Understanding Dwarf Galaxies in order to Understand Dark Matter

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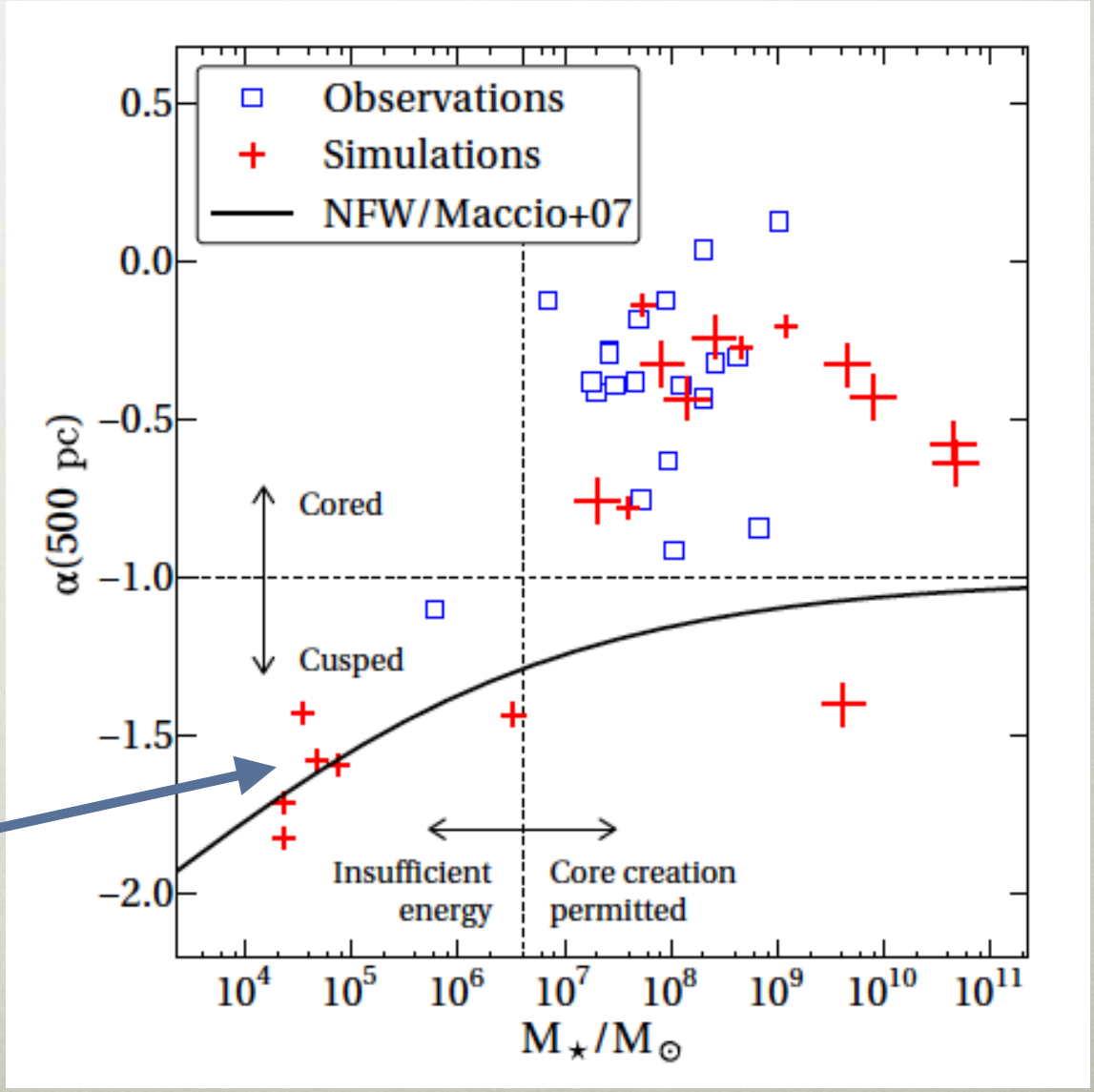
In collaboration with the University of Washington's N-body Shop™
makers of quality galaxies

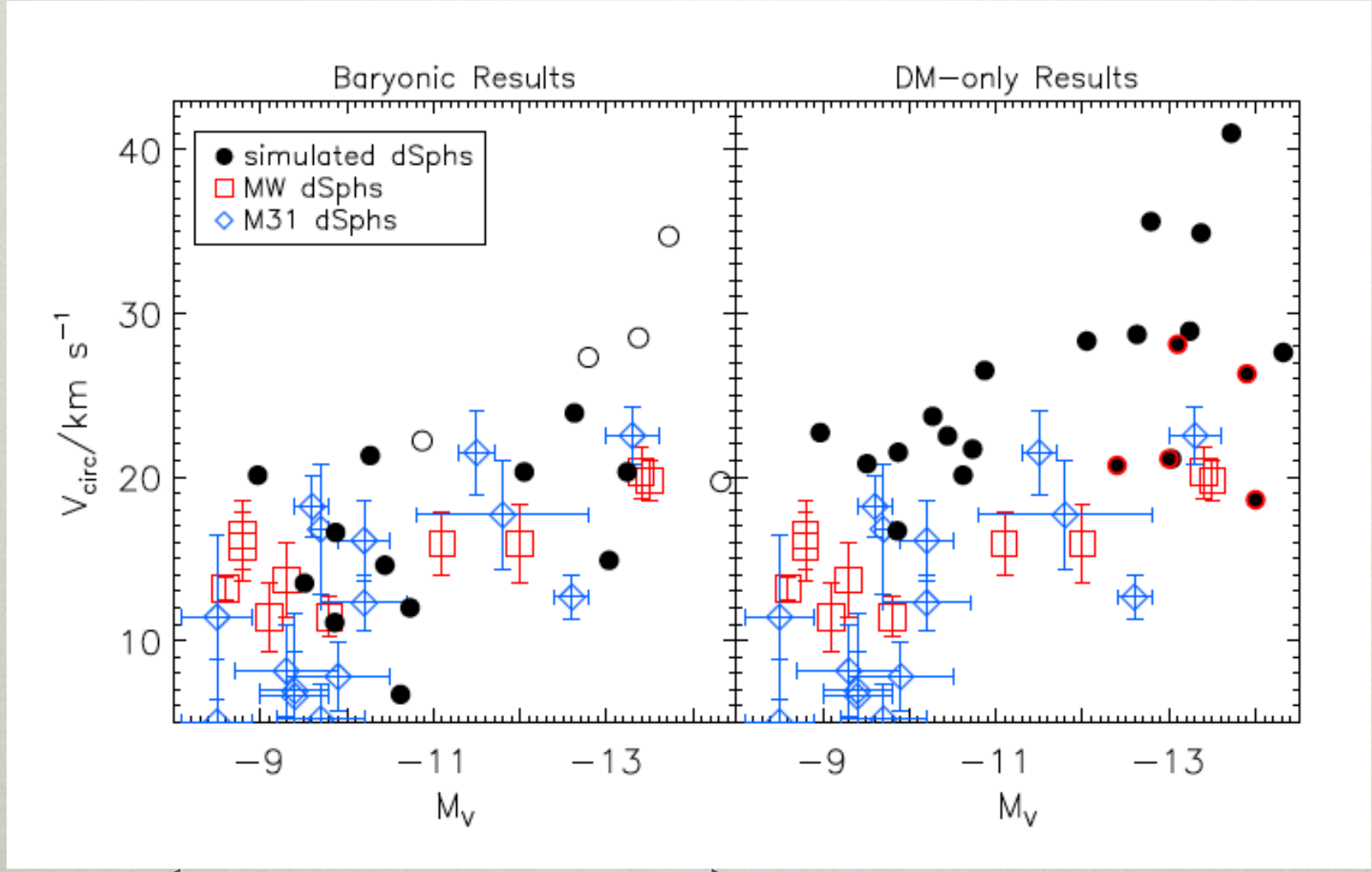
Starting Assumption:
There is No Small Scale "Crisis"

DM Cores in Galaxies

If galaxies in this mass range are observed to have large cores, then something beyond CDM is necessary

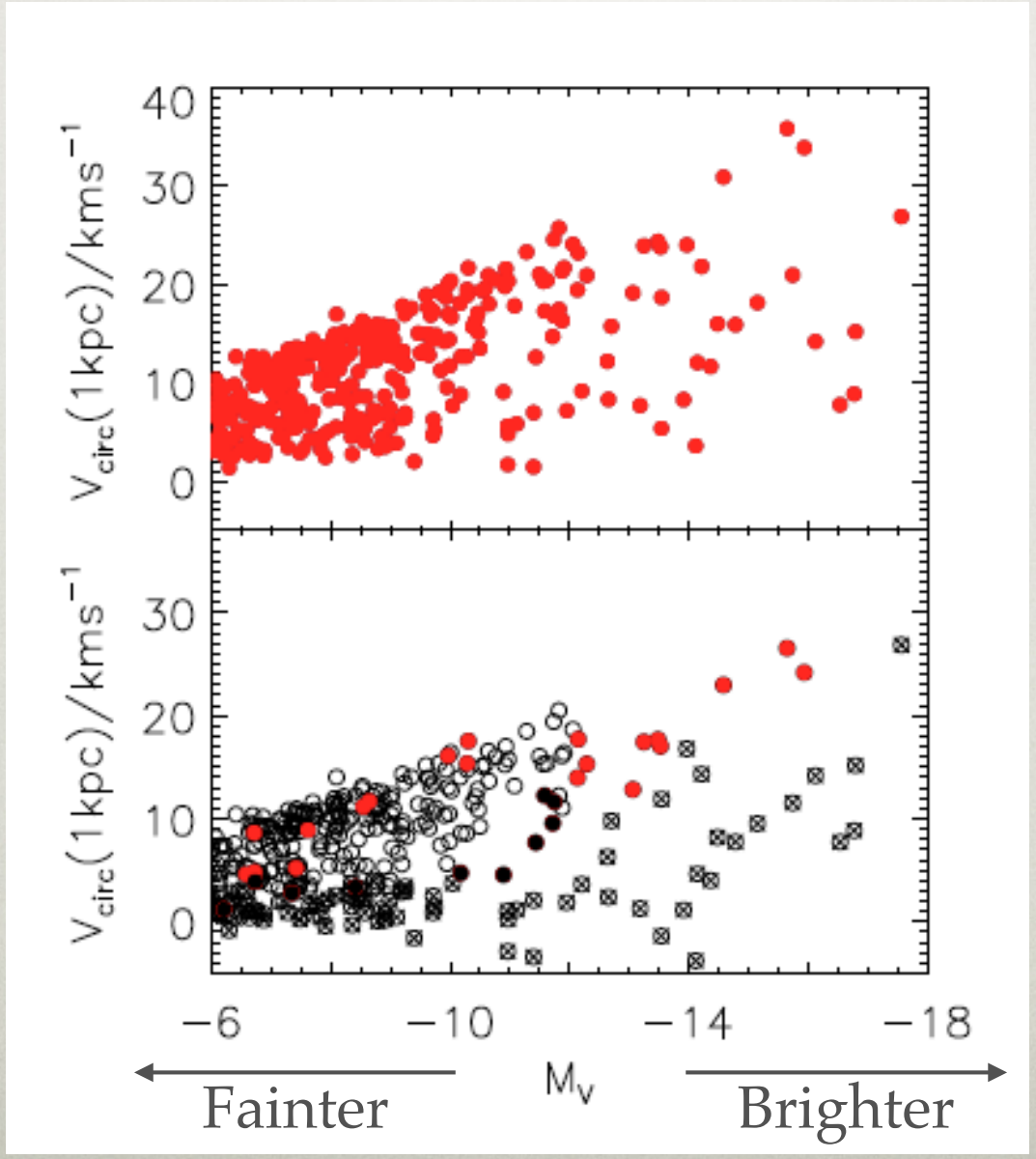


The Too Big to Fail Problem



Brooks & Zolotov (2014), ApJ, 786, 87, arXiv:1207.2468

Missing Massive Satellites?

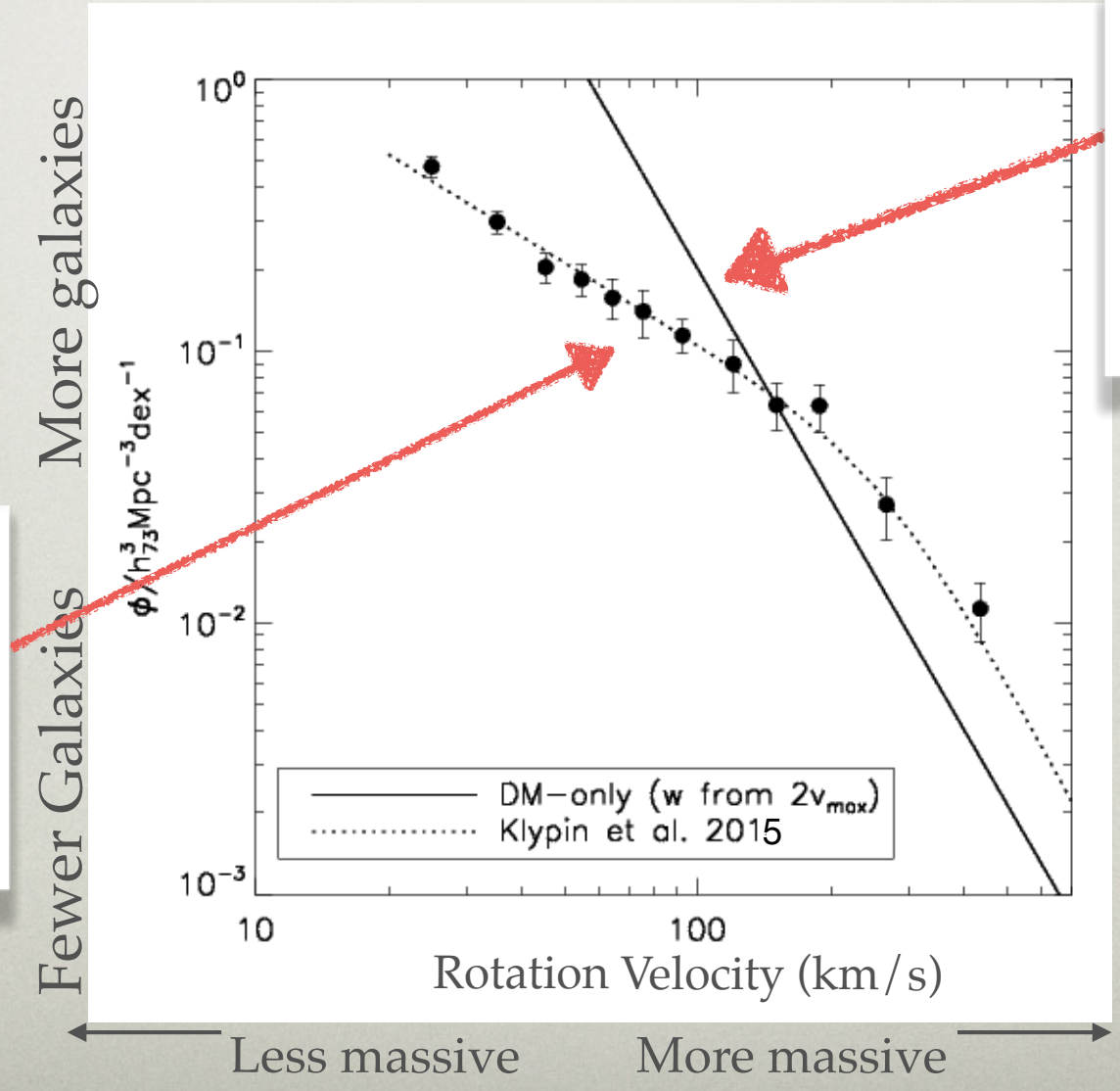


Brooks, Kuhlen, Zolotov, & Hooper (2013), ApJ, 765, 22, arXiv:1209.5394

The Missing Dwarf Problem in the Field

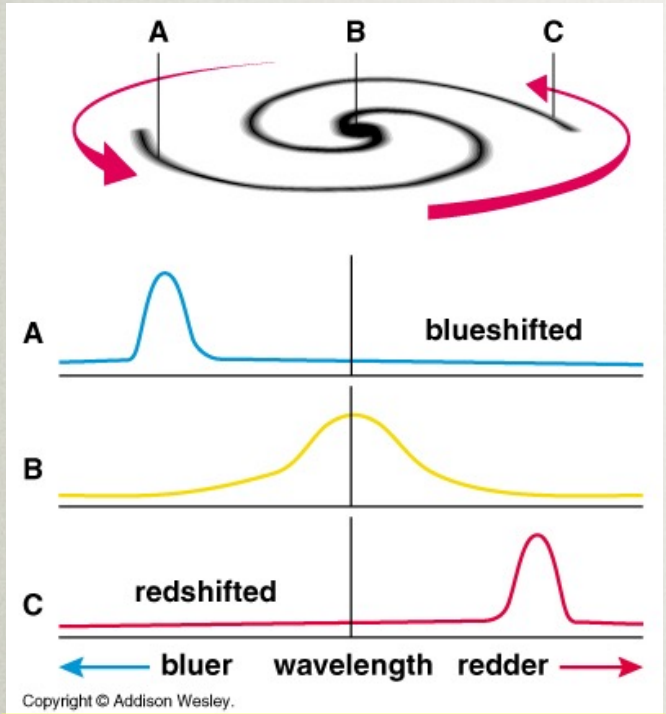
Predicted number of galaxies

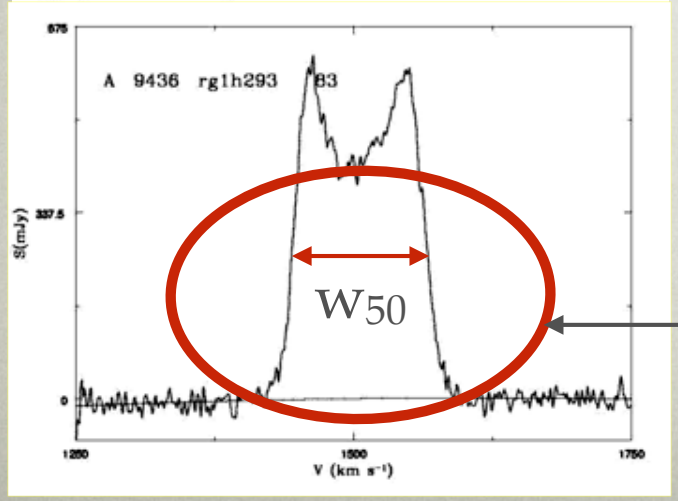
Observed number of galaxies



Klypin et al. (2015)

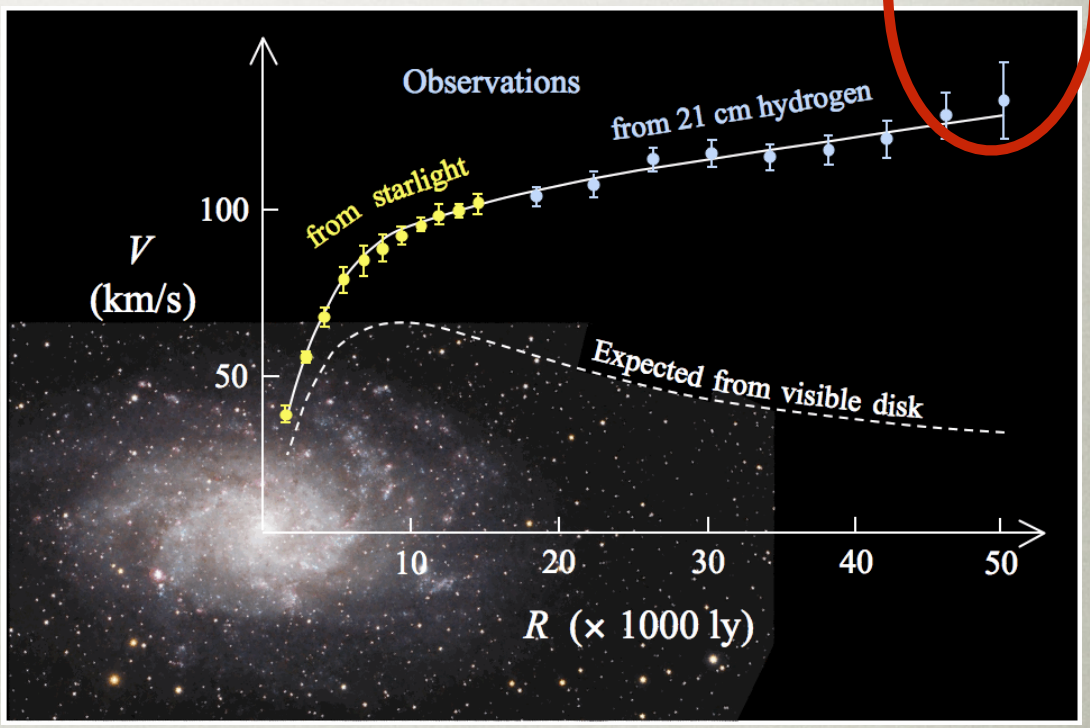
BUT: Two Ways to Measure Rotation (Resolved vs Unresolved)



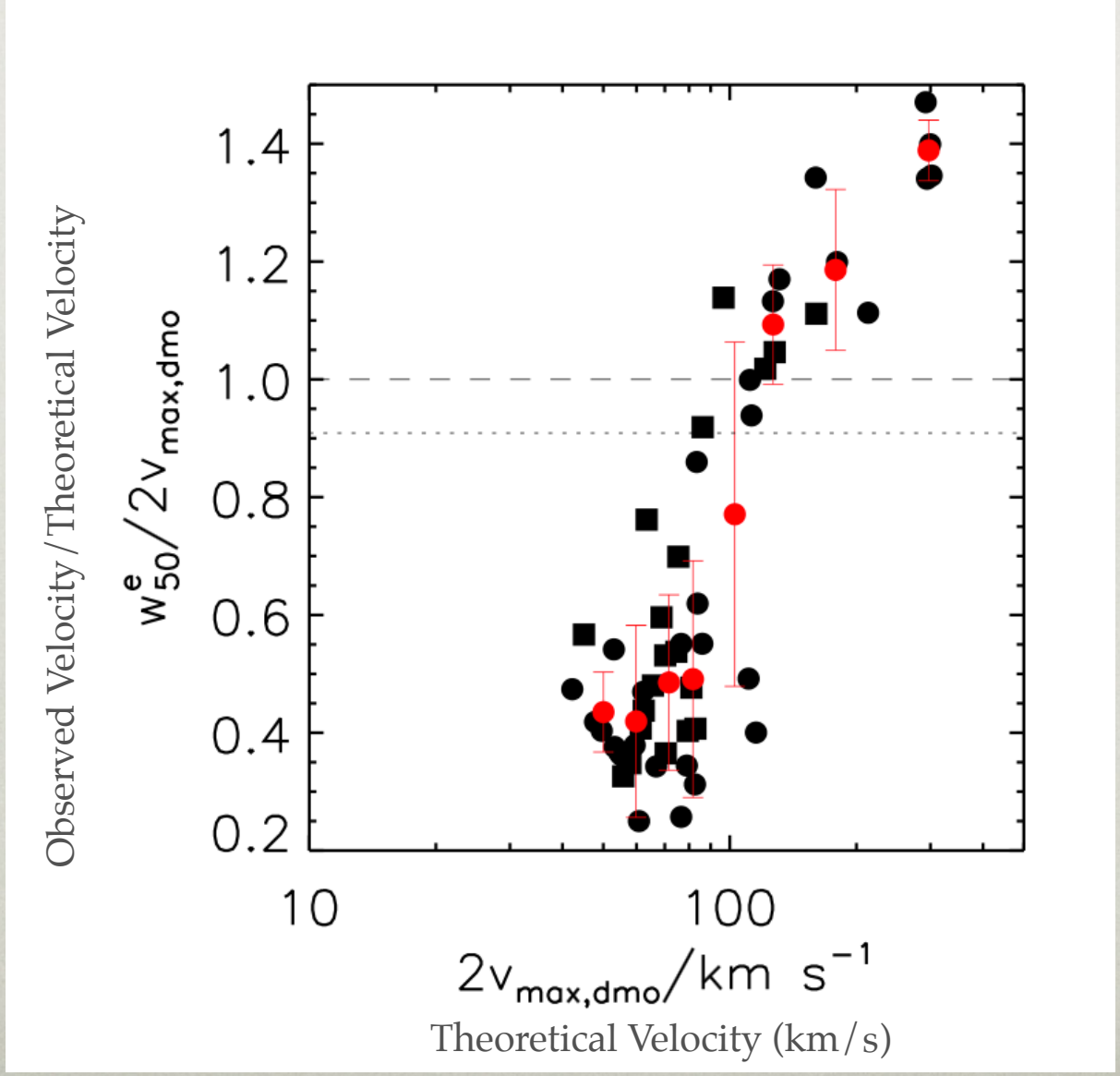


Observations

Theory → v_{max}

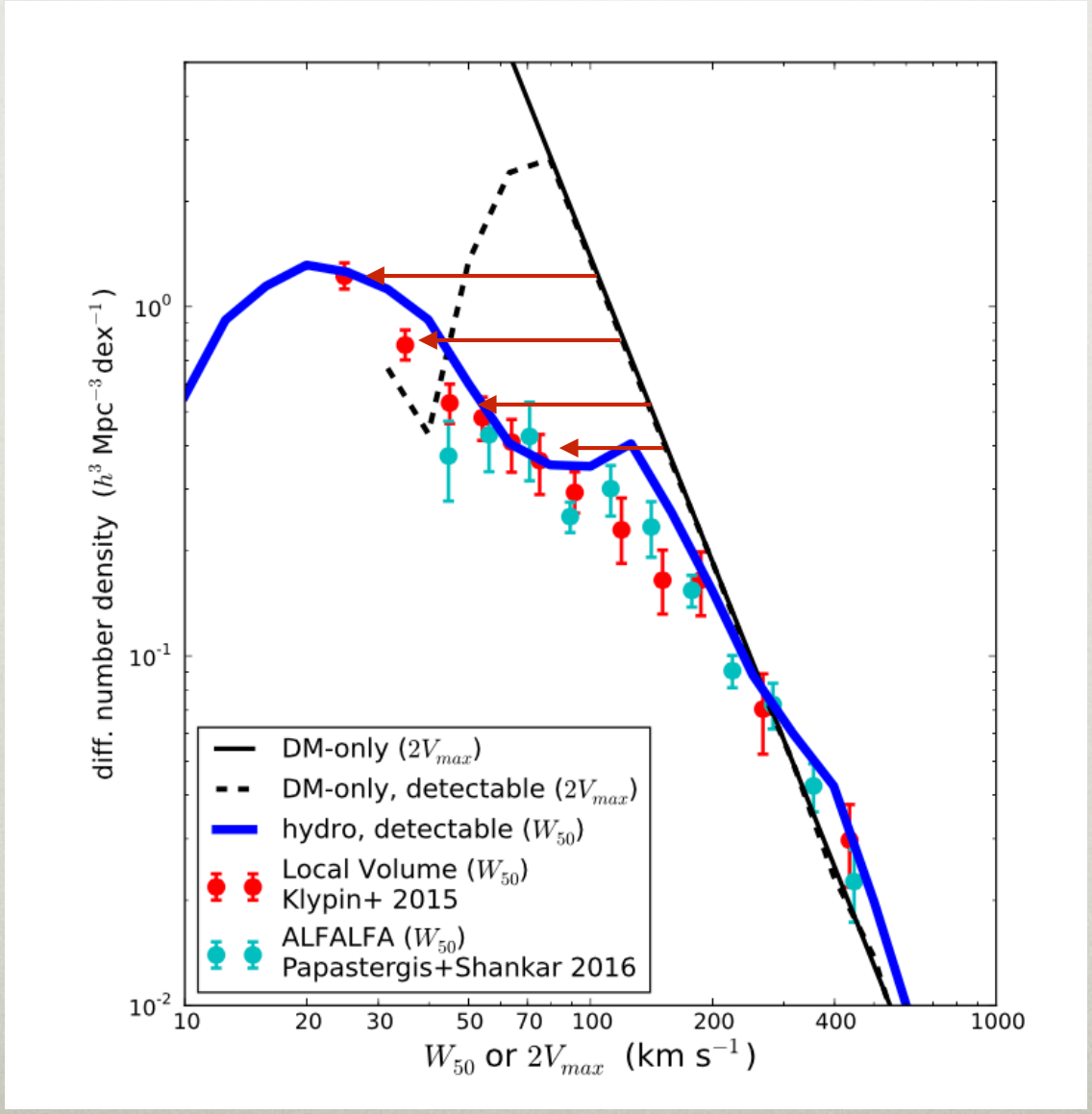


How Well Do Theory and Observation Match?



Brooks et al. (2017), arXiv:1701.07835

Putting it Together



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Starting Assumption:
There is No Small Scale "Crisis"

	CDM+Baryons	WDM	SIDM
Bulge-less disk galaxies			
The Cusp/ Core Problem			
Missing Satellites			
Missing Dwarfs (Field)			

see arXiv:1407.7544 for a review

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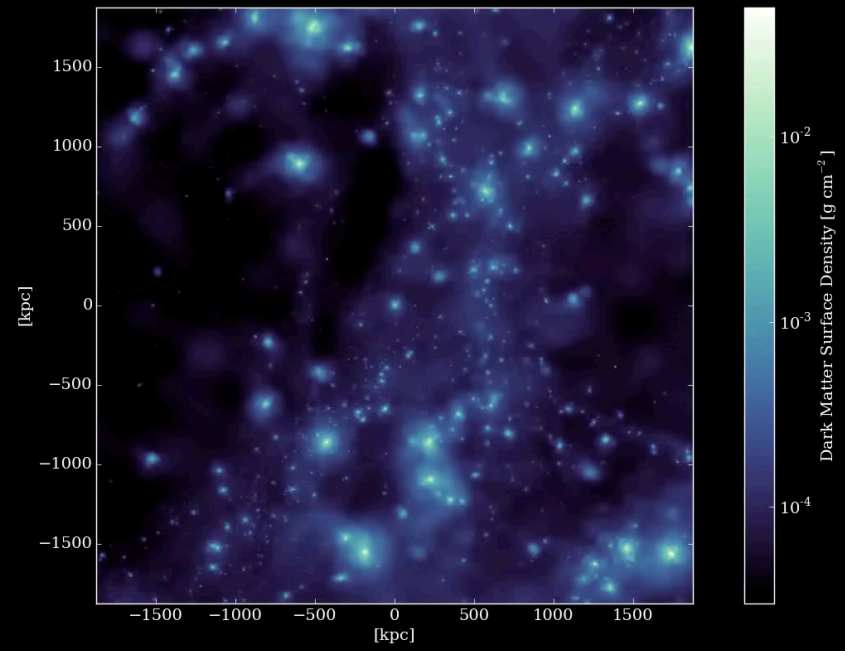
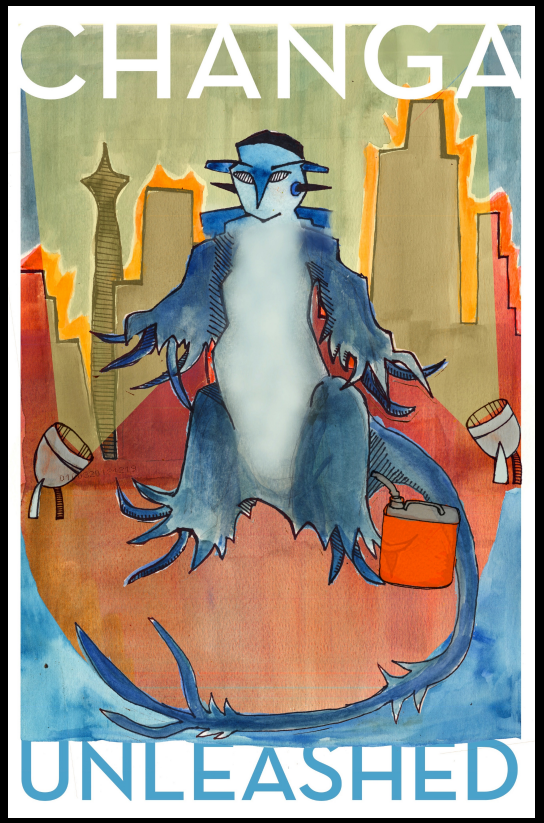
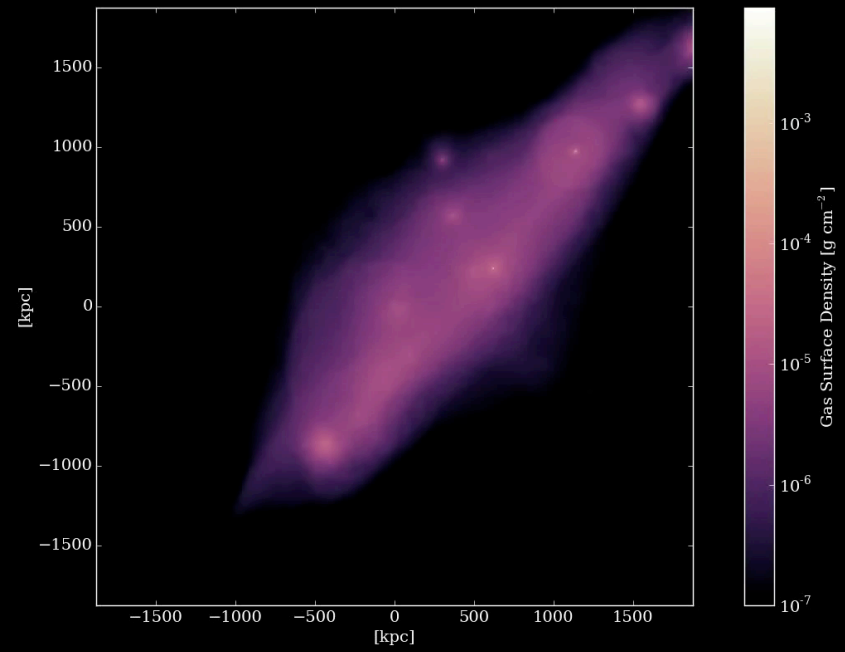
Key Problem

Can we understand the formation and evolution of dwarf galaxies?



z=0 DM density





z=0 Gas density

The Marvel-ous Volumes

Force resolution: 60pc
SPH resolution: 6pc
M_{star}: 400 Msun
M_{dm}: 6000 Msun
z~129 to 0

Many flavors:
- DM only
- With H2 + Black Holes
- Metal cooling + self shielding
- SIDM

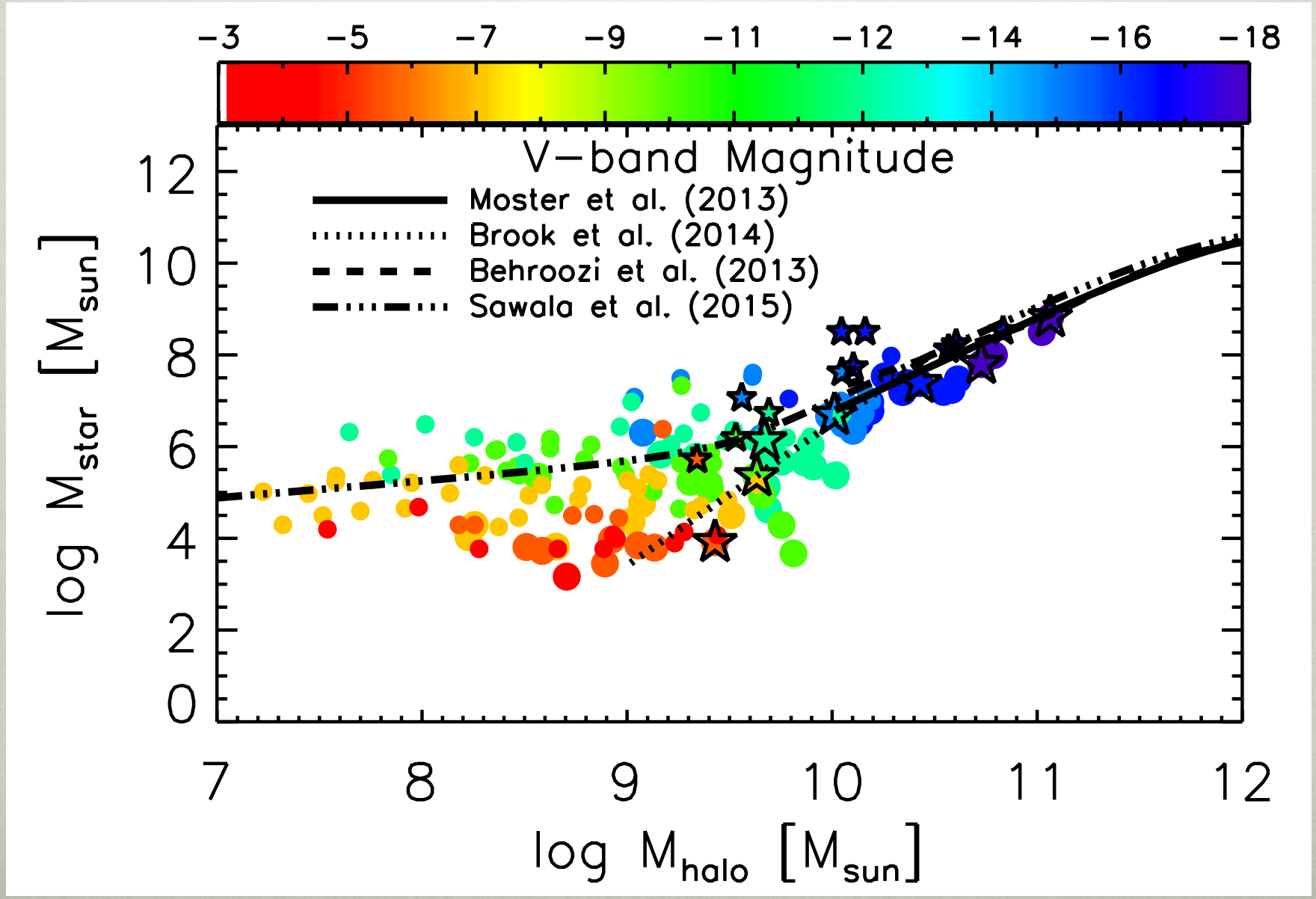
The DC Justice League

4 volumes centered on MW-mass halos

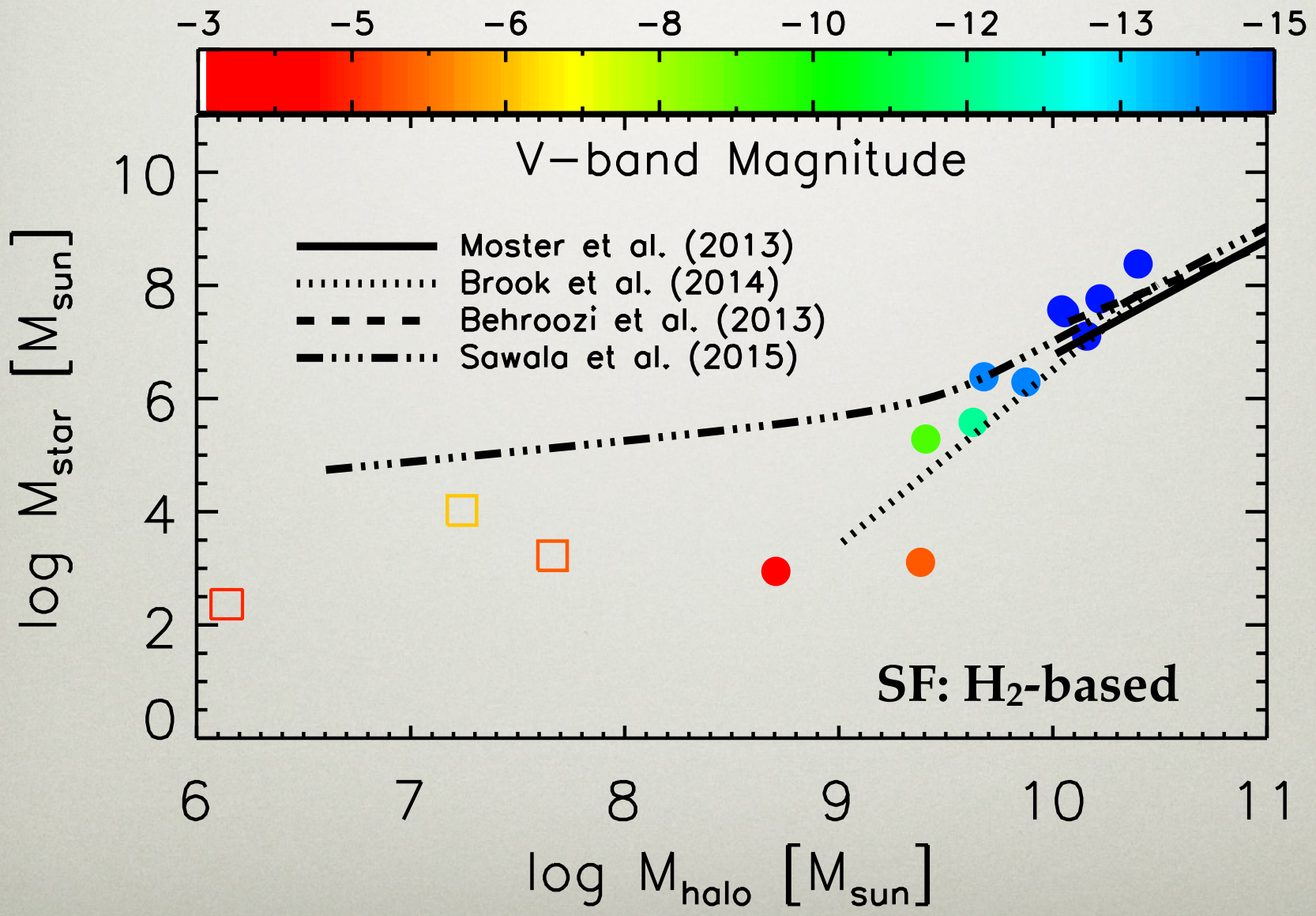
Force resolution: 170 & 85pc
SPH resolution: 17 & 9pc

M_{star}: 8000/1000 Msun
M_{dm}: $1.3 \times 10^5 / 1.6 \times 10^4$ Msun
z~to 0

The Stellar Mass — Halo Mass Relation



Does Star Formation Prescription Matter?



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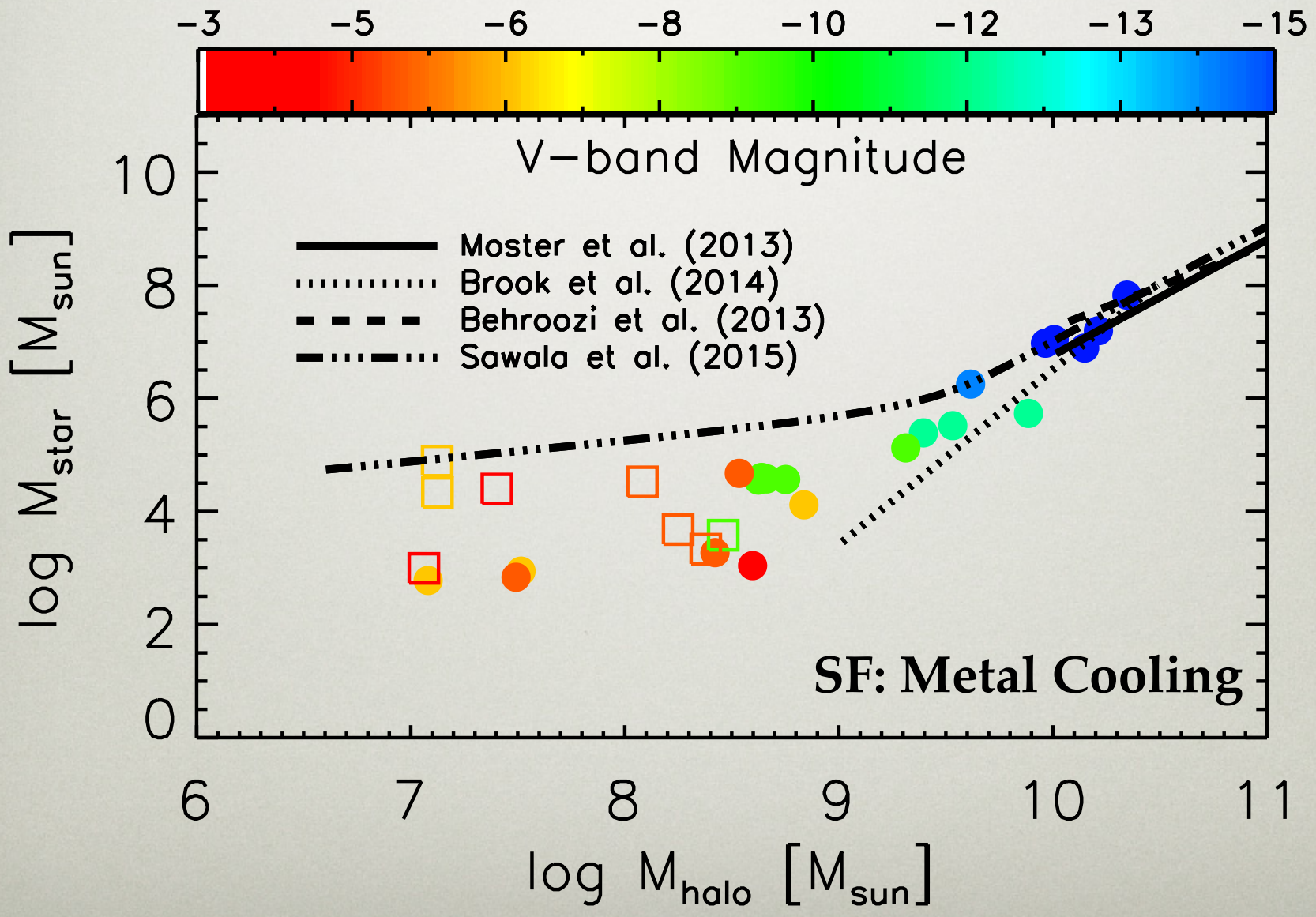
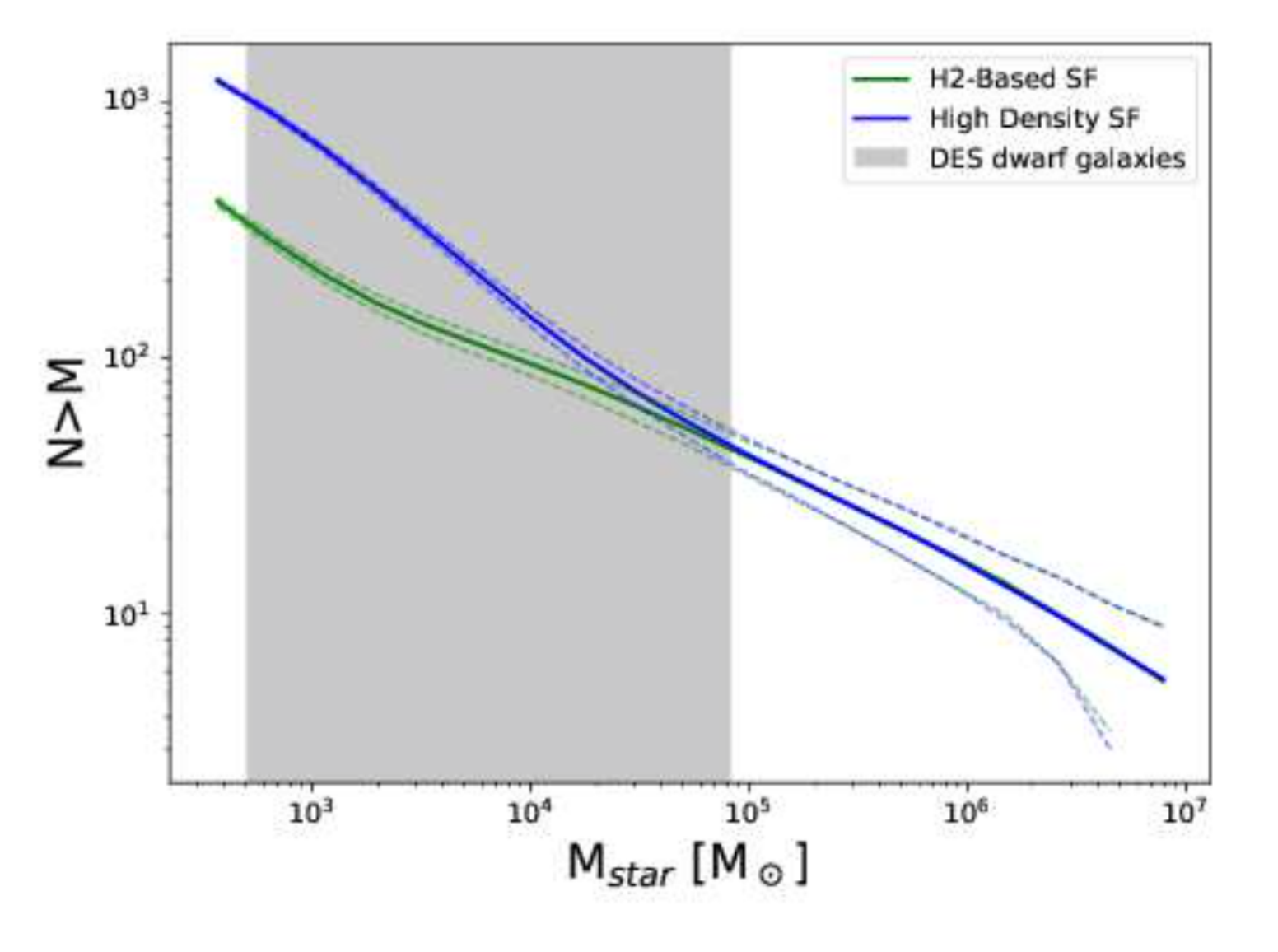


Implications for LSST



Munshi, Brooks, et al. (in prep)

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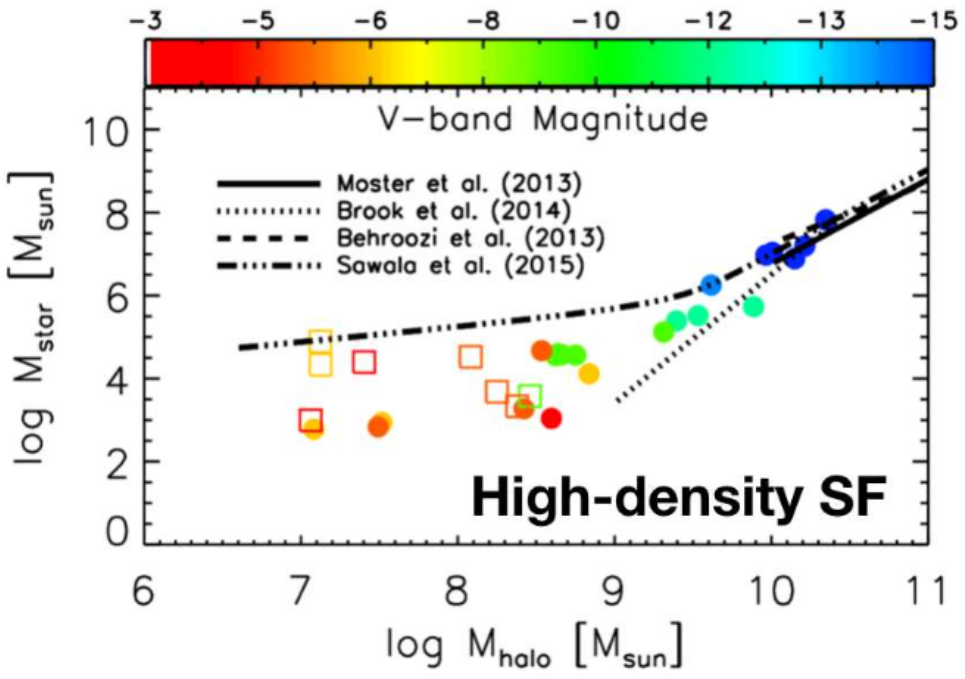

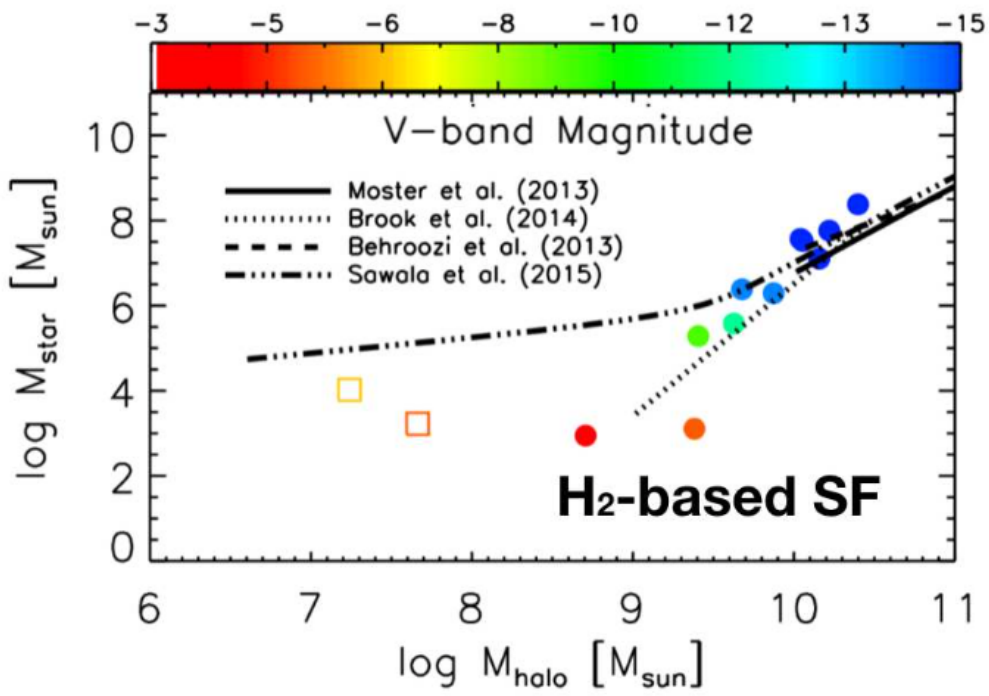

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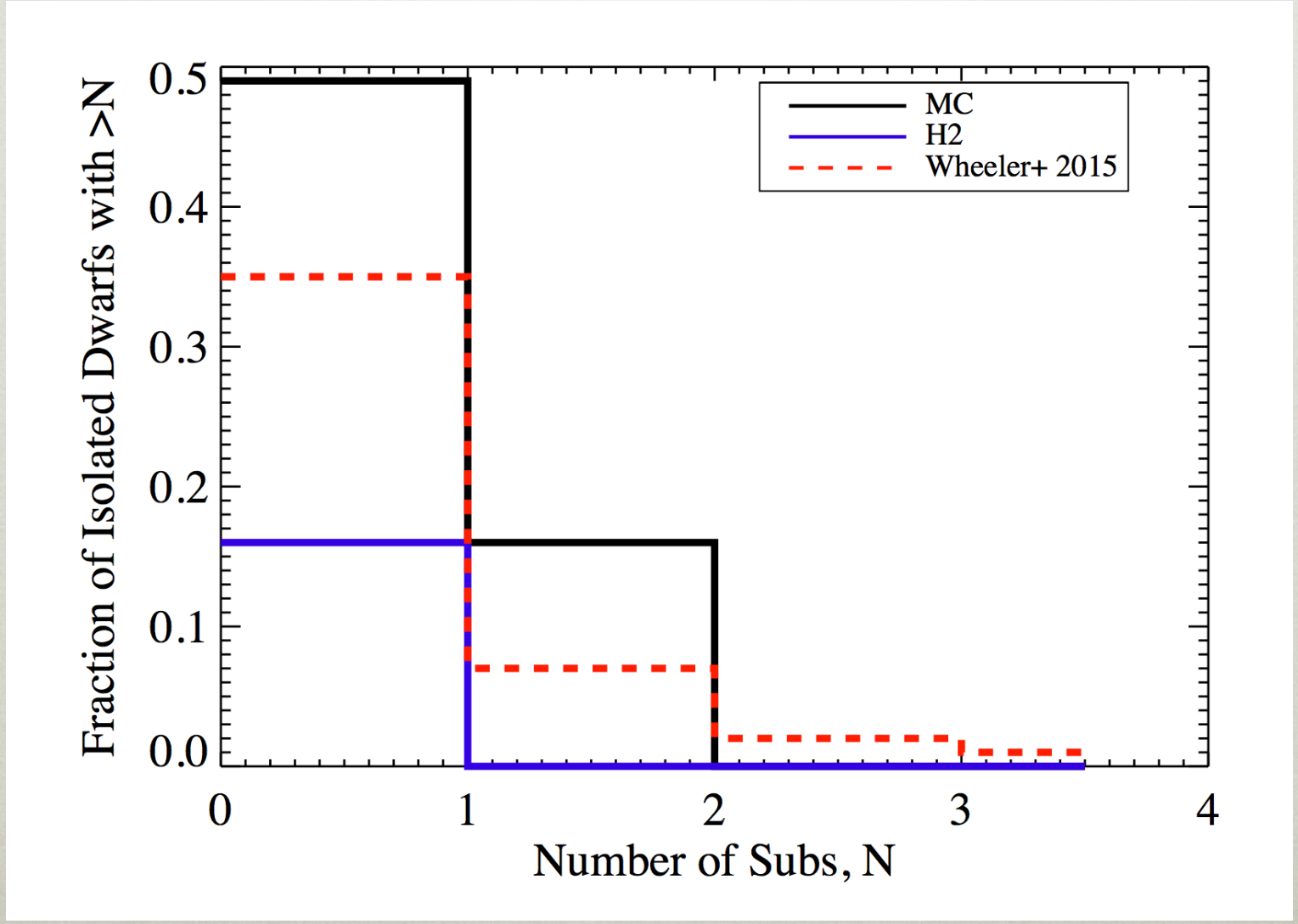
Impact on Expected Satellite Fraction in Dwarfs



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Conclusions

To constrain the Dark Matter model, we must understand the impact of baryonic physics on galaxy formation!

Baryonic physics alleviates the current problems with CDM

But that doesn't mean CDM is the correct model. All dark matter models must also include baryons!

Interpreting future dwarf galaxy counts (with LSST) will depend on understanding our SF prescription