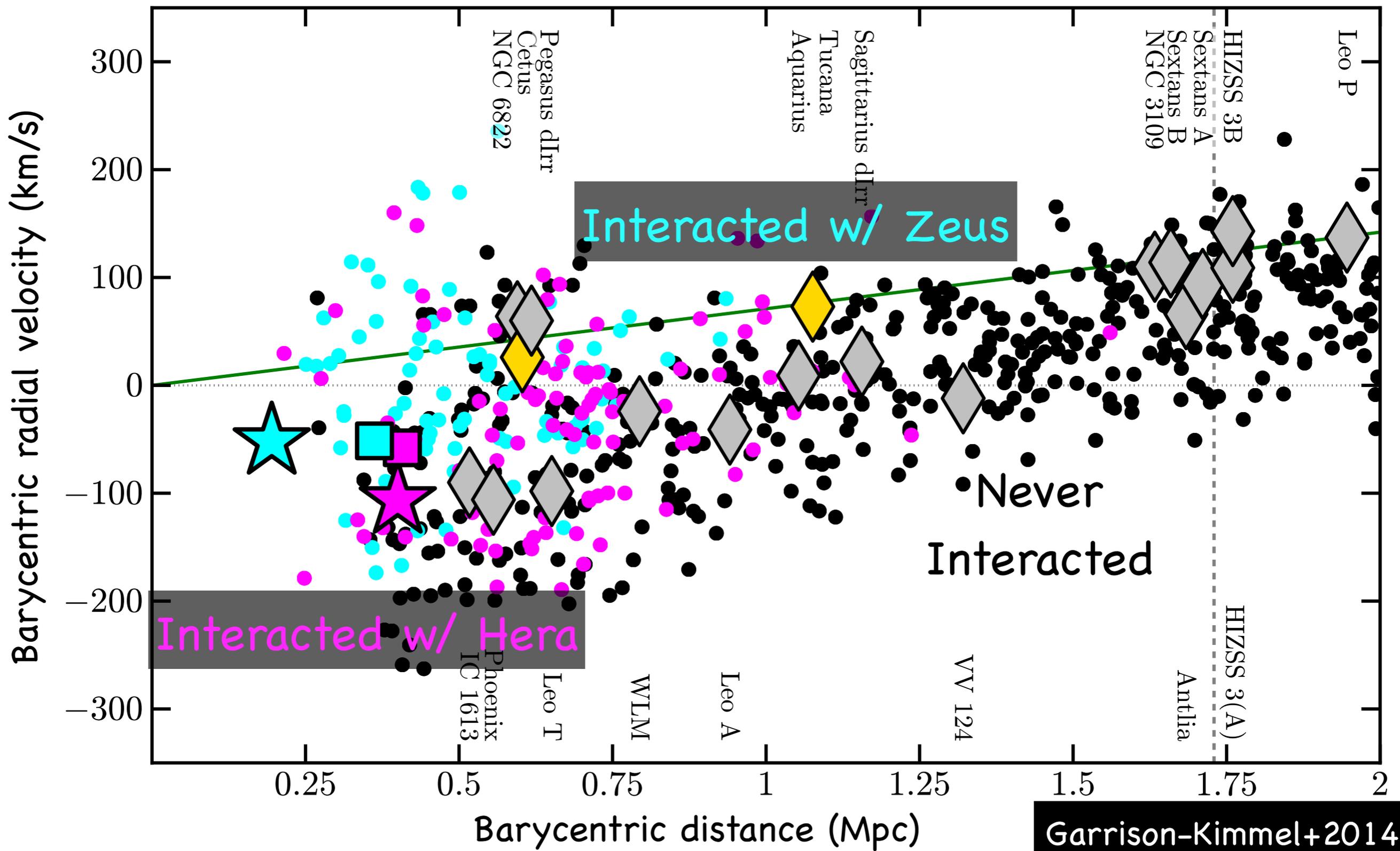
Too-big-to-fail in the ELVIS fields



In the field, where environmental baryonic effects can be largely ignored, there are **still more than 15 left-over, massive halos that remain large today**



Resolving the Hubble flow

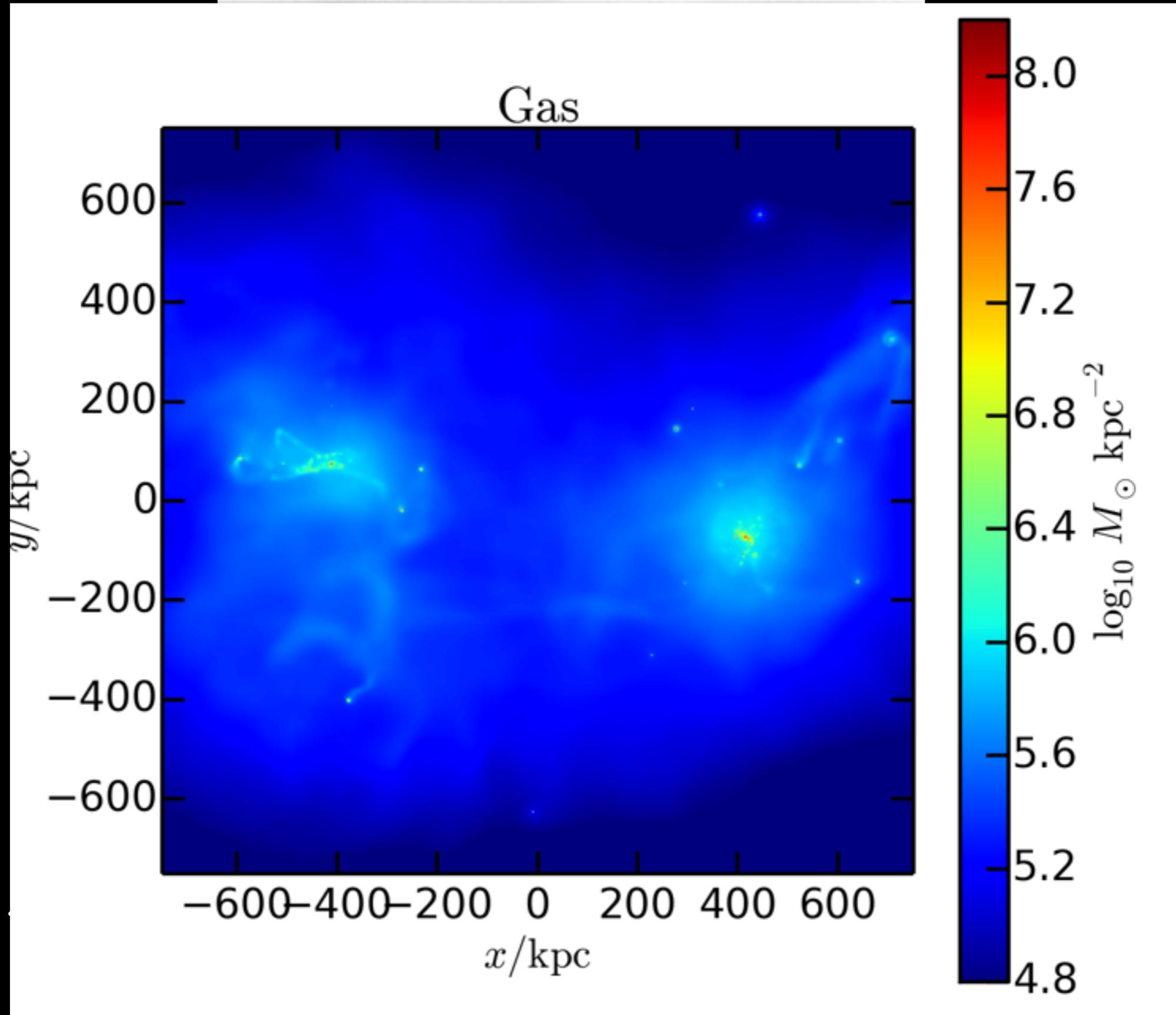


Coming soon...



ELVIS on FIRE: Simulating the Local Group
with Hopkins et al. hydrodynamics

Coming soon...



with Hopkins et al. Hydrodynamics

Conclusions

- **ELVIS**: a publicly-available suite of high-resolution zoom-in simulations targeting at LG-like pairs of halos, resolving regions **beyond 1.5 Mpc** from the barycenter
- You **must simulate full Local Groups** in order to make accurate predictions on ~ 1 Mpc scales
- The $M_{\text{star}}-M_{\text{halo}}$ relation is constrained down to $M_{\text{star}} \sim 10^6 M_{\text{sun}}$; a relation as flat as Behroozi+2012 overpredicts the observed counts at $10^6 M_{\text{sun}}$; adding scatter requires an even steeper relation (worsens Behroozi extrapolation)
- There is a **systematic overabundance** of large halos in the Local Field (TBTF), **independent of the specifics of AM**
- Coming soon: **ELVIS on FIRE**