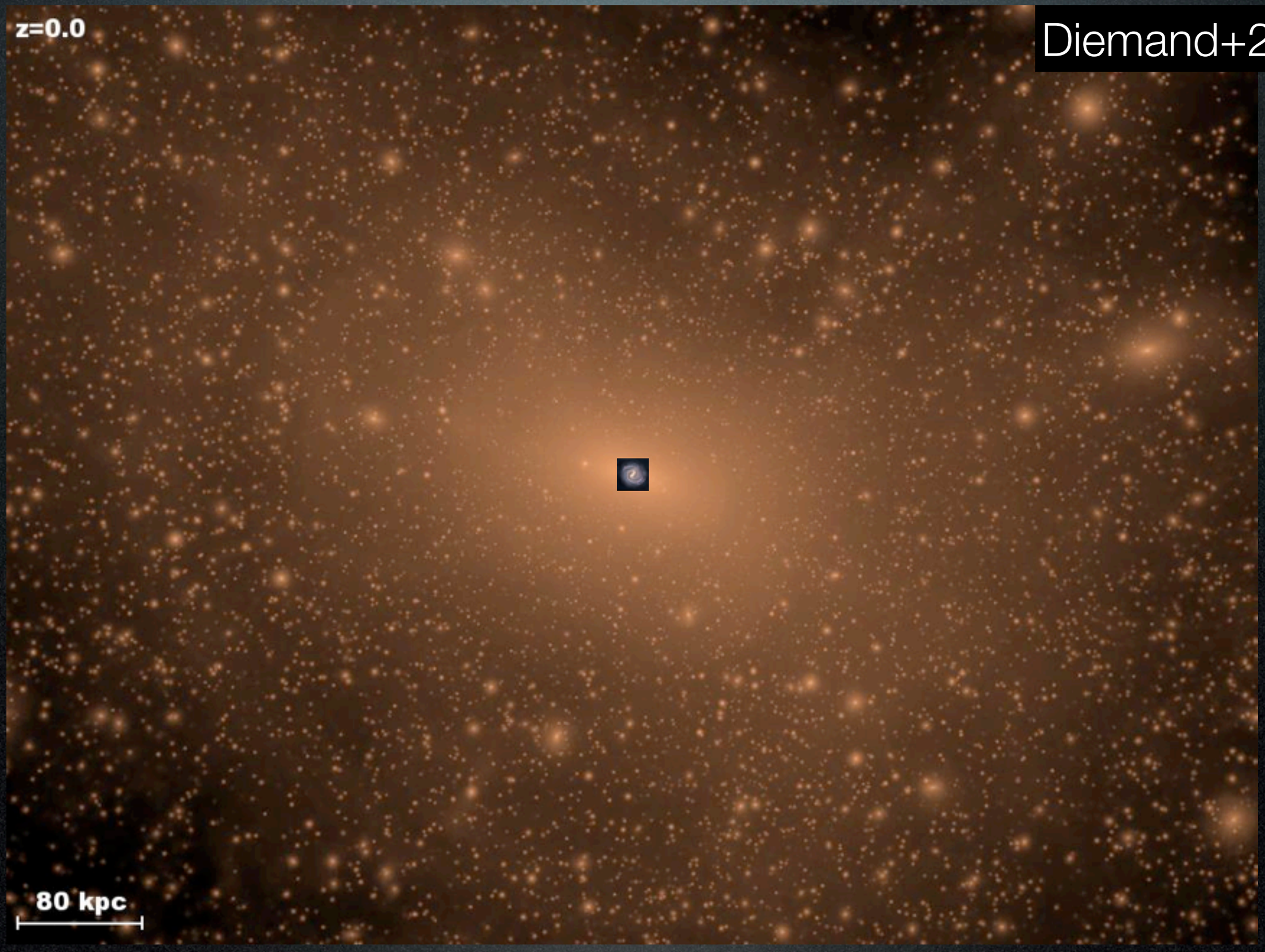
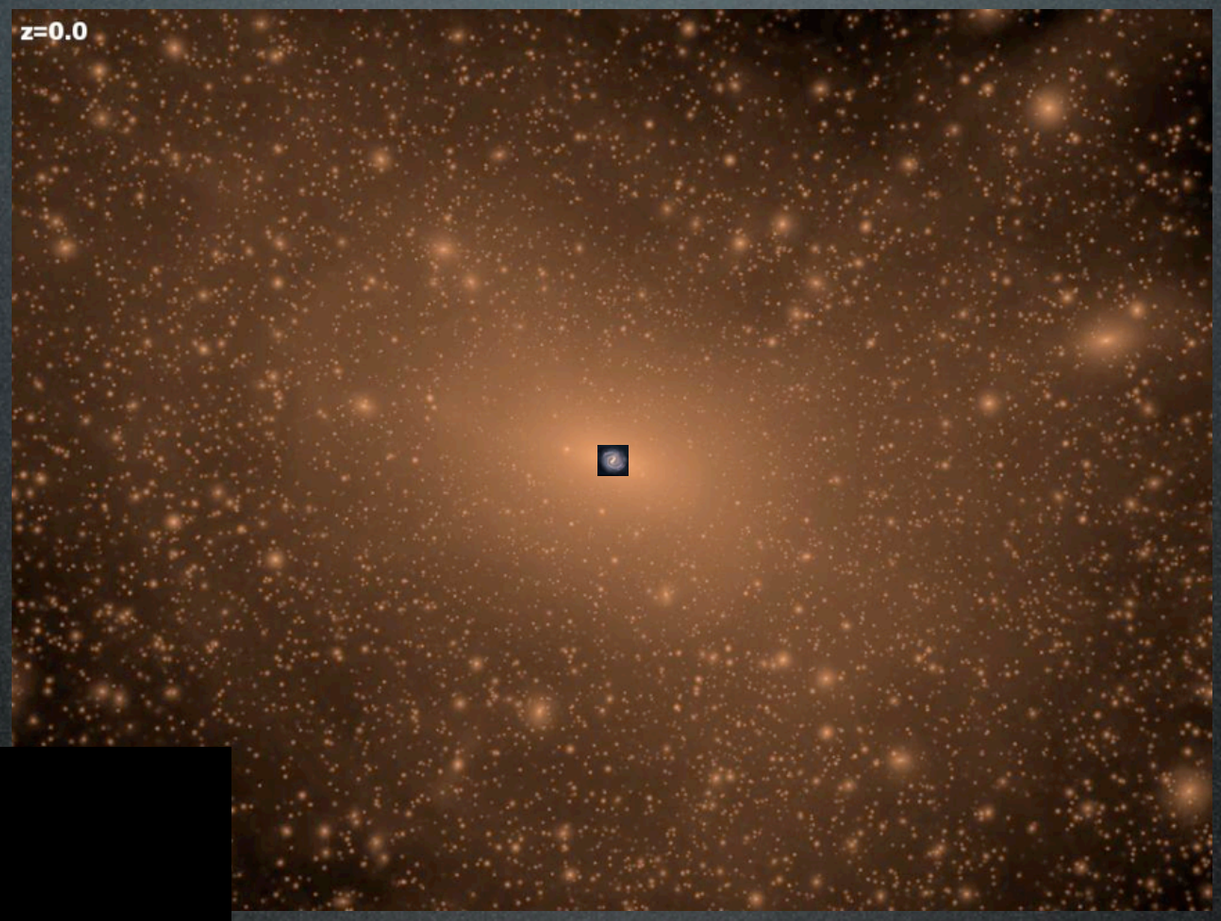
The ELVIS Project:

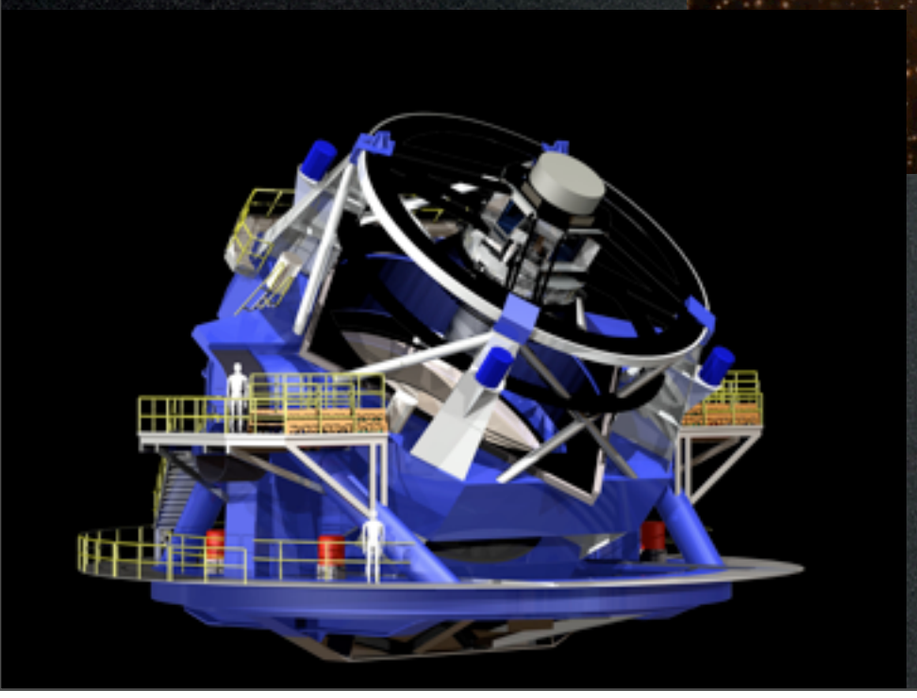
Exploring the Local Volume in Simulations

Shea Garrison-Kimmel
UC Irvine

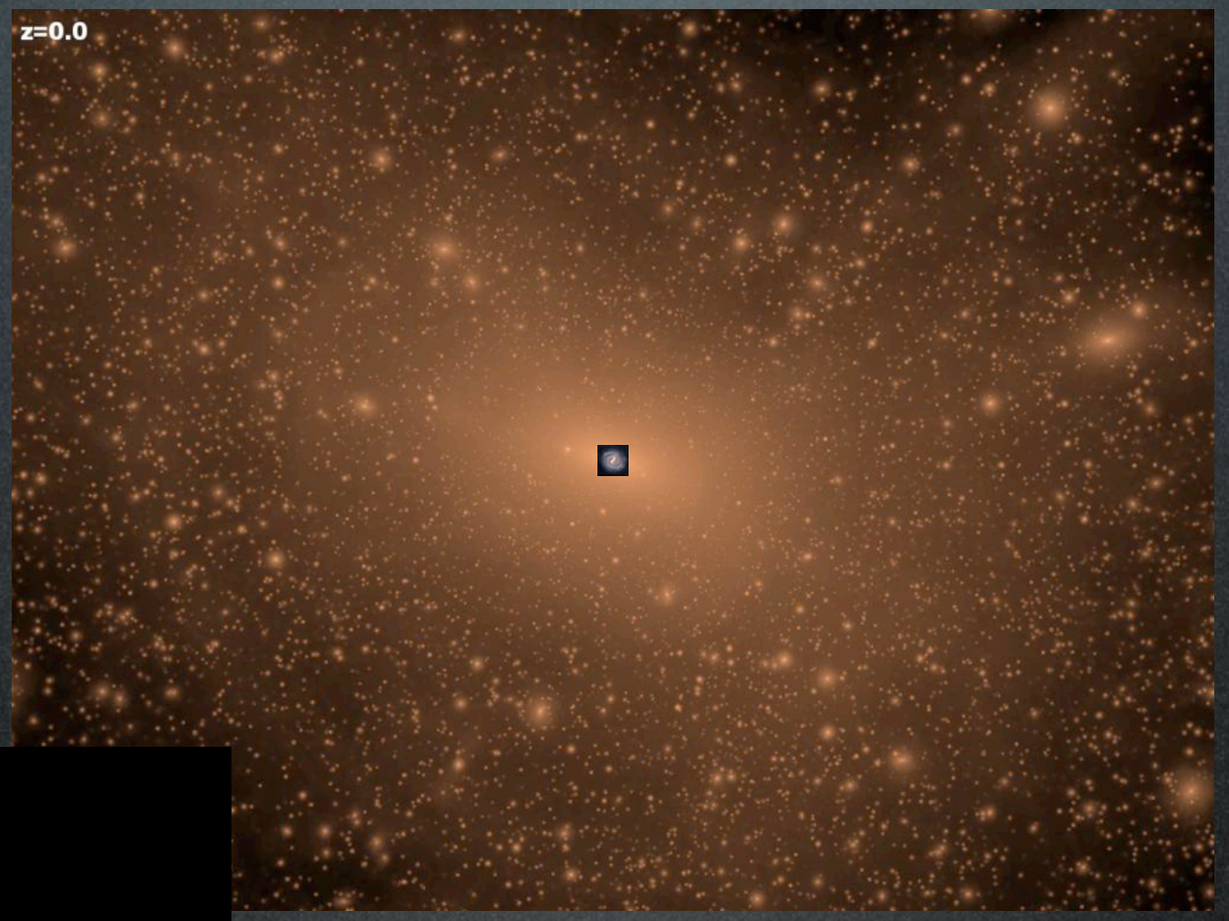

z=0.0
Diemand+2008
80 kpc

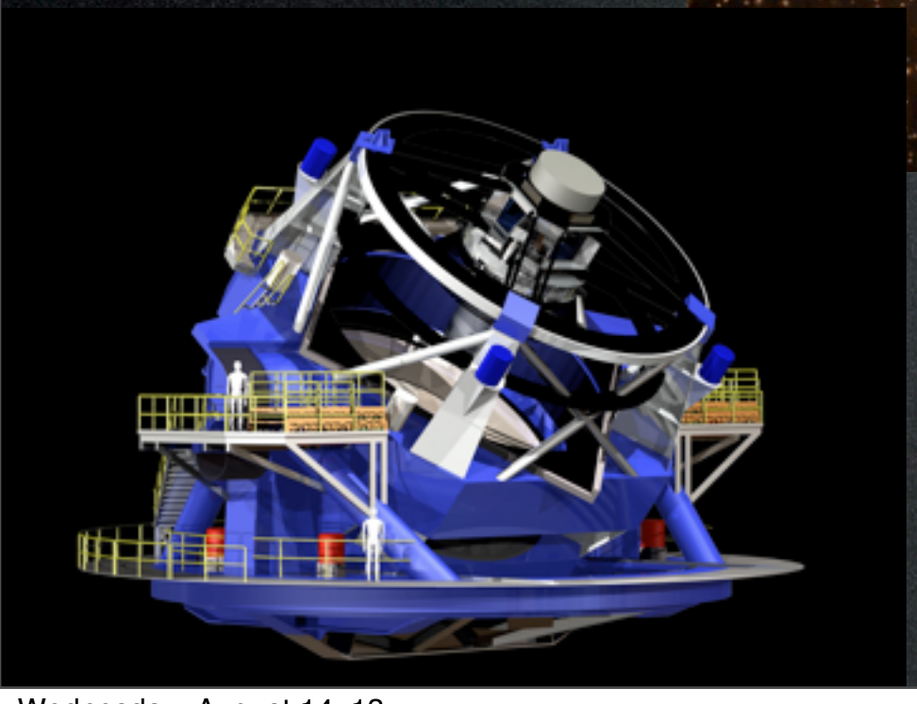
Diemand+2008



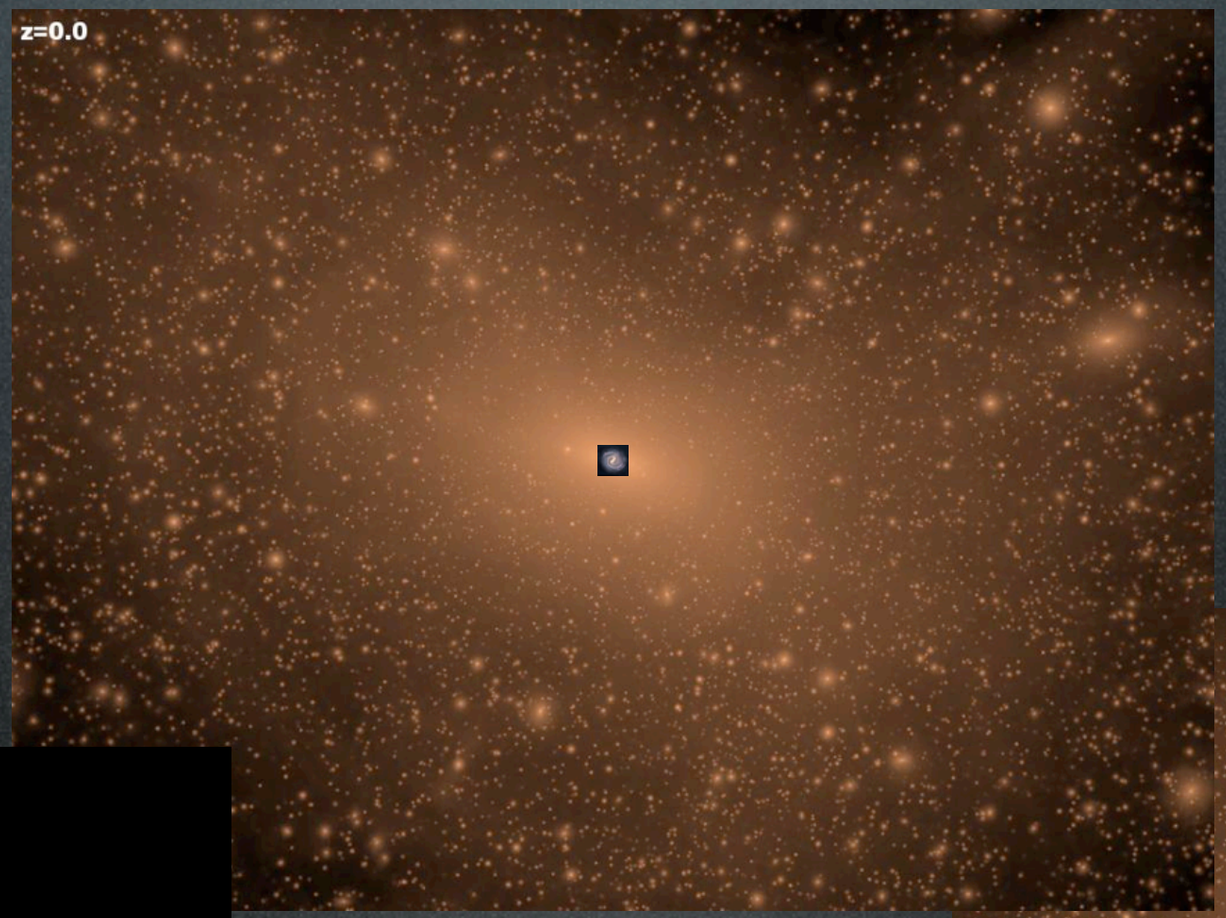


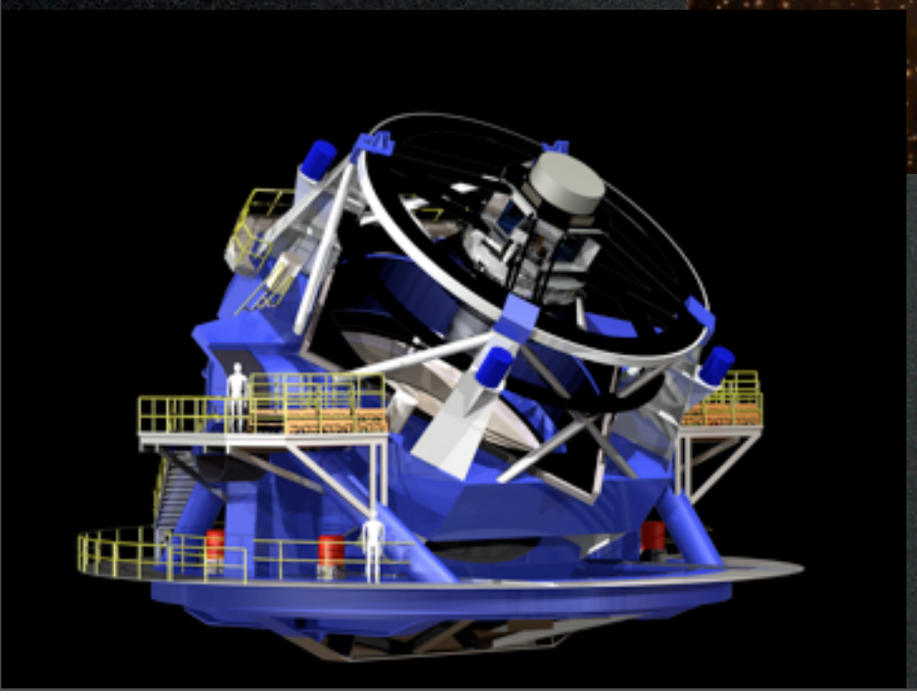
Diemand+2008

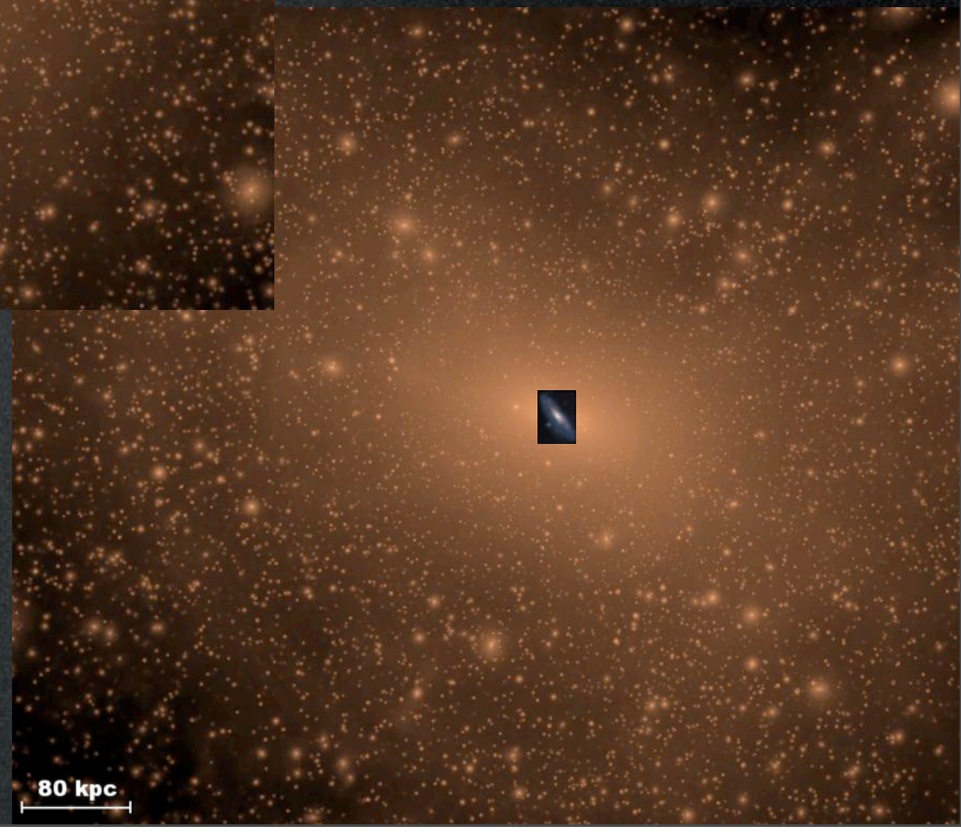




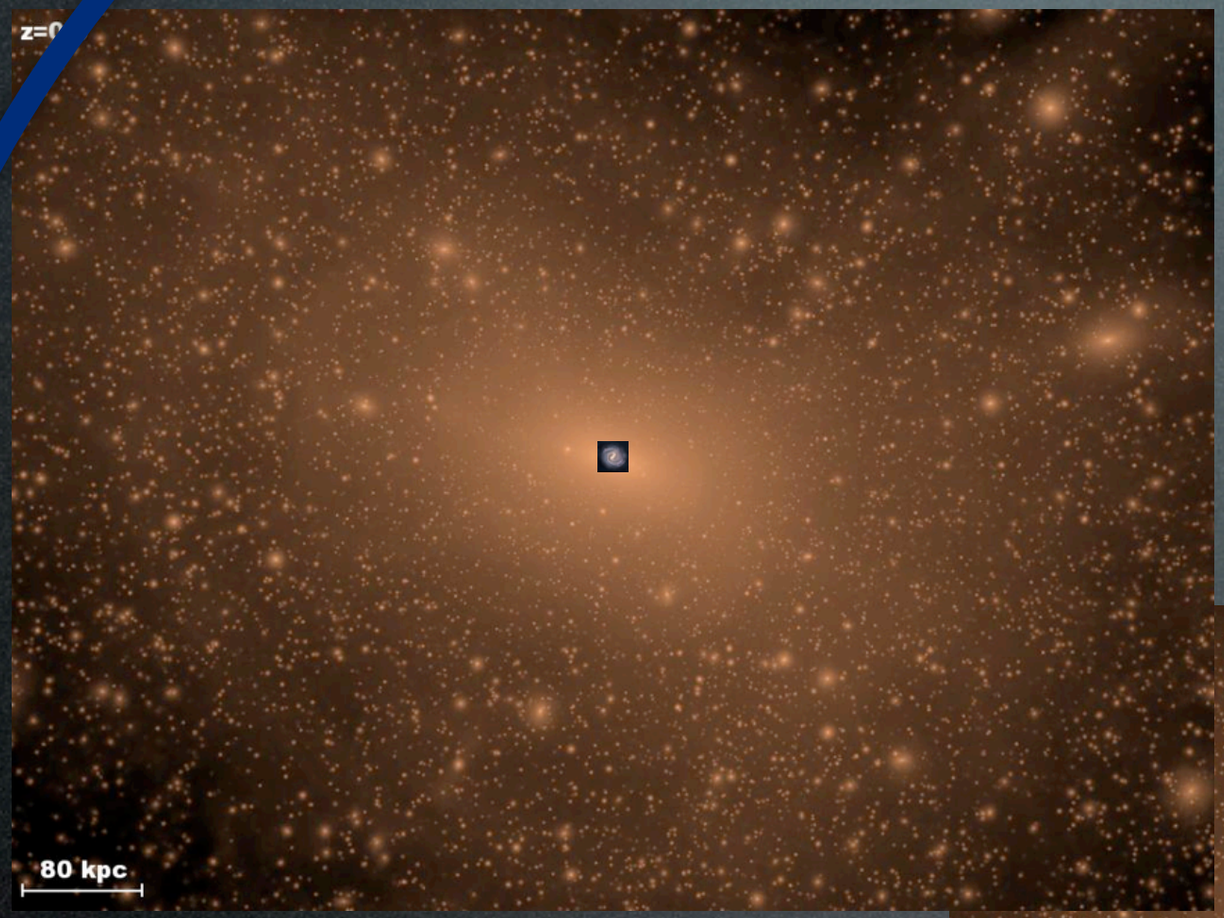
Diemand+2008

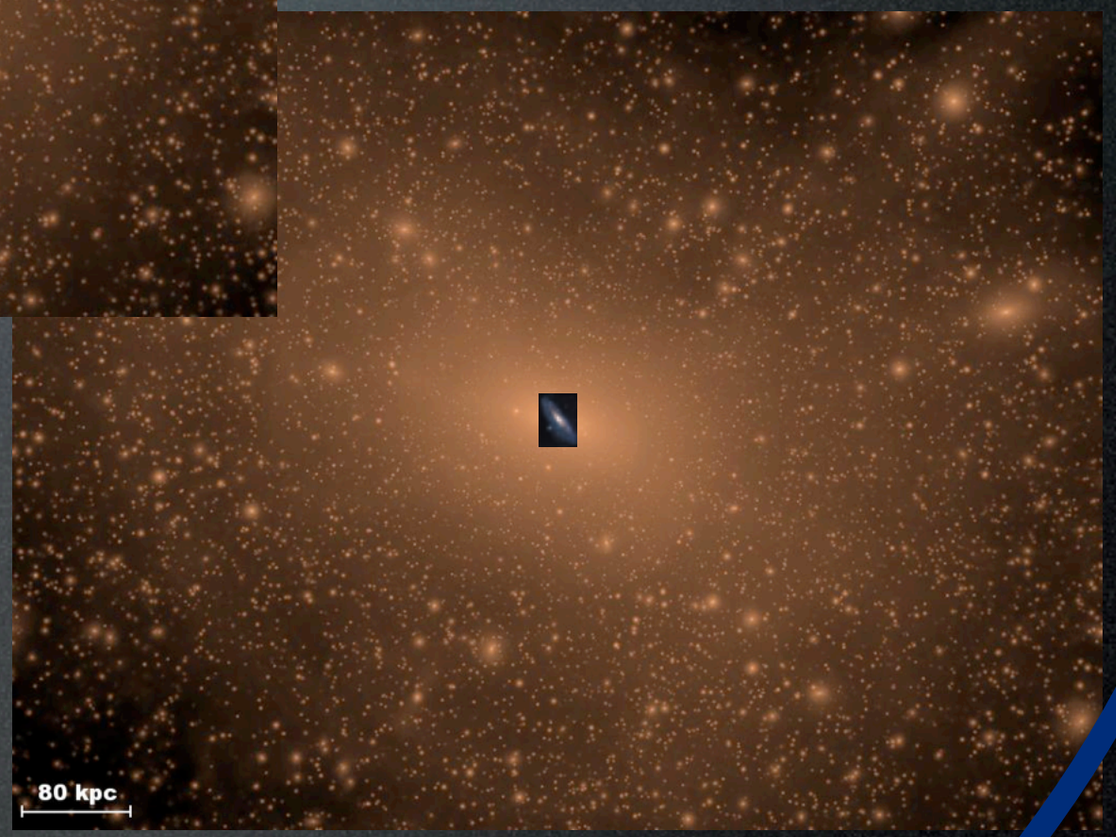


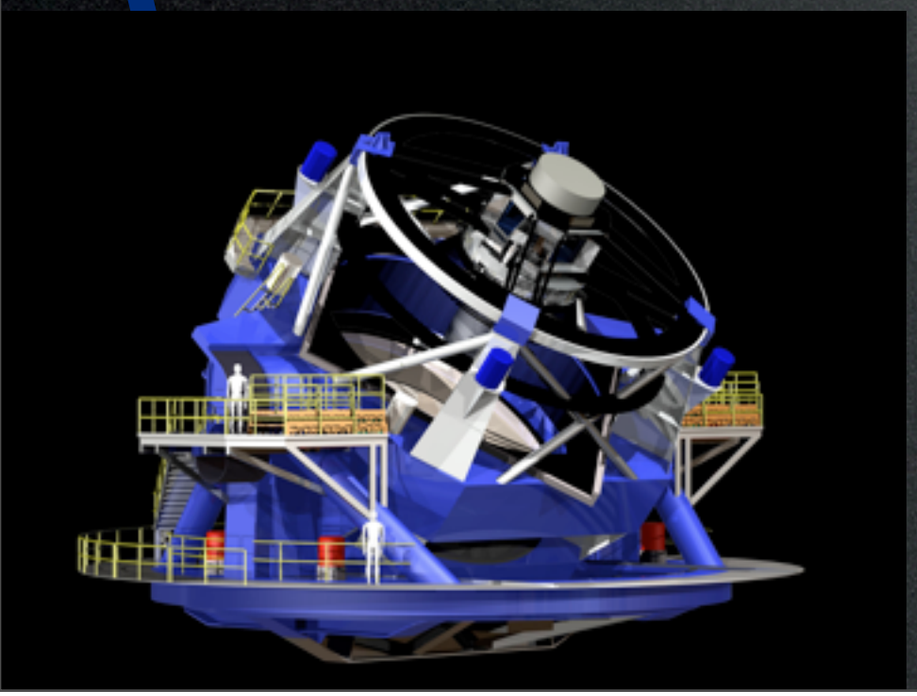




Diemand+2008







The ELVIS Suite

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- Twenty-two paired halos in LG-like pairs
- Twenty-two mass-matched isolated analogues

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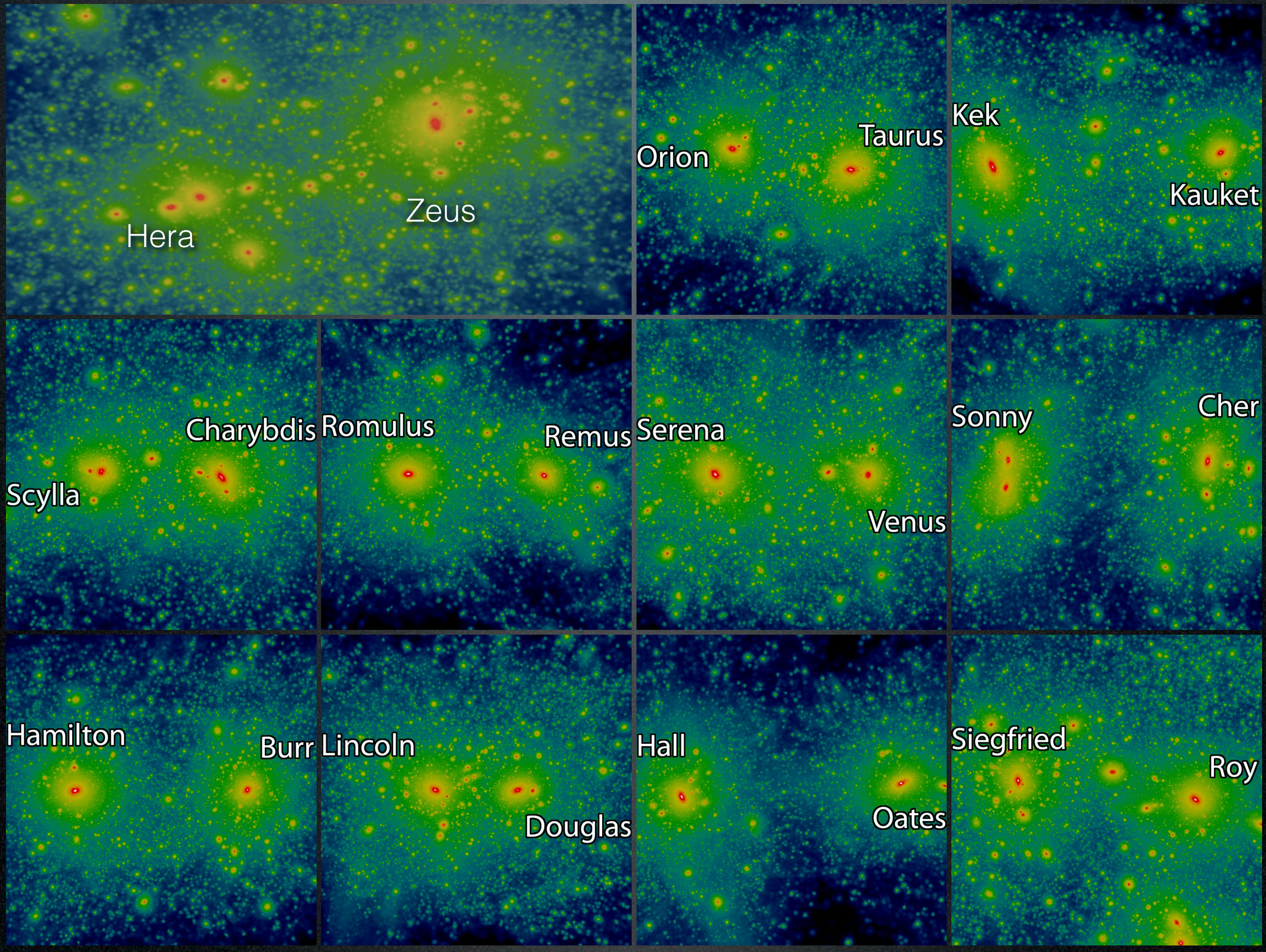
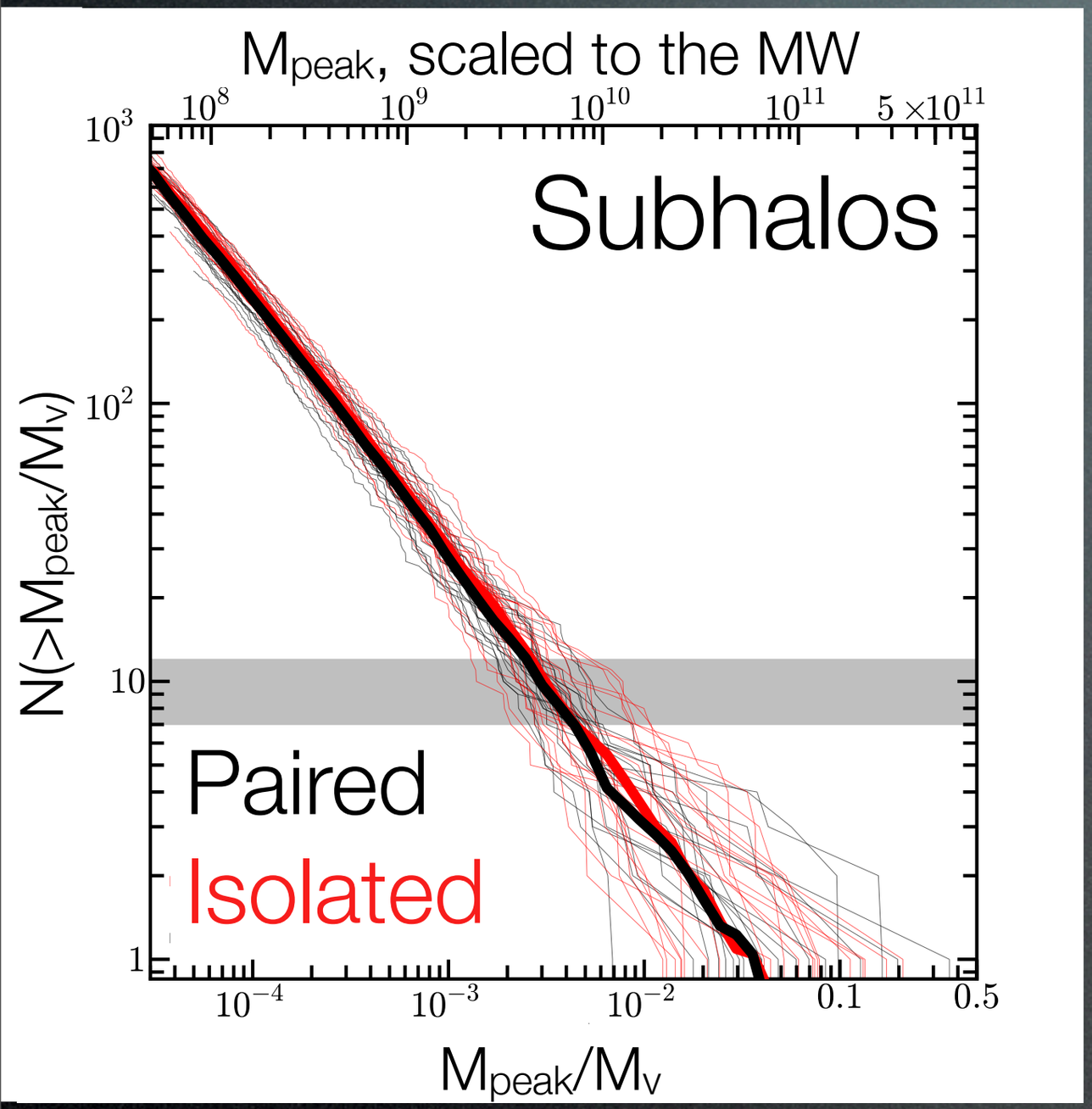
- Reliably identify halos expected to host the ultra-faint dwarf satellites ($M_{peak} = 6 \times 10^7\ M_{sun}$)
- Up to 15 million particles within R_v and up to 61 million within uncontaminated regions, which are as large as 43 Mpc^3


Hera
Zeus
Orion
Taurus
Kek
Kauket
Scylla
Charybdis
Romulus
Remus
Serena
Venus
Sonny
Cher
Hamilton
Burr
Lincoln
Douglas
Hall
Oates
Siegfried
Roy

Nearby Halo Counts



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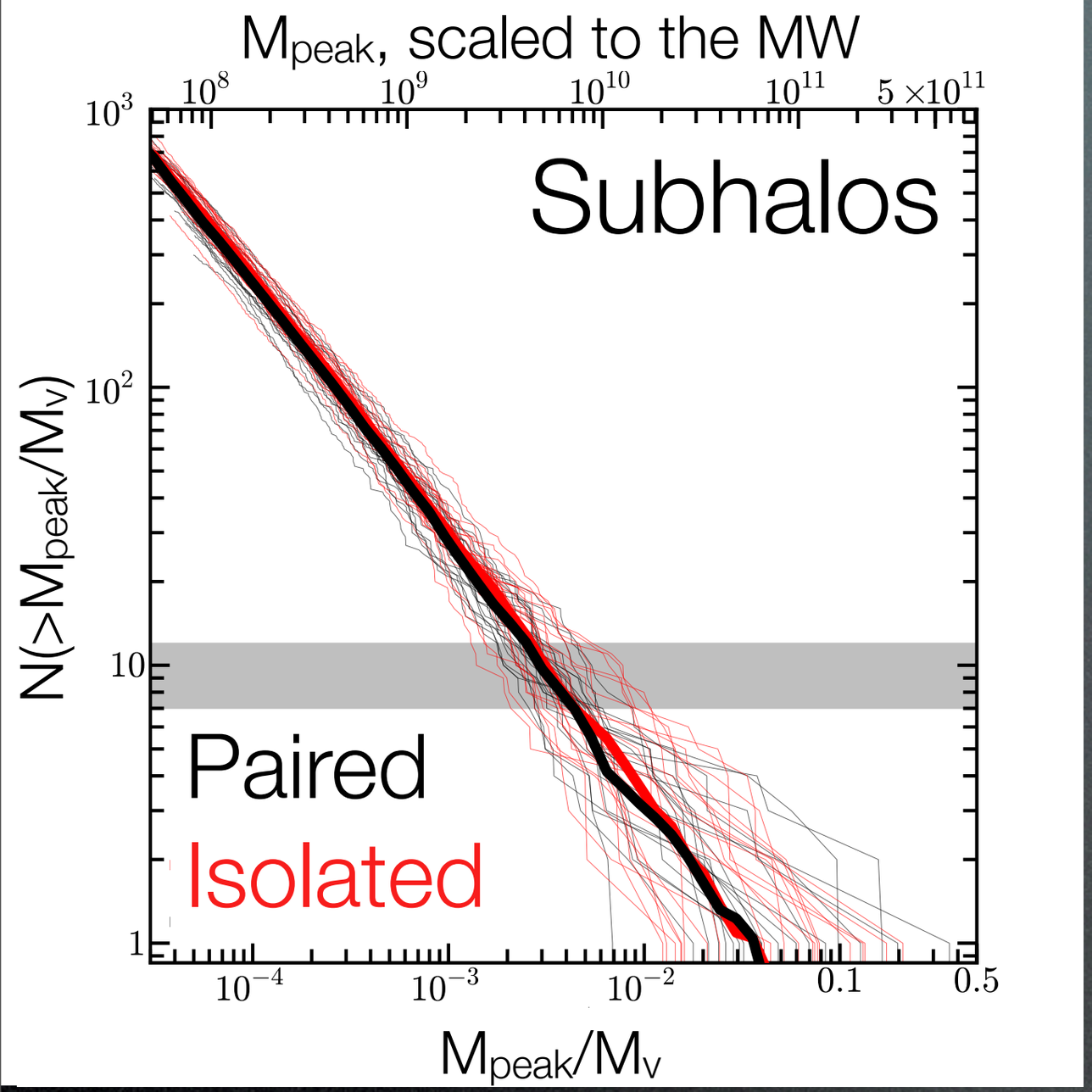
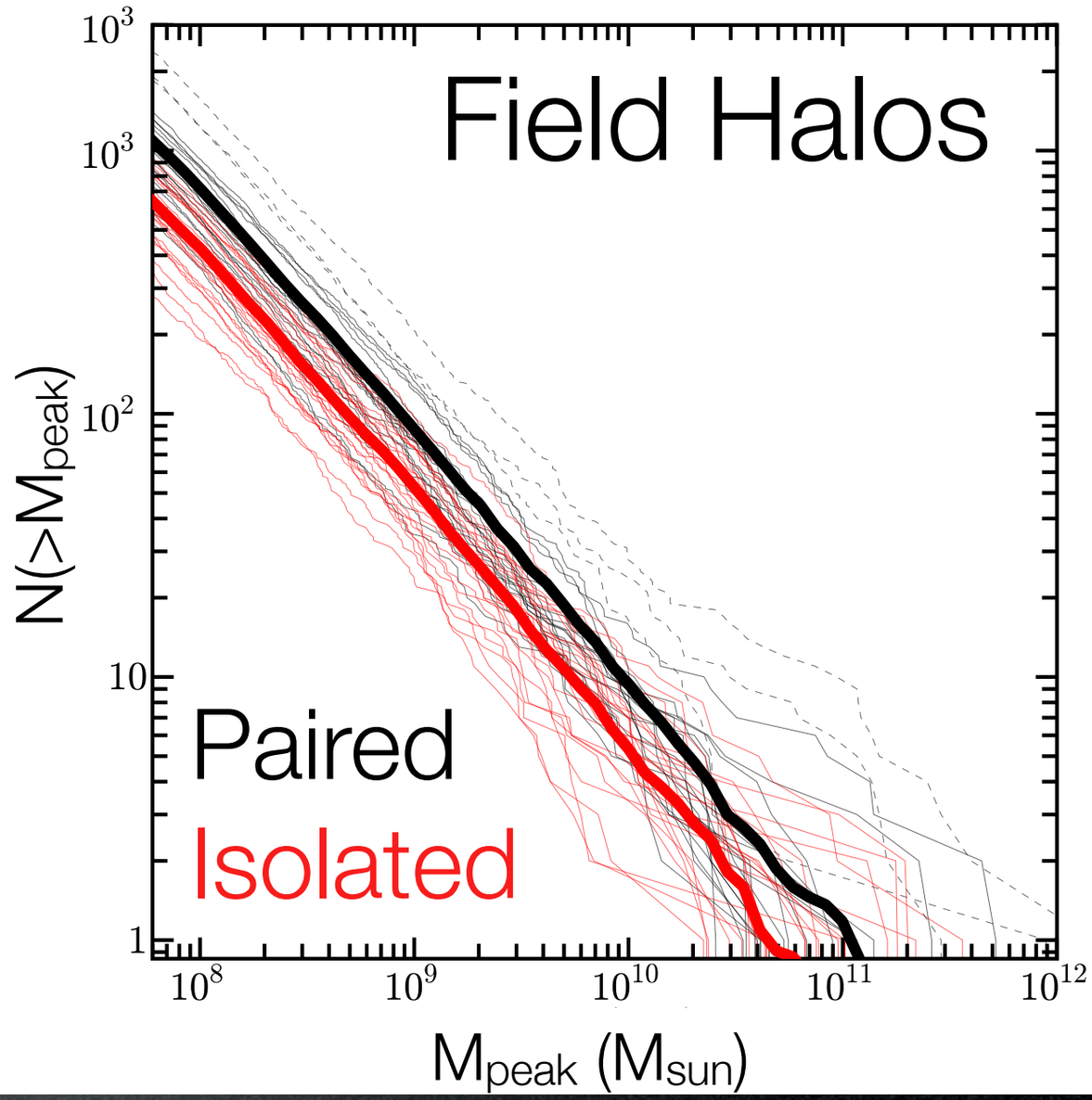
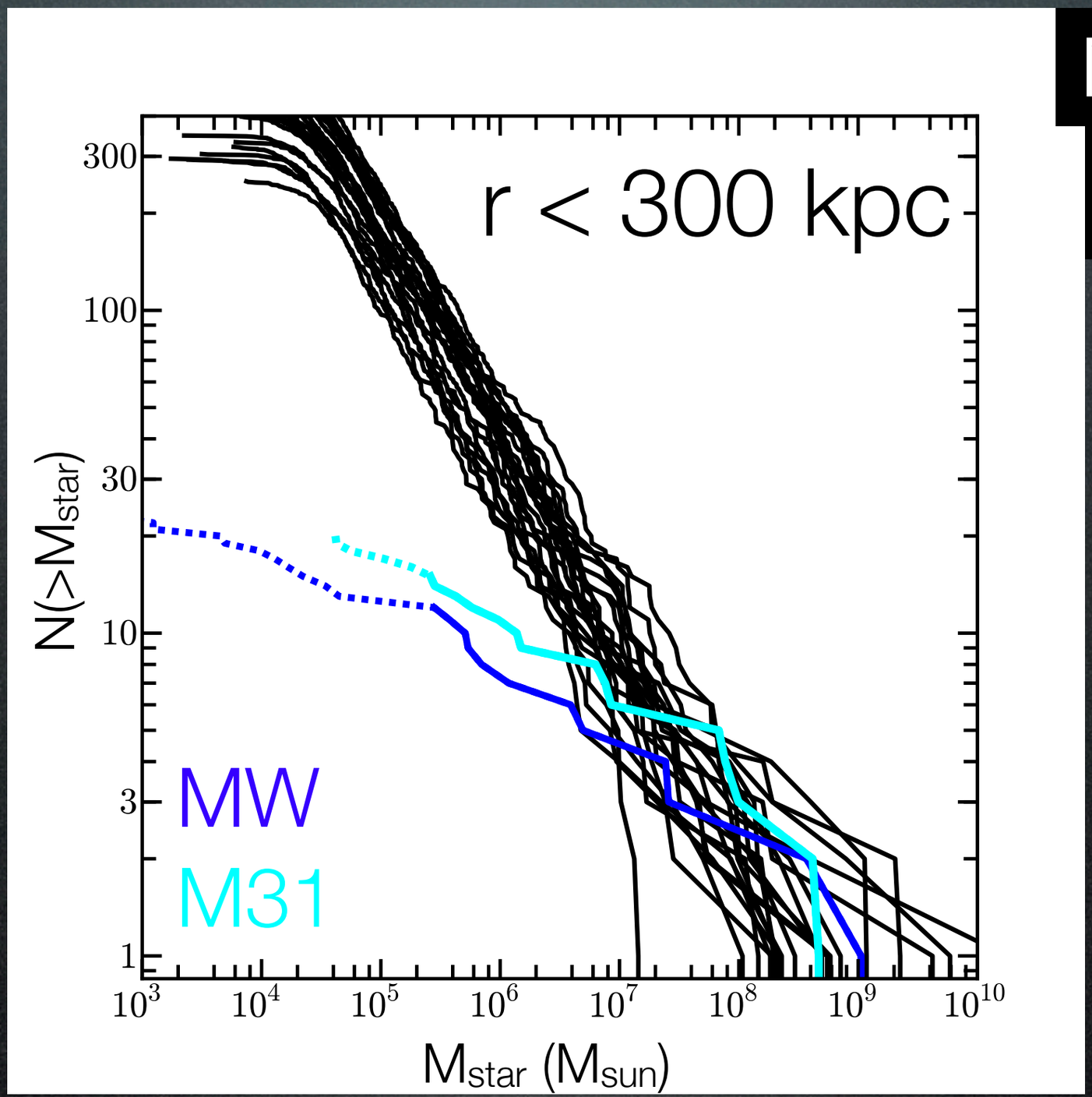




Mass functions agree within R_v, but

~80% more halos at fixed M_{peak} in the field

Implications for AM

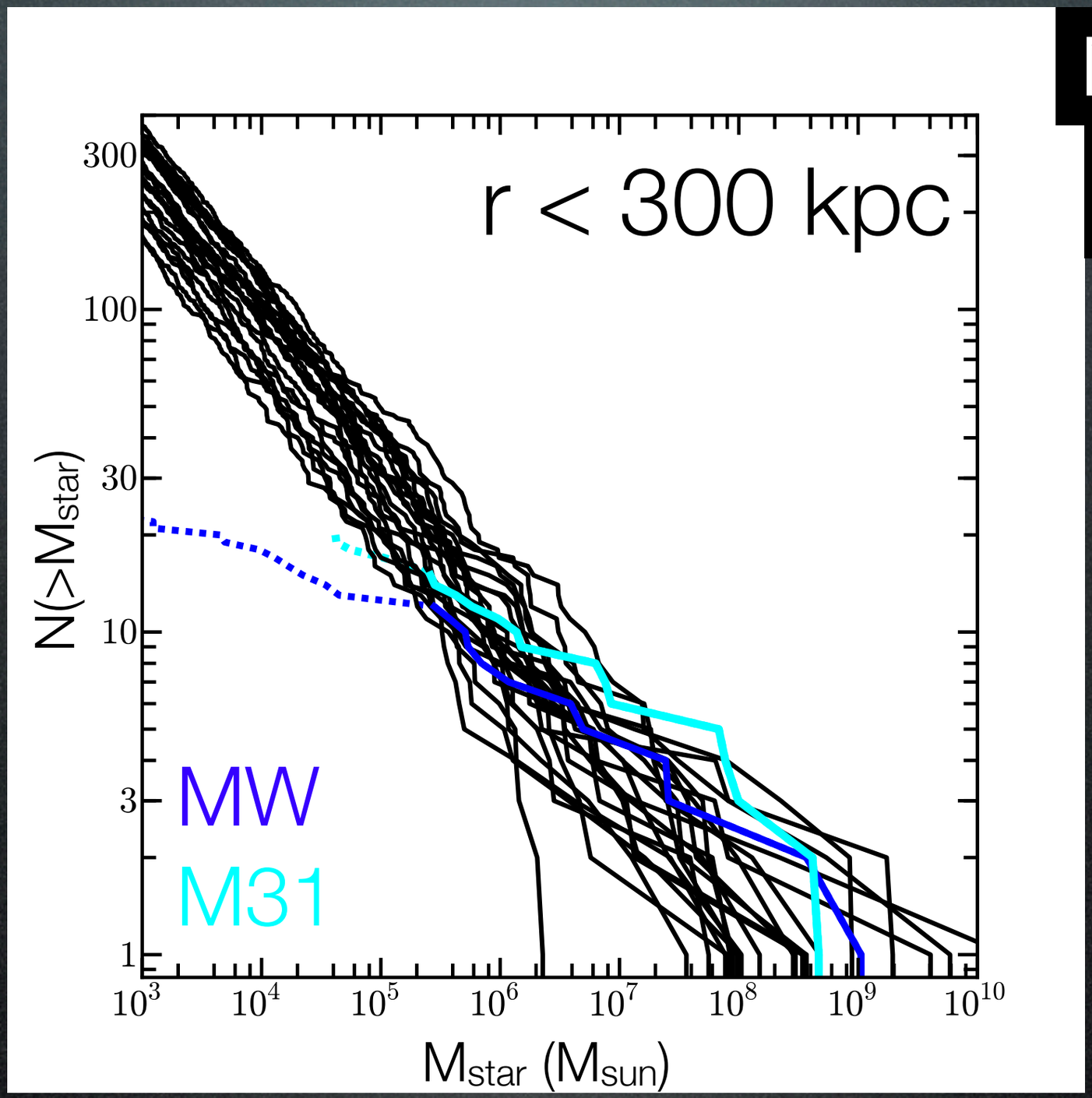


$M_{star} \propto M_{halo}^{\gamma}$

$\gamma = 1.412$

Behroozi+2013 abundance matching predicts too many low mass galaxies

Implications for AM

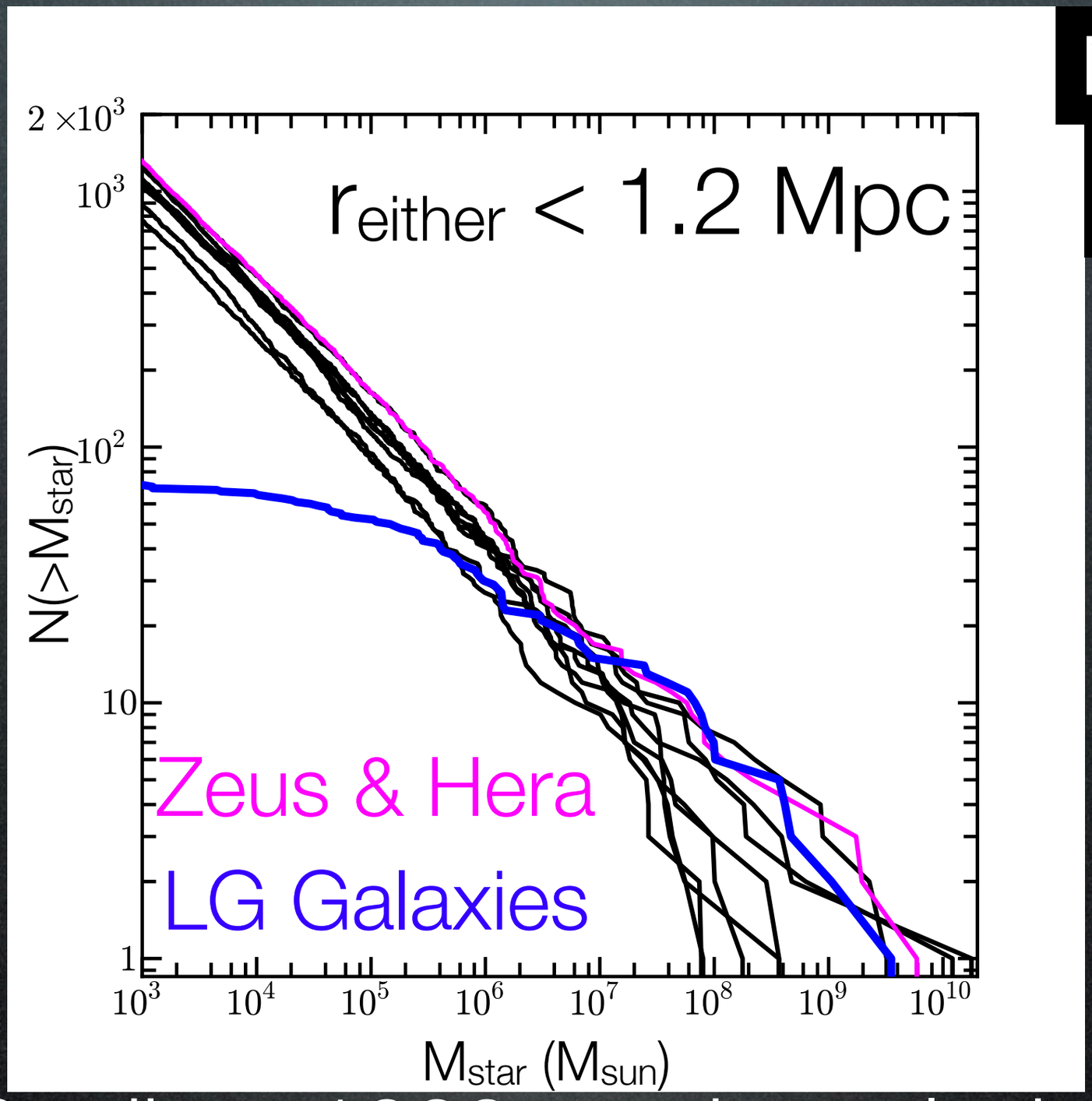


$M_{star} \propto M_{halo}^{\gamma}$

$\gamma = 1.92$

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

Field Galaxy Counts

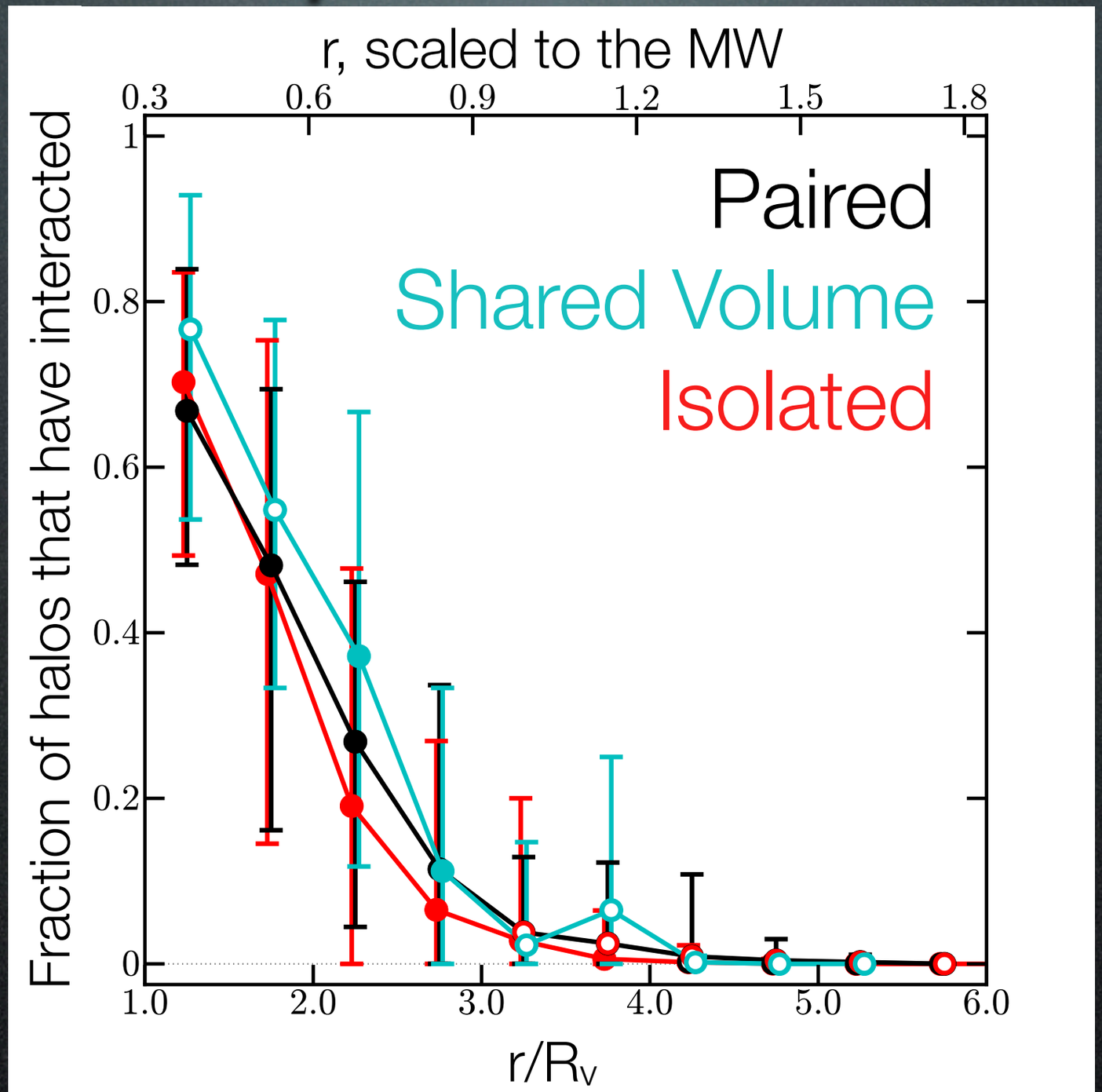


$M_{star} \propto M_{halo}^{\gamma}$

γ = 1.92

Predict ~1000 nearby galaxies with $M_{star} > 10^3\ M_{sun}$ (~70 known)

Backsplash Galaxies



Even at 2-2.5 x R_V, ~20% of field halos have previously passed within the virial radius of the host

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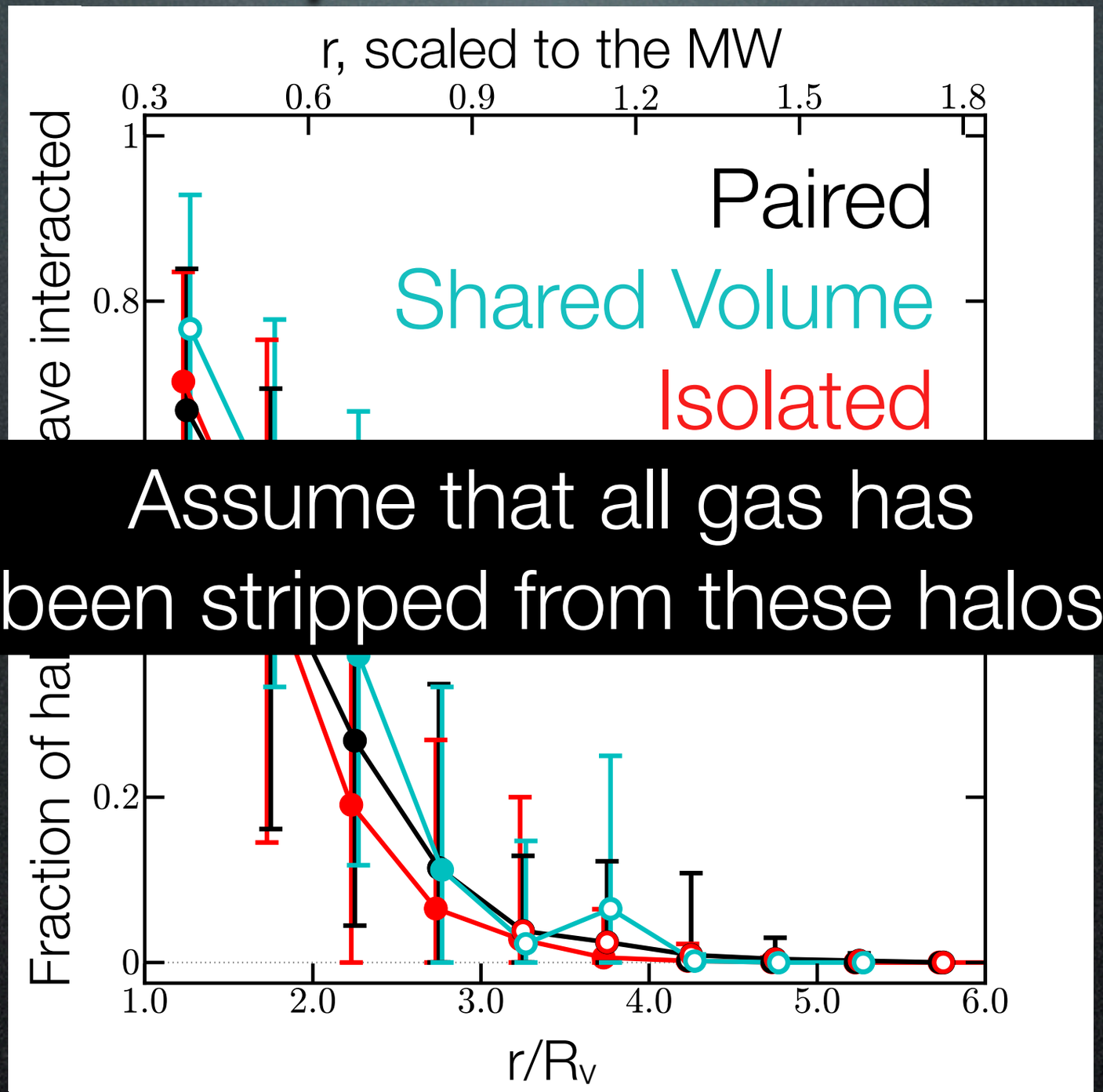


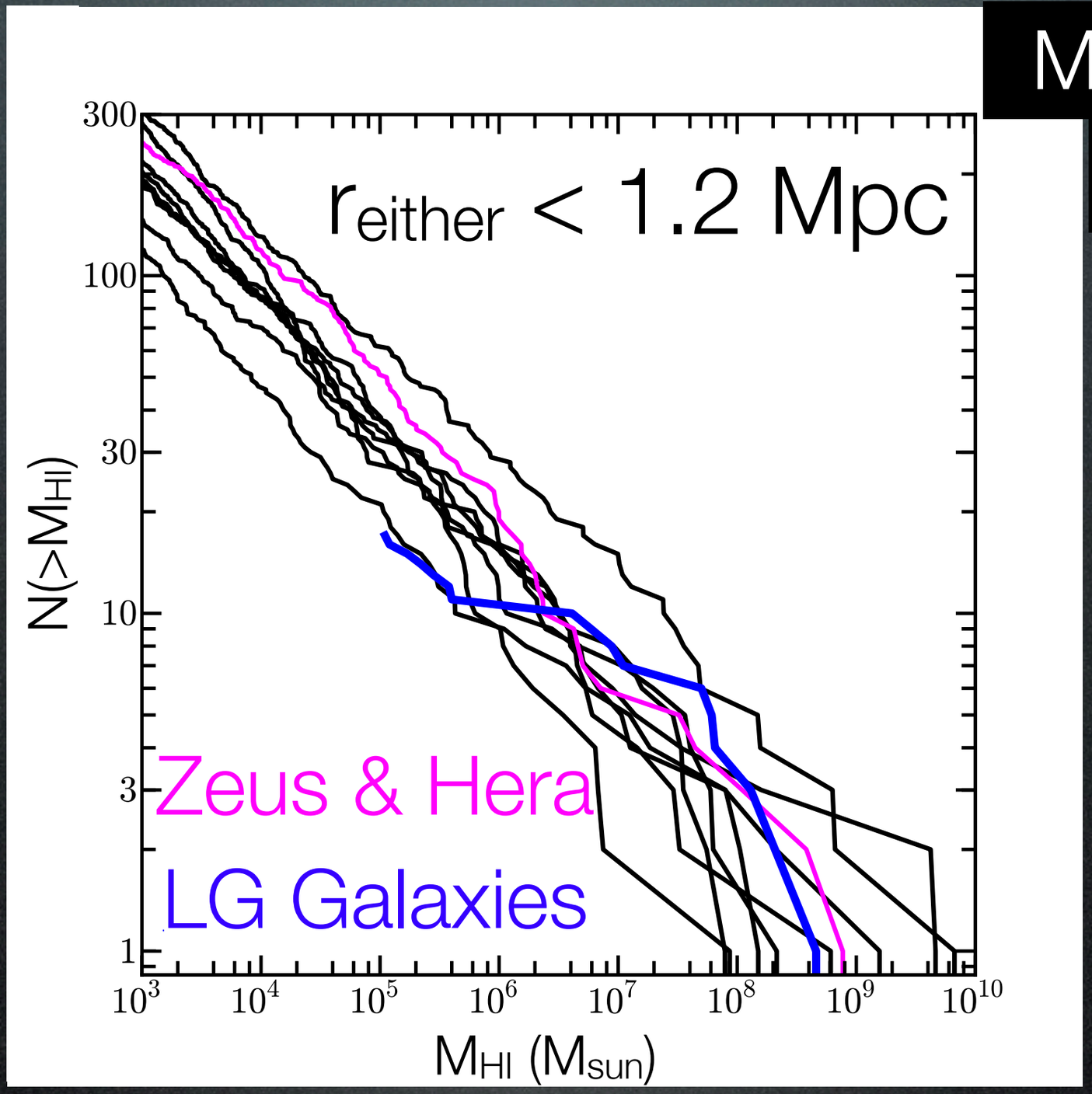
Assume that all gas has been stripped from these halos

Even at 2-2.5 x R_V, ~20% of field halos have previously passed within the virial radius of the host

Local HI Mass Function

$M_{HI} \propto M_{star}^{\beta}$

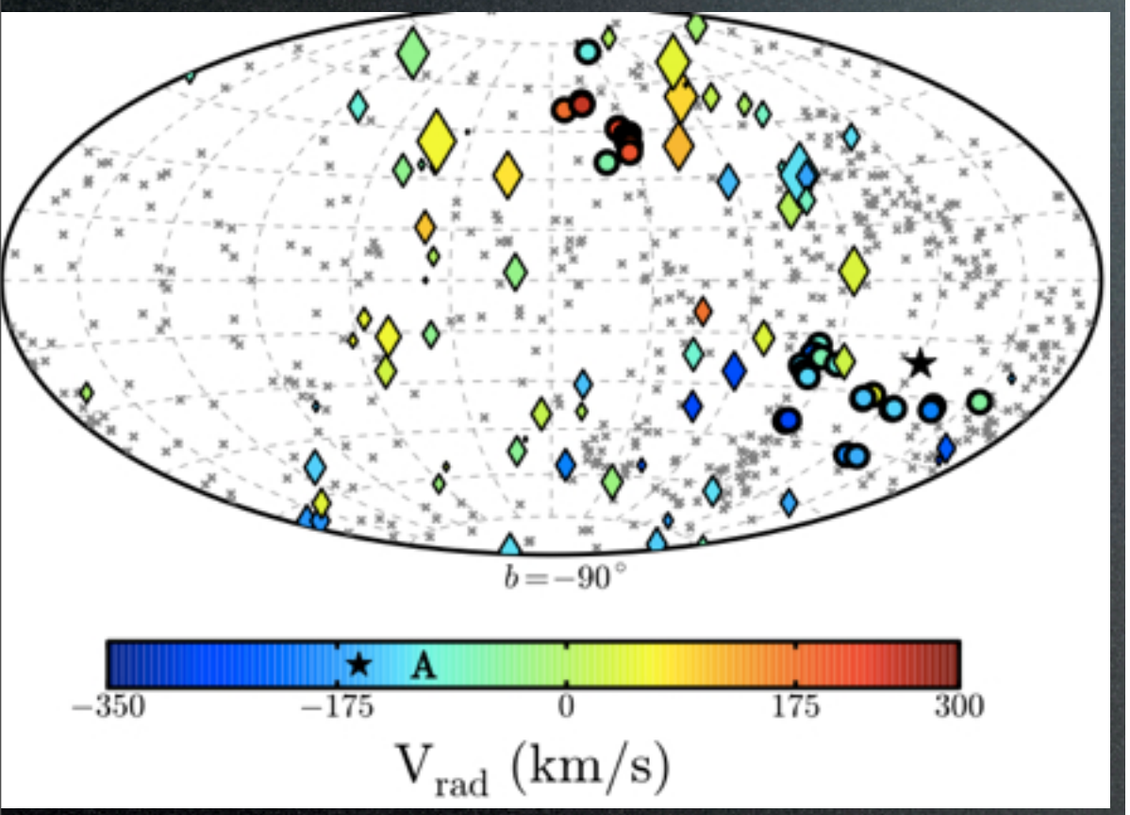
$\beta = 1.2$

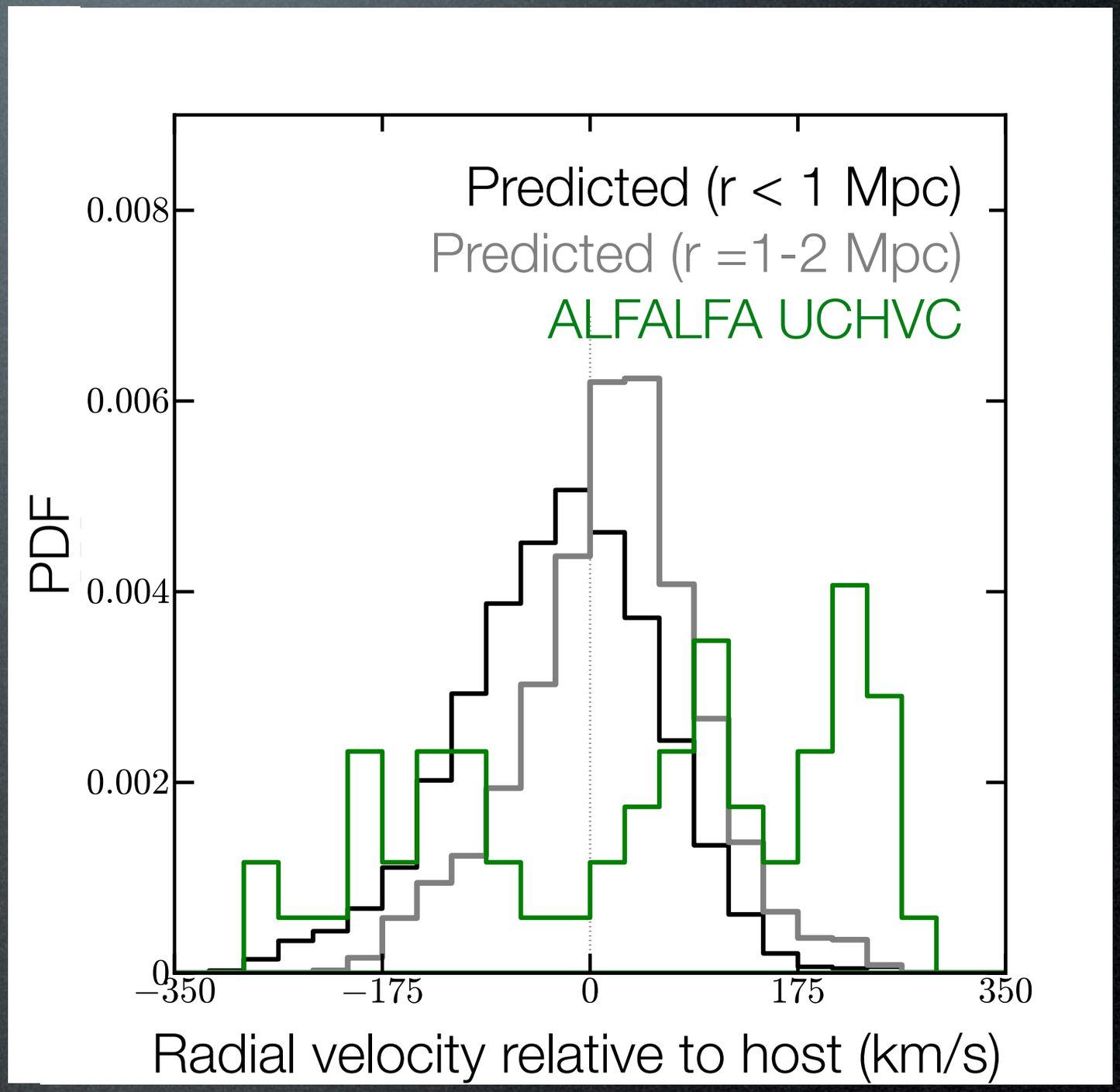


Local data agree well above incompleteness limit; predict only ~100 missing objects near the LG

Dynamics of Gas Rich Halos

Predicted gas-rich dwarfs w/in ~1 Mpc





Gas rich halos (i.e. those that have never passed within R_V) are preferentially inflowing

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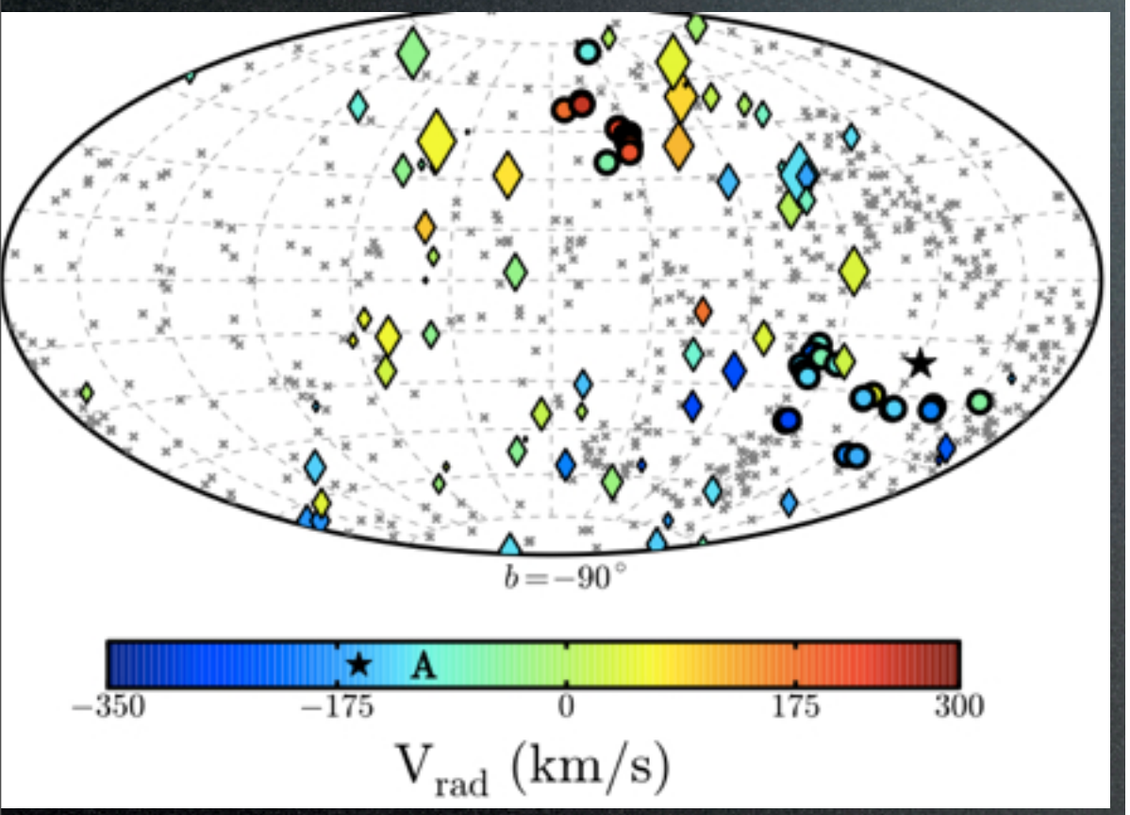

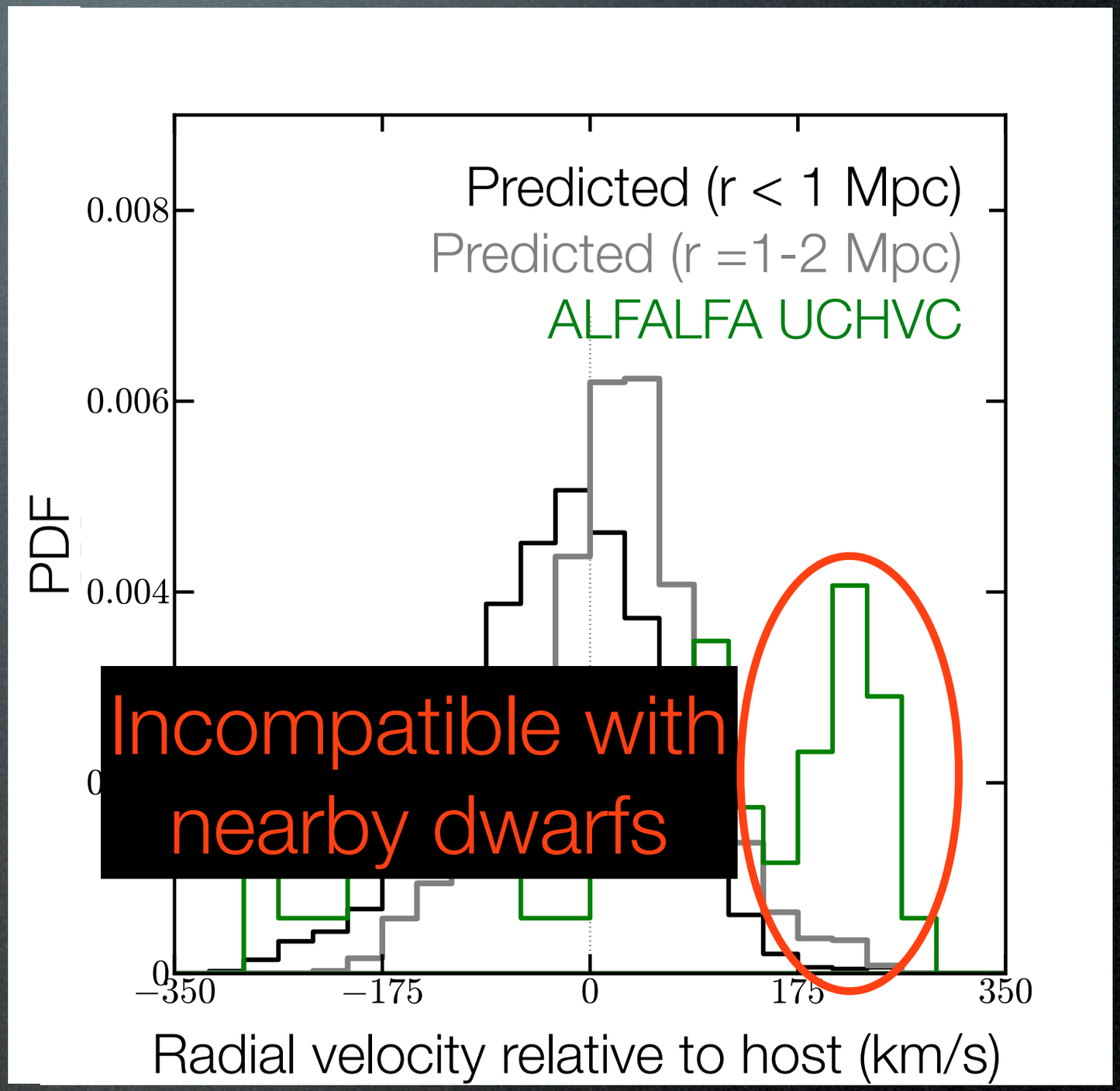

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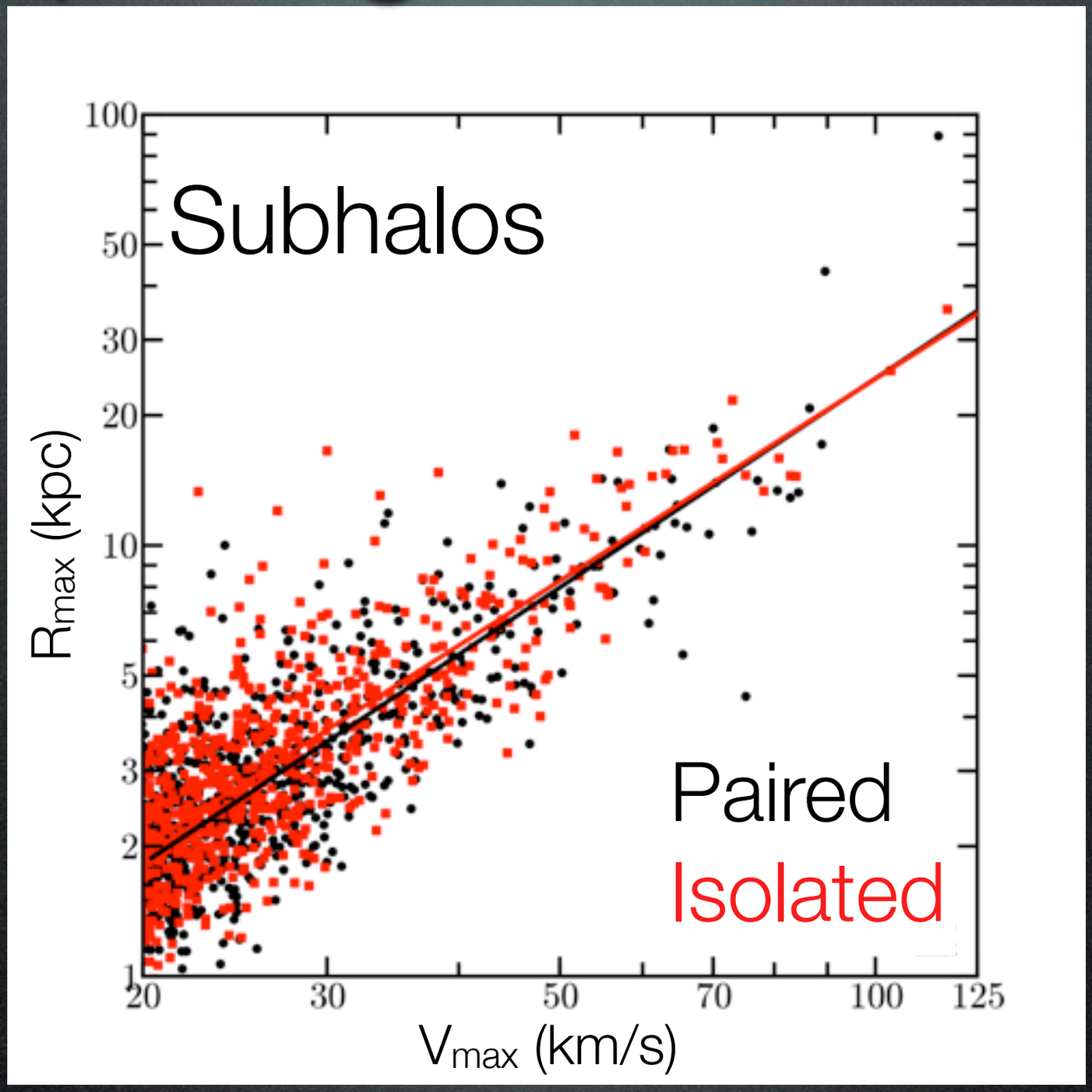
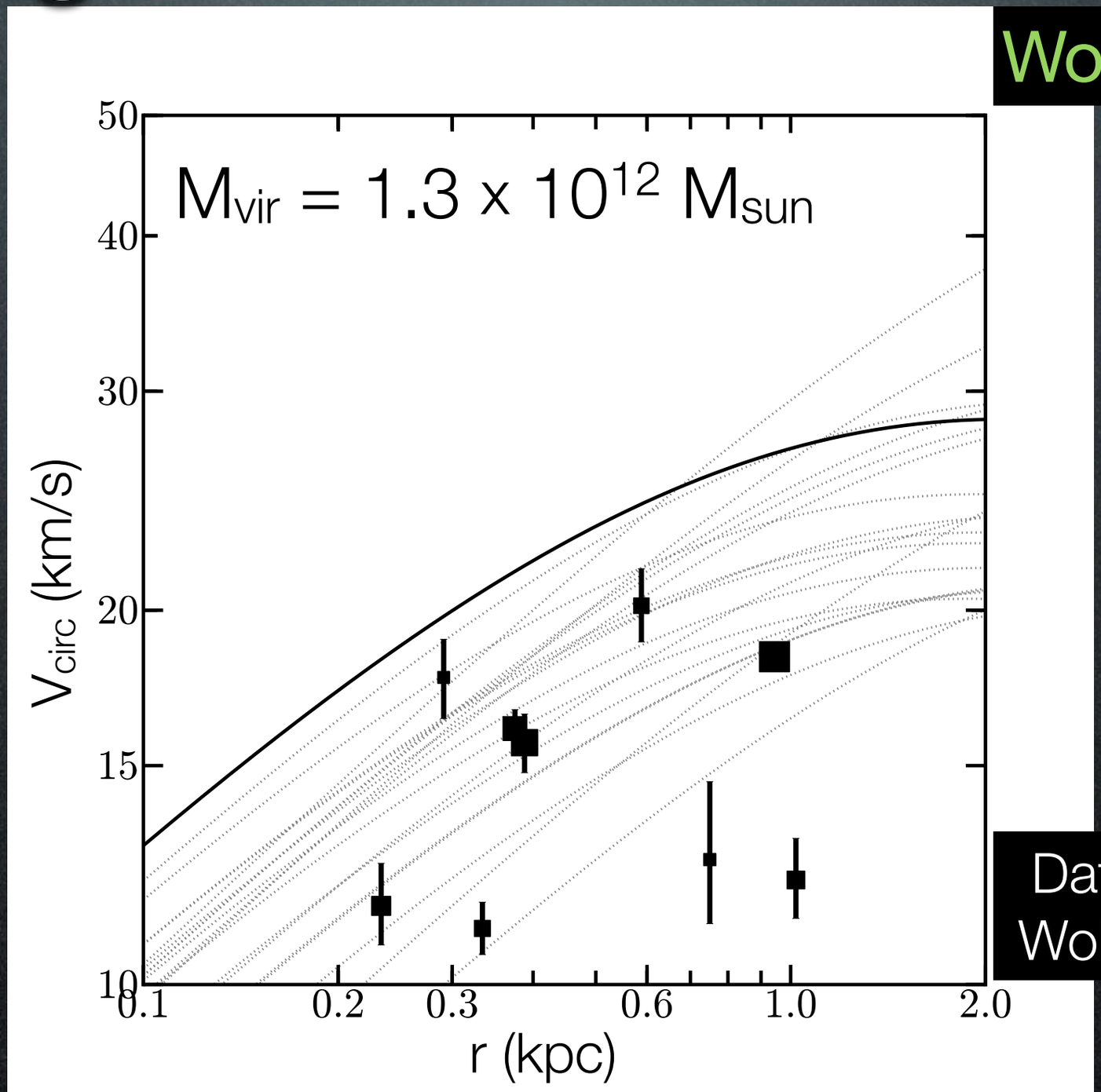
Comparing Halo Structure



Populations agree, so we can combine them for better statistics

Too Big To Fail in ELVIS Hosts

Work in progress!



Data from Wolf+2010

Count halos with V_{circ} denser than *all* the bright MW satellites

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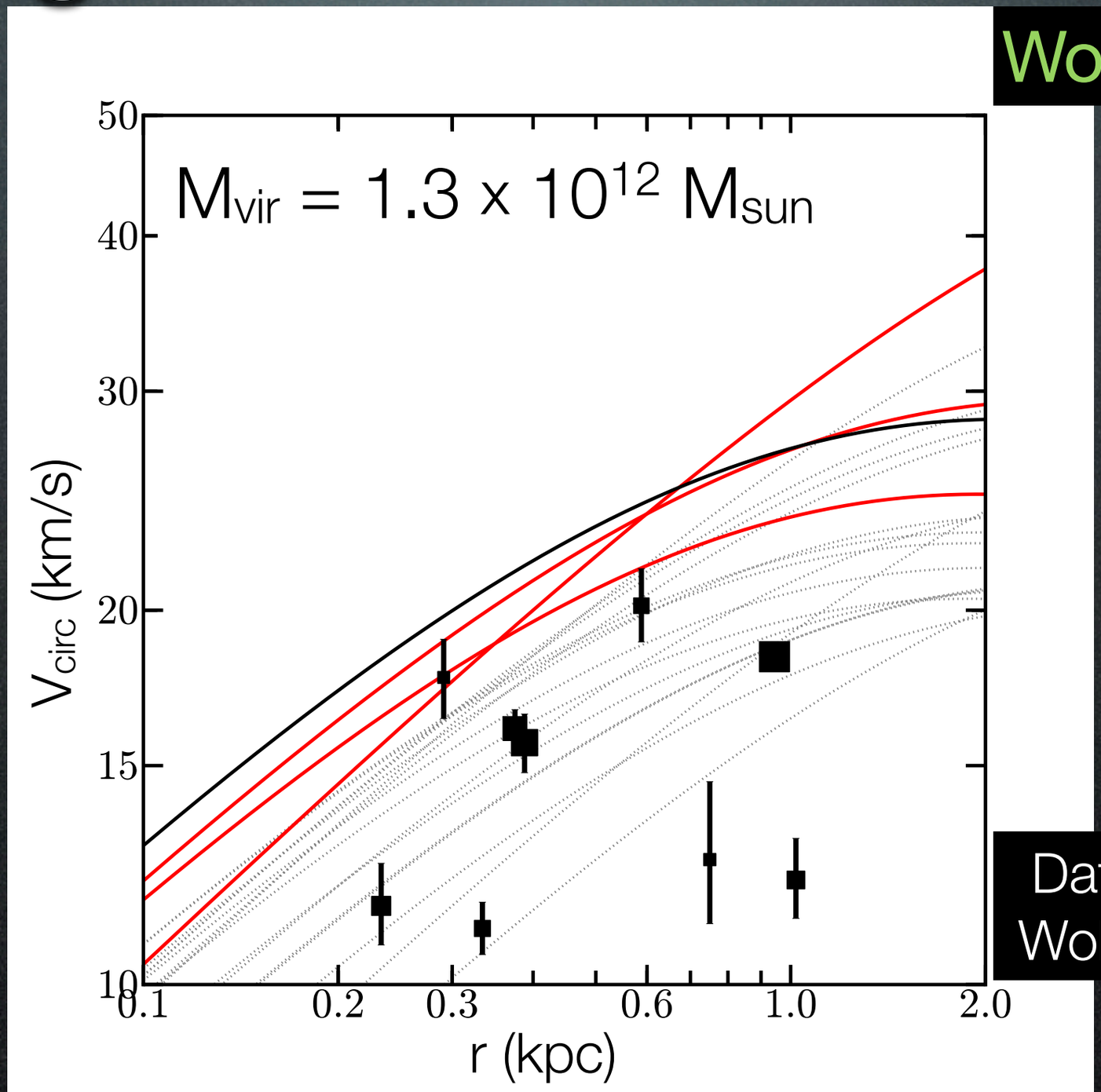

Data from Wolf+2010

Accounting for the rarity of,
e.g., Draco exacerbates the problem

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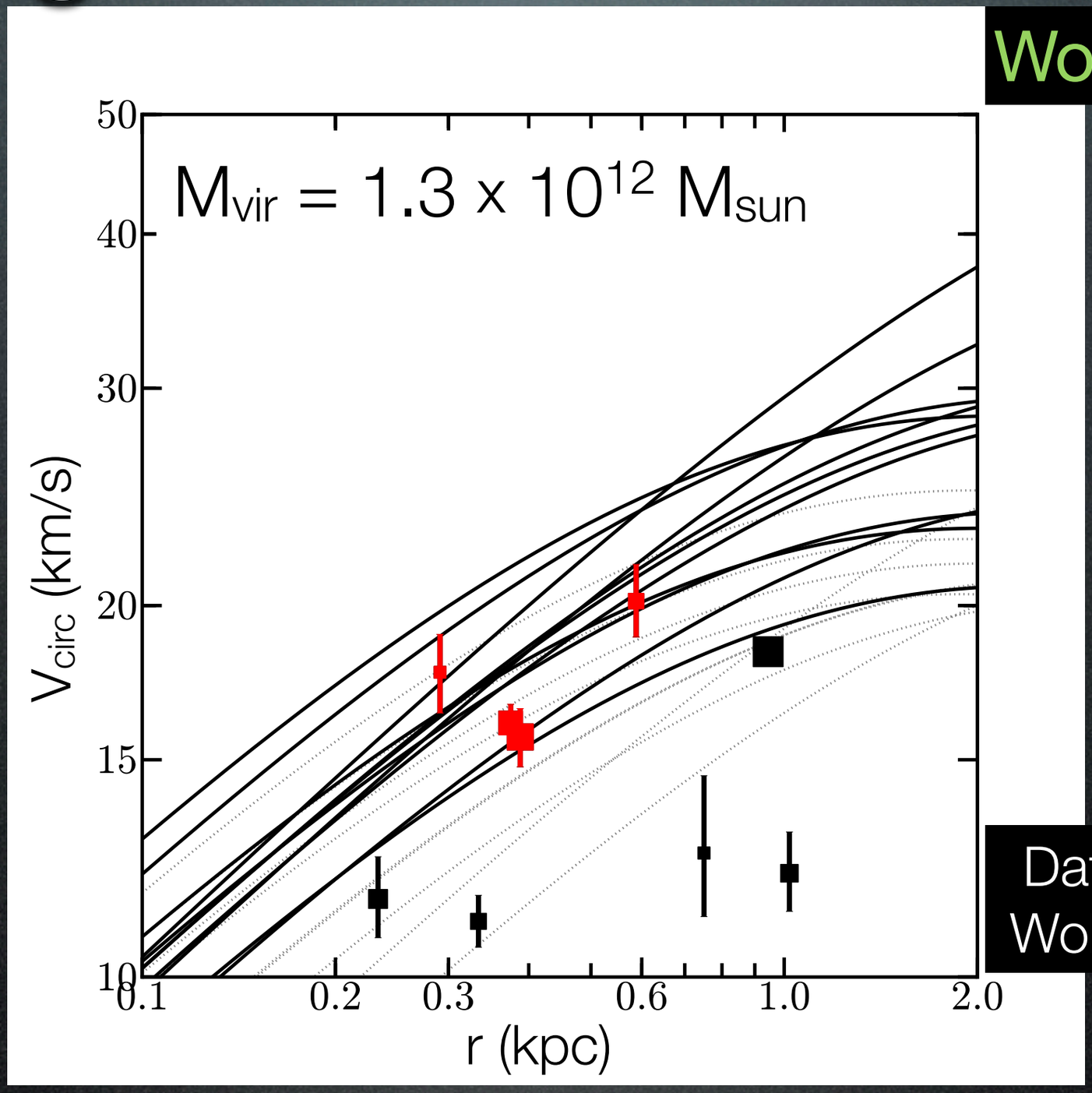
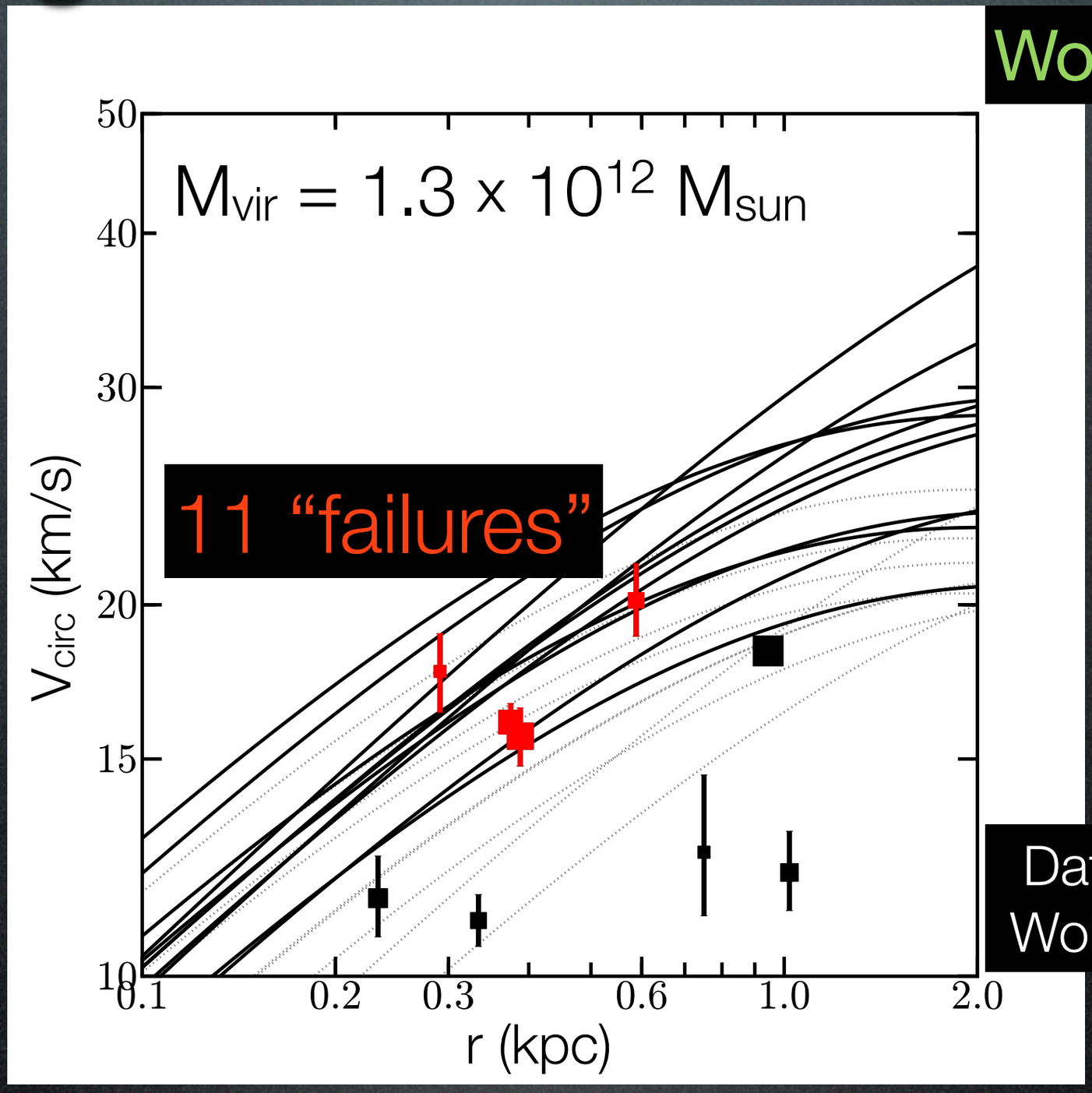


Data from Wolf+2010

Count dense subhalos without corresponding dense satellites

Too Big To Fail in ELVIS Hosts

Work in progress!

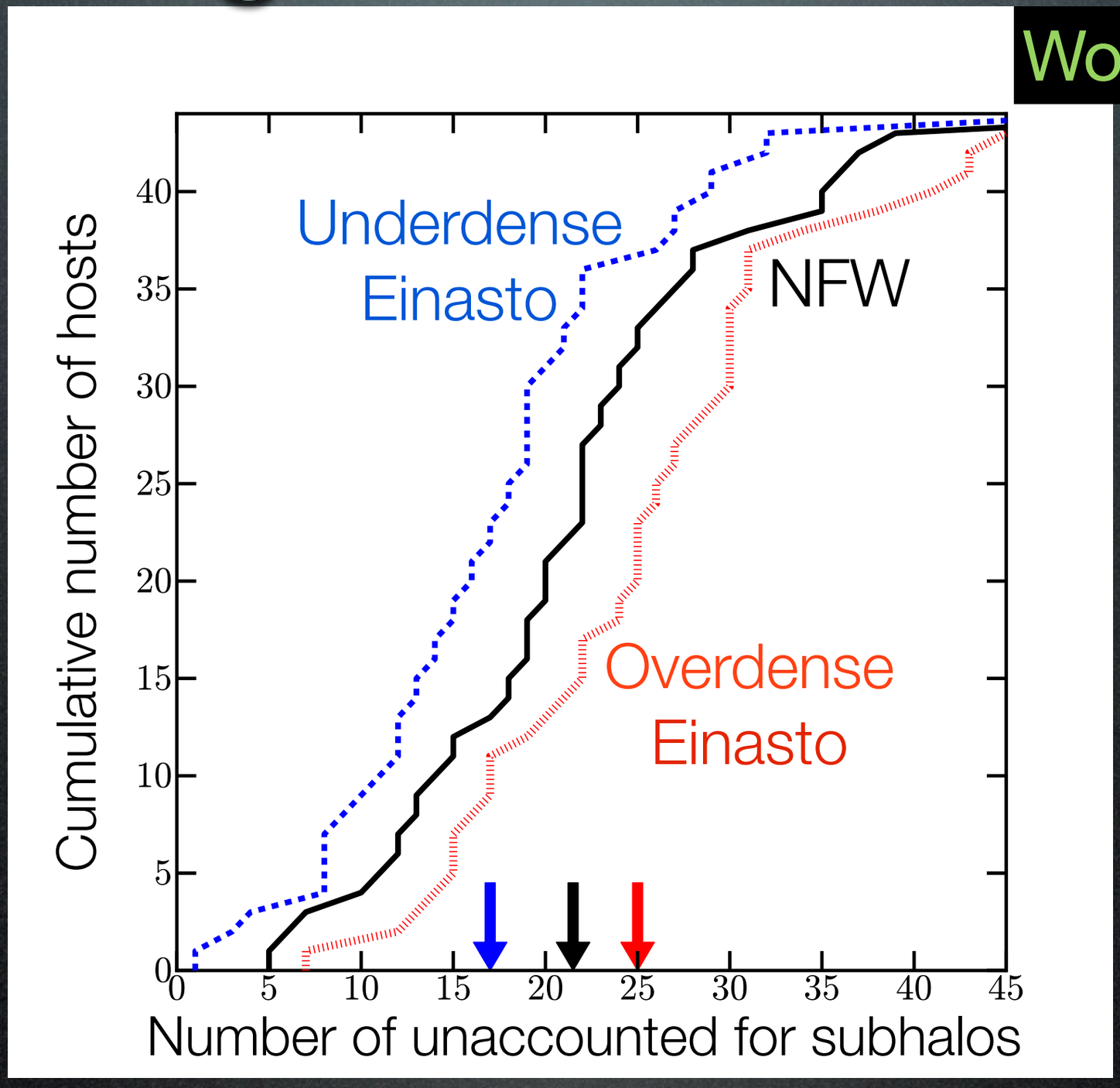


Data from Wolf+2010

Count dense subhalos without corresponding dense satellites

Counting “Massive Failures”

Work in progress!



~15-25 unaccounted for subhalos in each host, and all hosts have at least one “massive failure”

Summary of (some) ELVIS Results

- **Halo counts:** Paired/isolated samples agree within R_v, but LG hosts have ~80% more nearby field halos, which LSST, etc. will soon test
- **Abundance matching:** Flatter faint-end slope implied by MW/M31 satellites predicts ~1000 galaxies near the LG with $M_{star} > 10^3\ M_{sun}$
- **Gas rich halos:** Predict ~100 unfound gas-rich (non-backsplash) halos, which are preferentially inflowing (unlike many ALFALFA high-velocity clouds)
- **Too Big To Fail:** Requiring that each dense galaxy lives in only one subhalo results in ~15-25 "failures" per host, with a minimum of ~1-7

Ongoing ELVIS Projects

- **Counting dense field satellites** around LG-like halos
- **Finding planes of satellites** to test the commonality of the plane recently identified around Andromeda (with Basilio Yniguez, Mike Boylan-Kolchin, and James Bullock)
- **Constraints on WDM** from the MW/M31 luminosity functions (Shunsaku Horiuchi and Jose Oñorbe)
- **Effects of a disk** on the substructure population of an MW-size halo (with Andrew Grauss and James Bullock)
- **Ultrafaint Galaxy Luminosity Function** under various dark matter models (Cassi Lochhaas and Annika Peter)

We will publicly release the data soon -- contact us for early access!