The Milky Way Dwarf Galaxy Population in the DES and LSST Era

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Introduction

Large area surveys such as SDSS and PAndAS have facilitated the discovery of more than a dozen ultra-faint ($L \gtrsim 5 \times 10^4\ L_\odot$) dwarf galaxies in the Local Group (LG). Ongoing and upcoming surveys such as the Dark Energy Survey (5,000 deg^2) and the Large Synoptic Survey Telescope (20,000 deg^2) should significantly increase the LG dwarf census and help address a key outstanding question: are the observed properties of LG dwarfs – e.g., their total numbers and spatial distribution – consistent with the expectations from ΛCDM models? **We predict the total number and spatial distribution of Milky Way dwarfs to be discovered in the DES and LSST surveys**, using a combination of (1) ΛCDM MW+M31 galaxy formation simulations, (2) robust SDSS detection limits, and (3) multiple models for which dark matter subhalos may host dwarf galaxies.

Dwarf Galaxy Toy Models

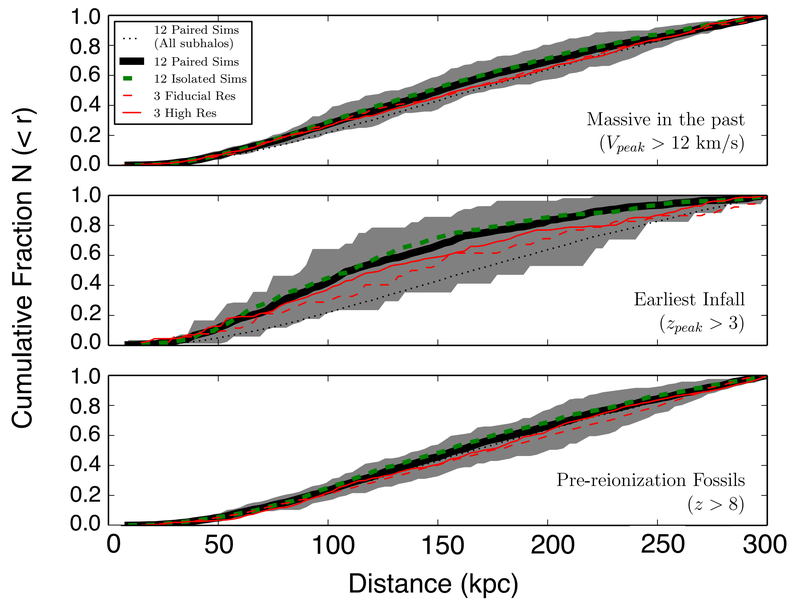
To obtain completeness corrections for the SDSS dwarf population, we use the spatial distributions of dark matter subhalos from the Exploring the Local Volume In Simulations (ELVIS; Garrison-Kimmel et al. 2014) suite of N-body simulations. **We consider three physically motivated toy models** for populating subhalos with galaxies:

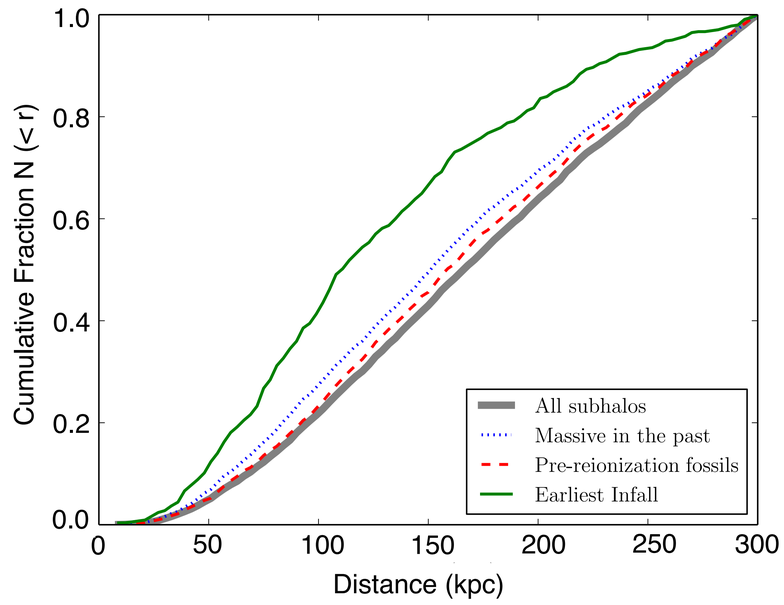
- **Massive in the past**: subhalos with historical peak circular velocities $V_{peak} > 12$ km/s
- **Formed before reionization**: subhalos with resolved progenitors in the simulations at $z > 8$ and $V_{peak} < 20$ km/s
- **Earliest infall**: subhalos which reach their peak circular velocities at $z > 3$, or $t_{infall} \gtrsim 11.5$ Gyr ago

For each model, we simulate 100 mock-SDSS + DES/LSST survey pointings centered on the MW analog in the 12 paired ELVIS simulations. Each dwarf is corrected by the fraction of model subhalos within the dwarf's maximum detection distance (Walsh et al. 2009). The corrected number is scaled to the DES/LSST area and a range of point-source detection limits.

Predicted Spatial Distribution of Dwarfs

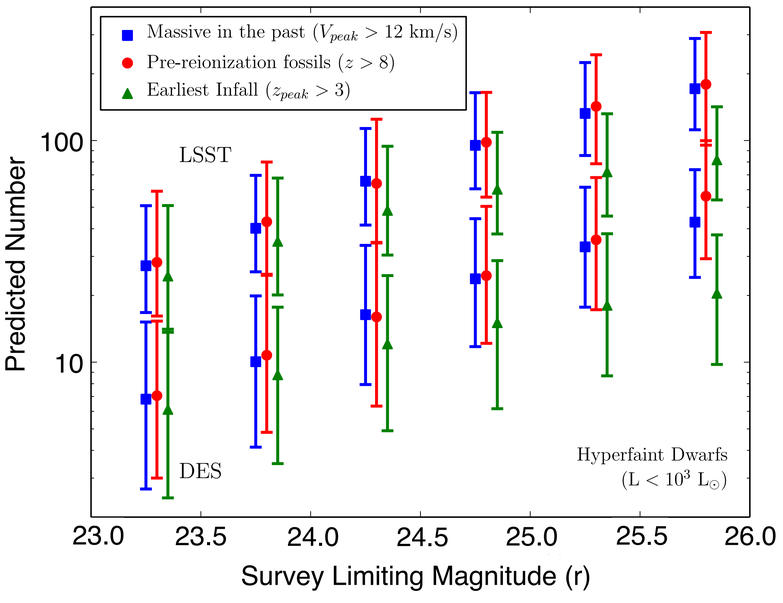
Hargis et al. 2014

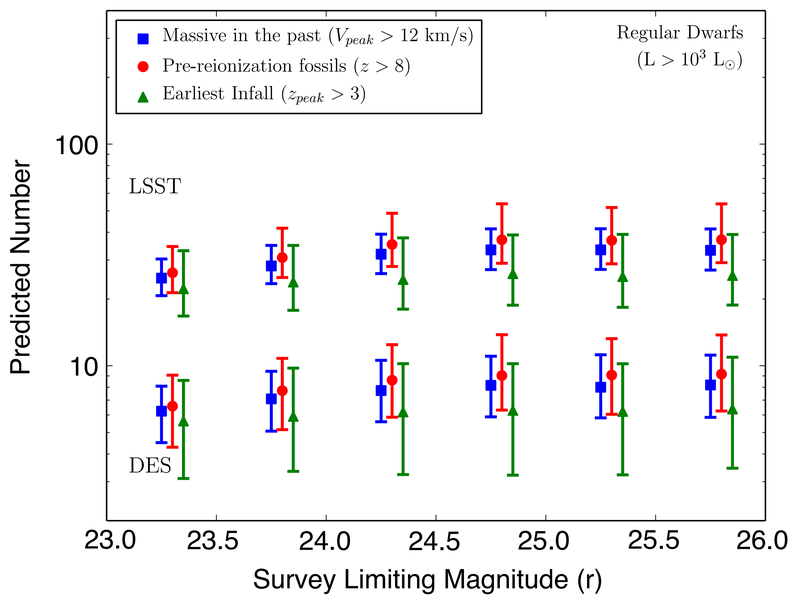




Predicted Number of Dwarfs vs. Survey Limiting Magnitude

Hargis et al. 2014





Results and Conclusions

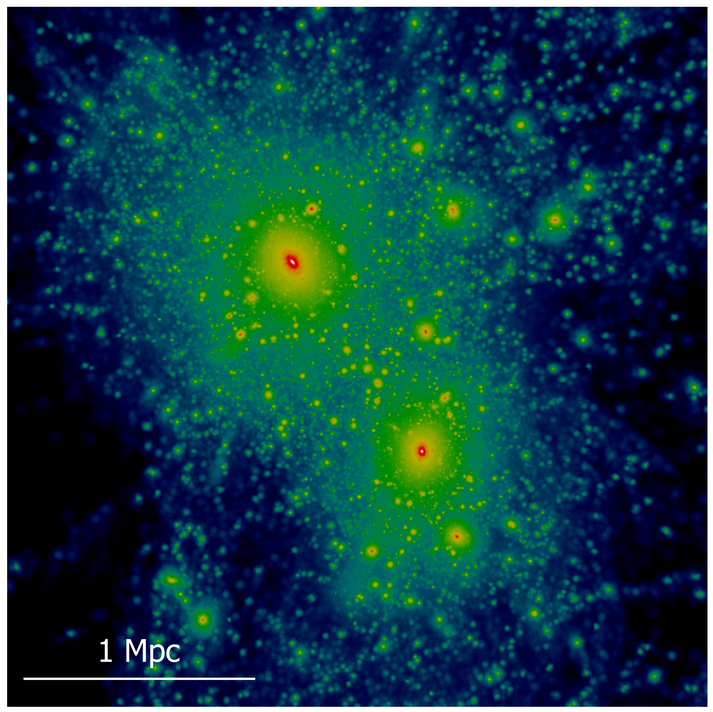
- The observed spatial distribution of Milky Way dwarfs in the LSST-era may discriminate between the earliest infall and other simplified models.
- The use of paired versus isolated simulations does not yield systematically different predictions for the Milky Way dwarf population.
- For relatively shallow survey limits, the discovery of only a few dwarfs in DES could be consistent with our lower limits.
- Within their footprint and at high Galactic latitudes, both DES and LSST (single-visit) should easily recover the full population of MW dwarfs with $L \gtrsim 10^3\ L_\odot$ within 300 kpc, since the RGB stellar populations in these galaxies are resolved at $r \sim 23.5$.

TABLE 2
PREDICTED NUMBER OF DWARF GALAXIES WITHIN $d = 300$ KPC

	All Sky (± 10/90)
$L > 10^3 L_\odot$	
Massive in the past	69^{+19}_{-14}
Pre-reionization Fossils	78^{+36}_{-21}
Earliest Infall	53^{+30}_{-16}
$L < 10^3 L_\odot$	
Massive in the past	477^{+305}_{-185}
Pre-reionization Fossils	485^{+277}_{-246}
Earliest Infall	197^{+145}_{-66}

[a]These numbers do not include objects like the "classical" dwarf galaxies.

Right: Example dark matter-only simulation of the Local Group from the ELVIS suite of simulations (Garrison-Kimmel et al. 2014).



References

Garrison-Kimmel et al. 2014, MNRAS, 438, 2578
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Walsh et al. 2009, AJ, 137, 450

Acknowledgments

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