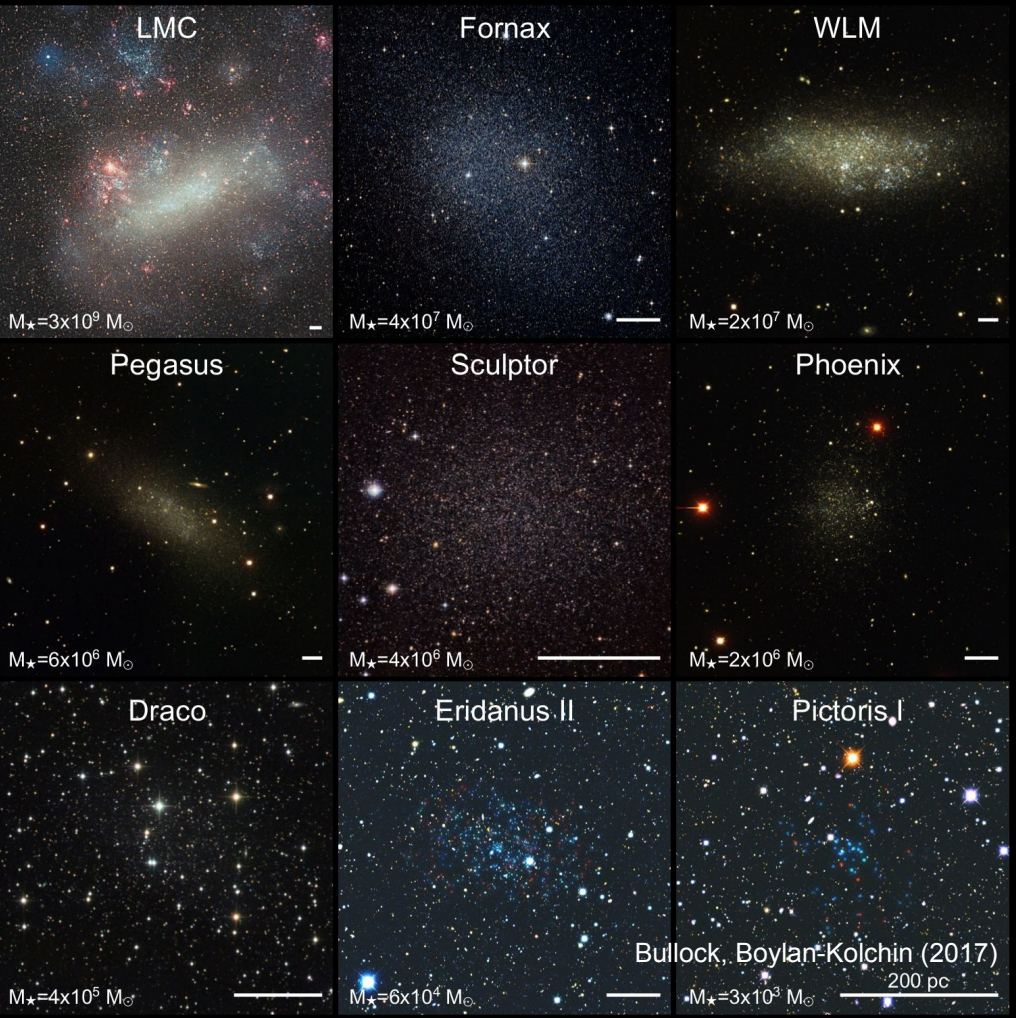
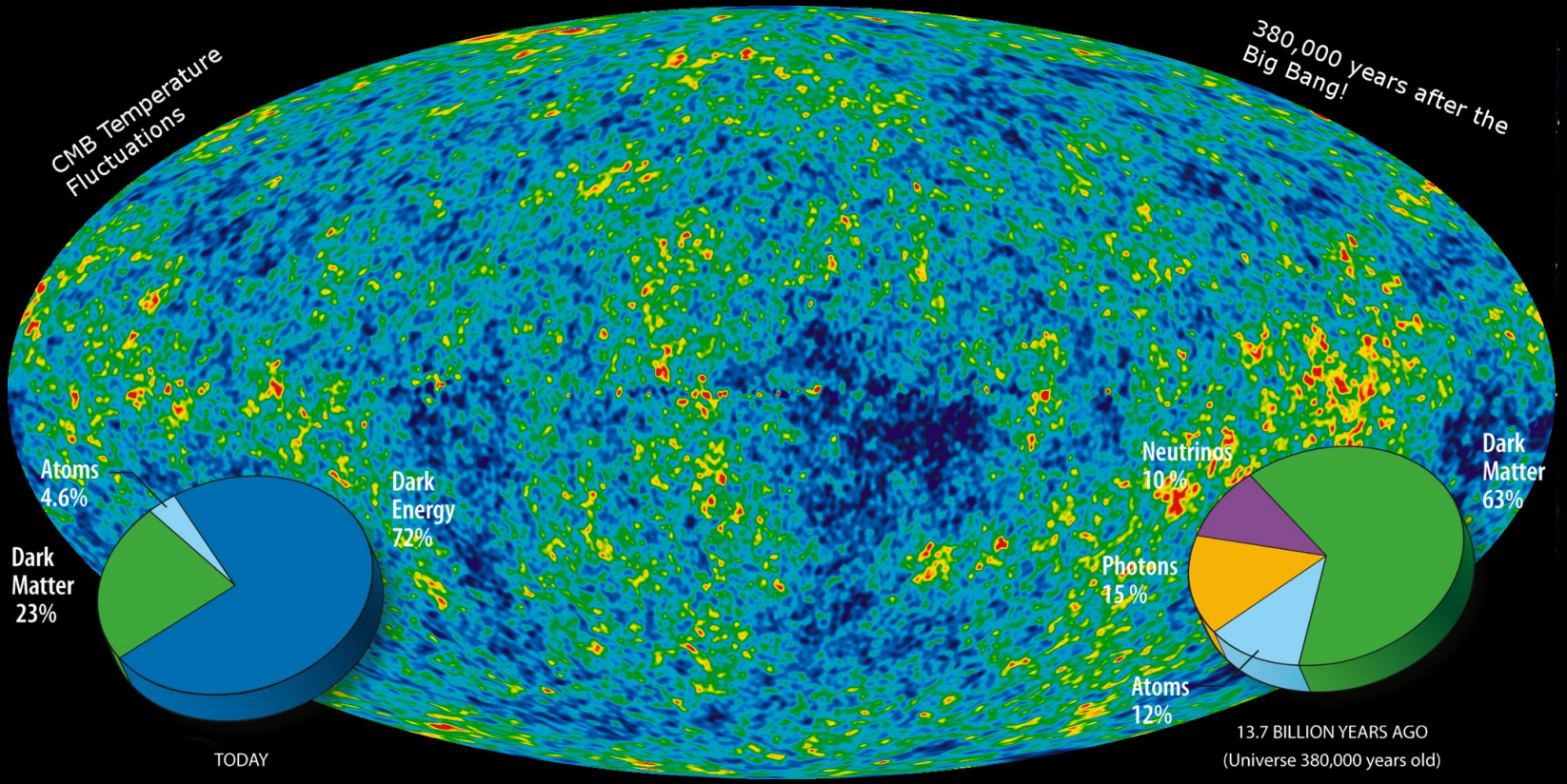


ΛCDM in the context of the ultra-faint galaxies of the Milky Way

Gabriel Torrealba, ASIAA



At the scale of the Universe!

From the CMB until today

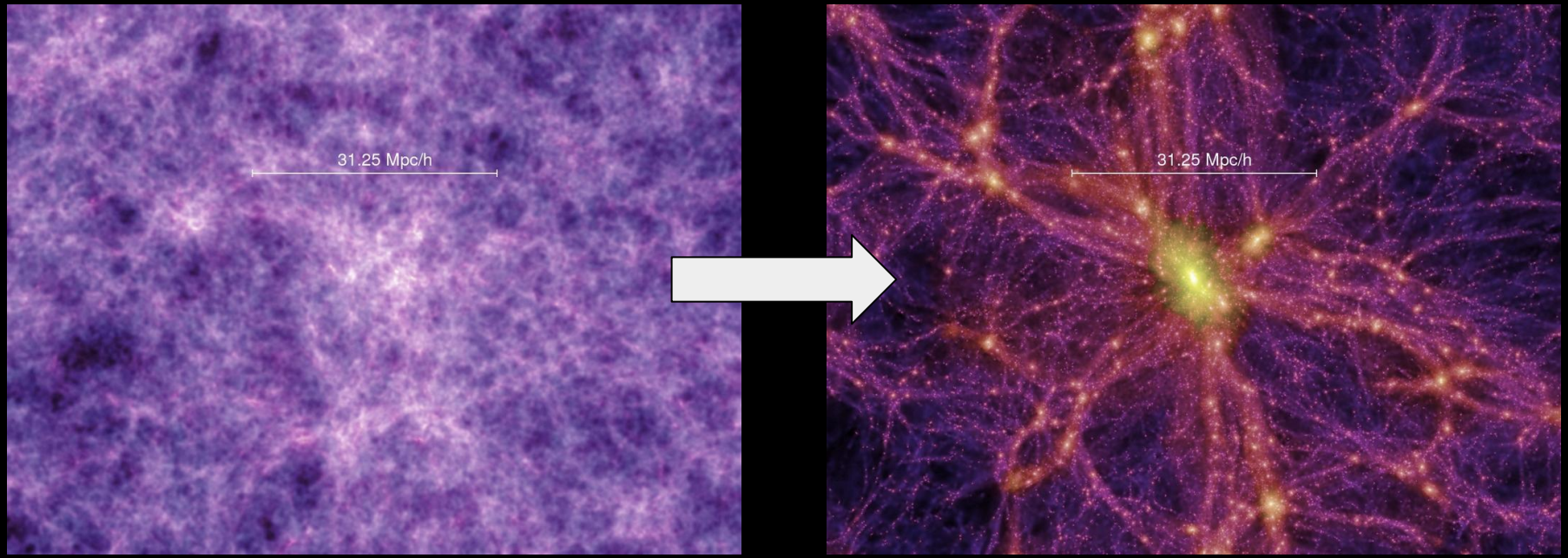
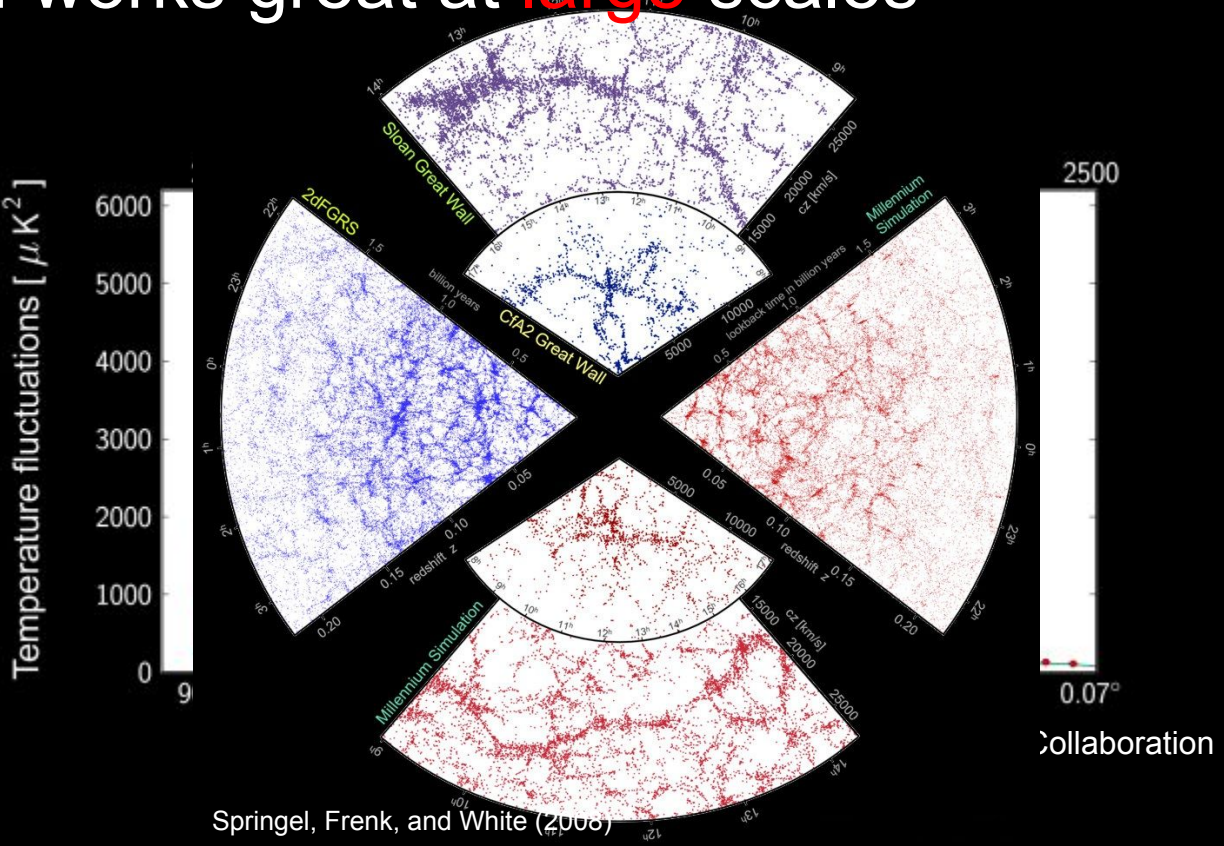


Image: Millennium Simulation

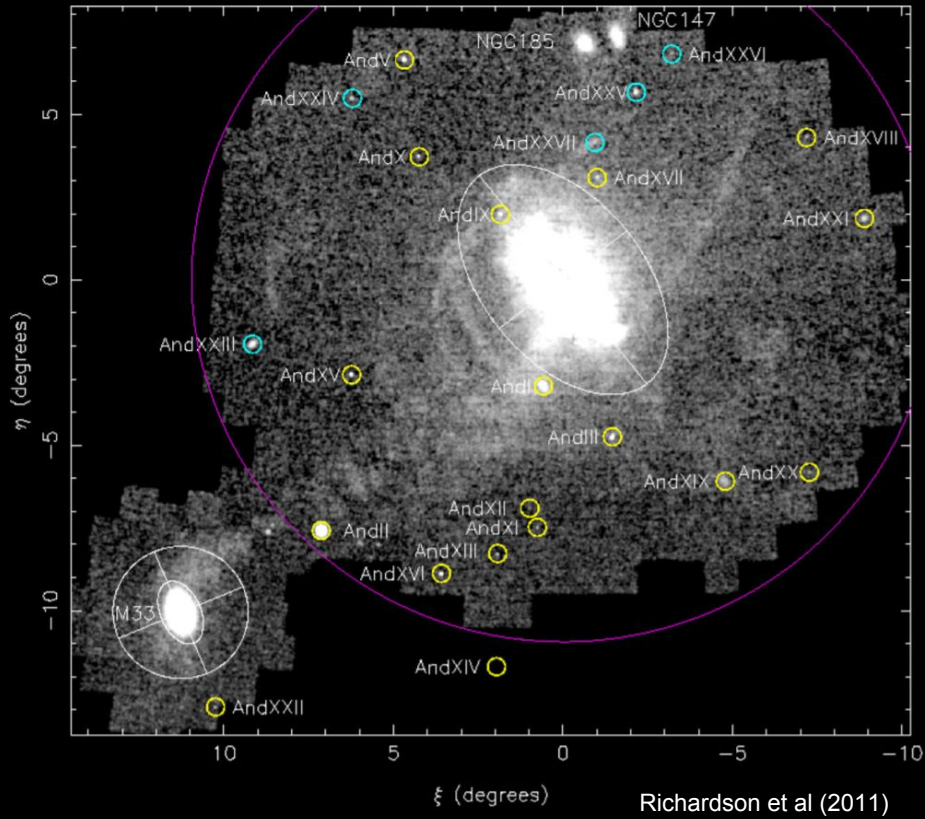
ΛCDM works great at large scales



Springel, Frenk, and White (2008)

The (apparent?) small scale crisis...

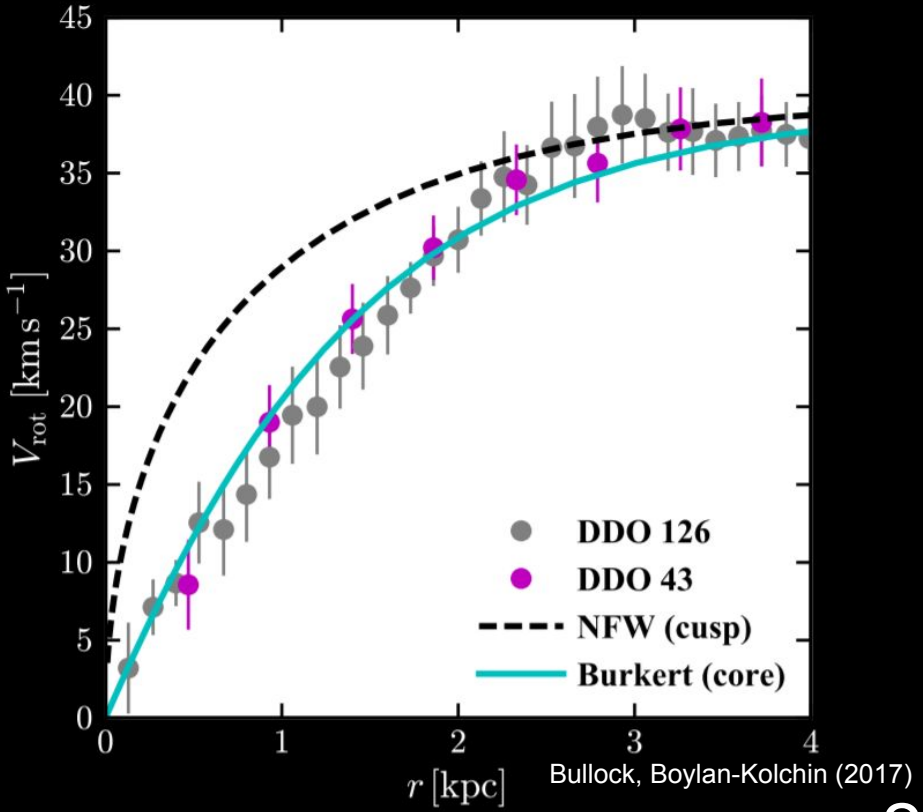
Sawala et al (2016)



Richardson et al (2011)

1 - Missing satellites

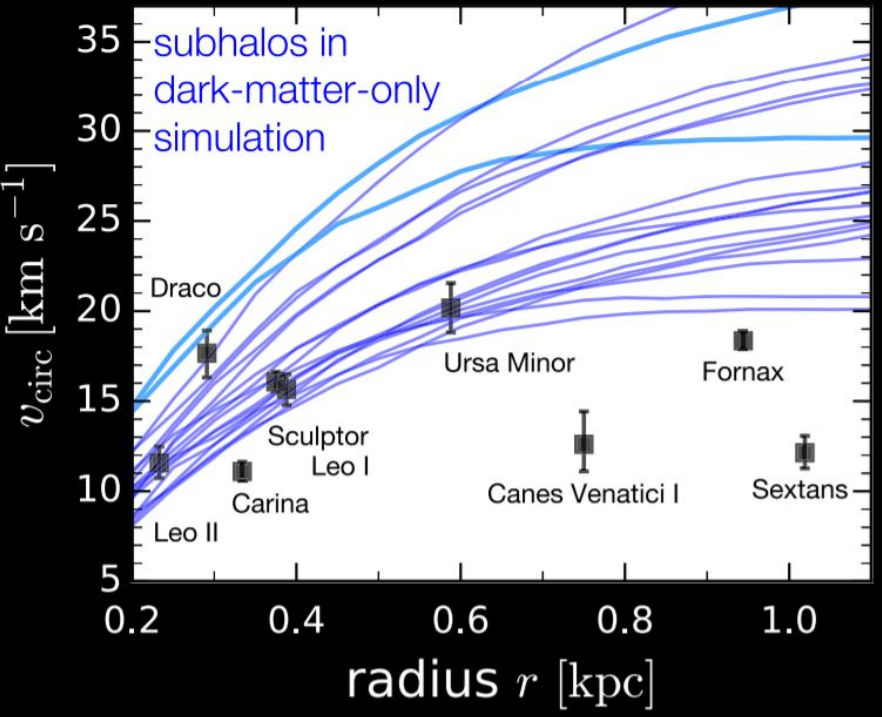
The (apparent?) small scale crisis...



Bullock, Boylan-Kolchin (2017)

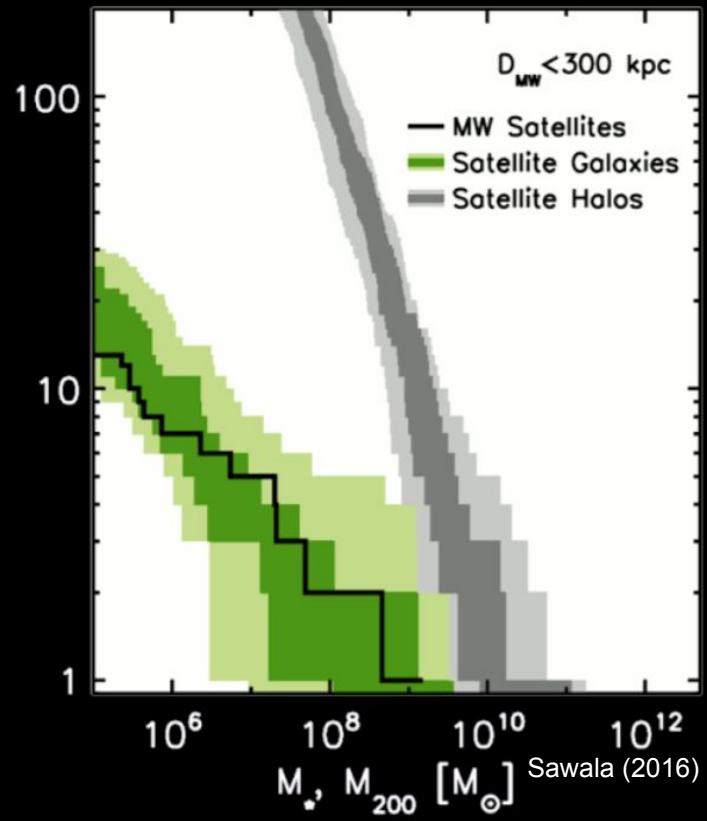
2 - Core/Cusp

The (apparent?) small scale crisis...



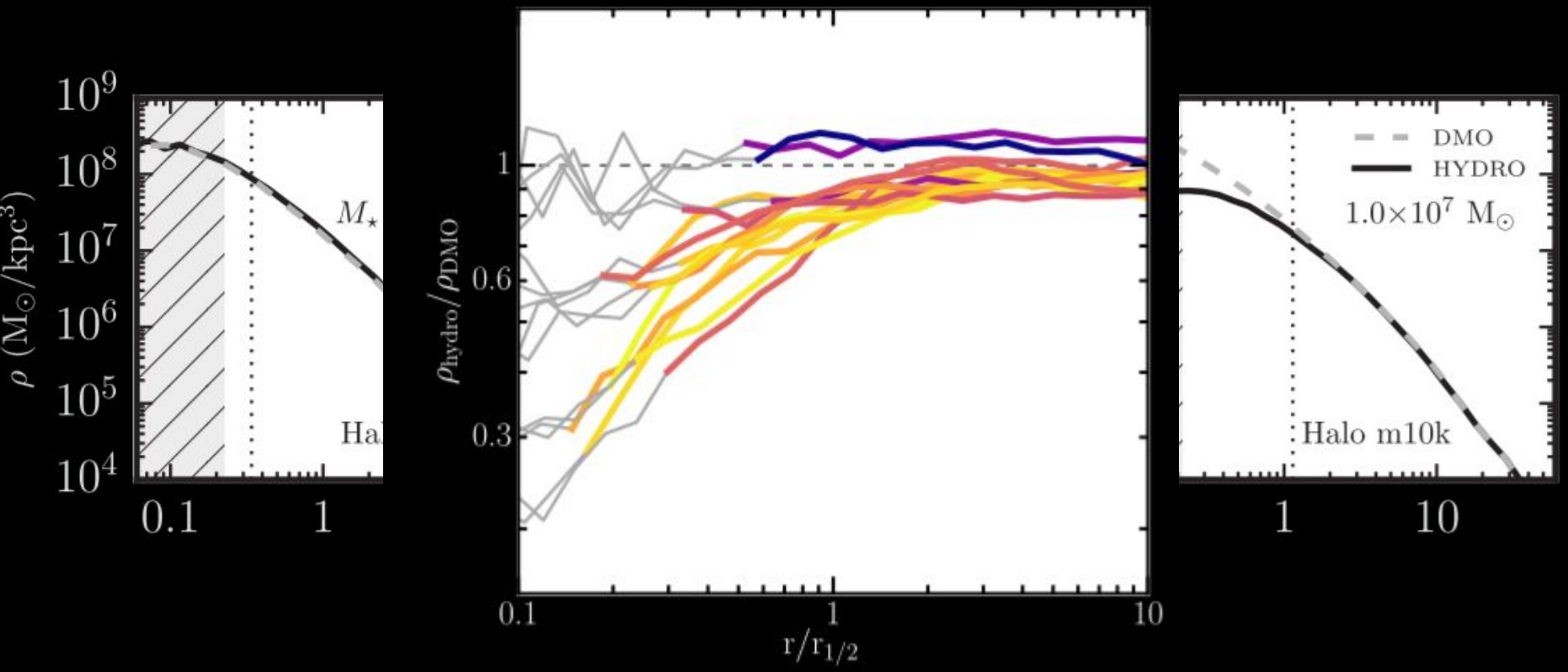
3 - Too big too fail

The baryon approach



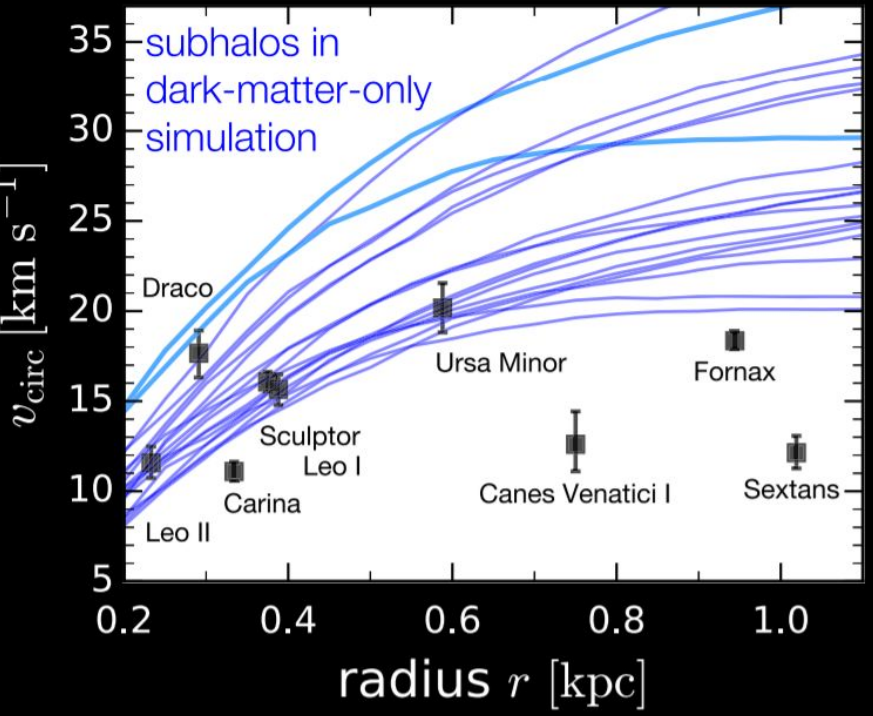
Sawala (2016)

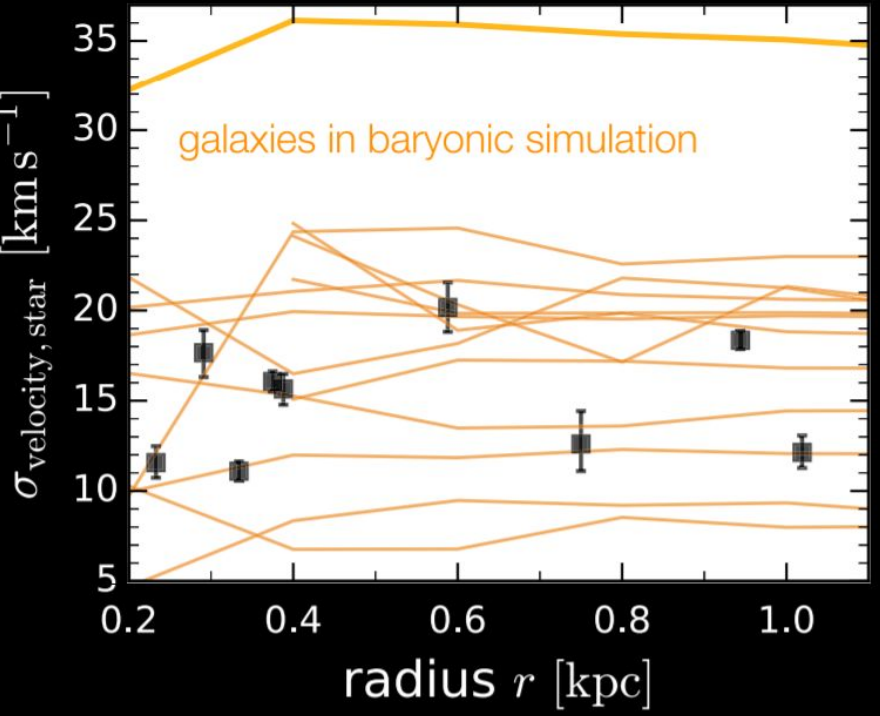
The baryon approach



Fitts et al (2017)

The baryon approach



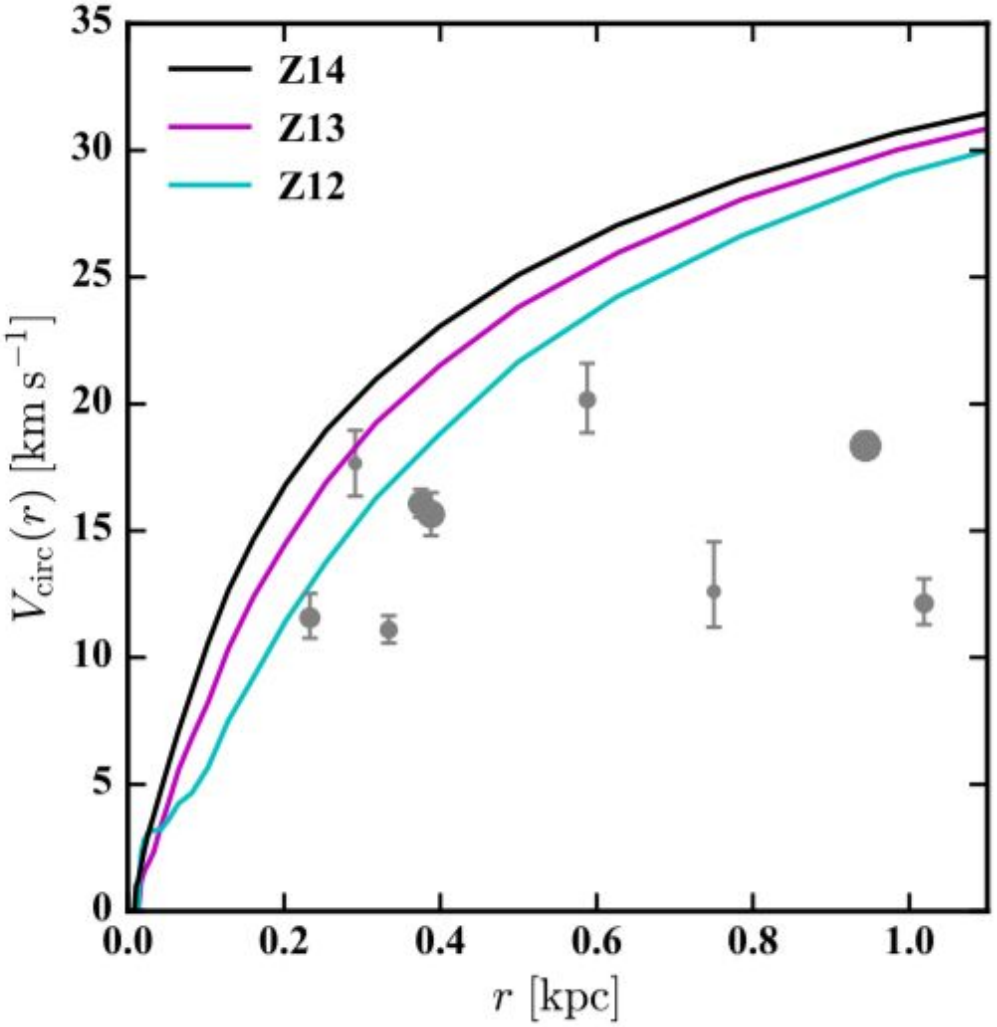


Not so F

In most cases t baryonic physics might

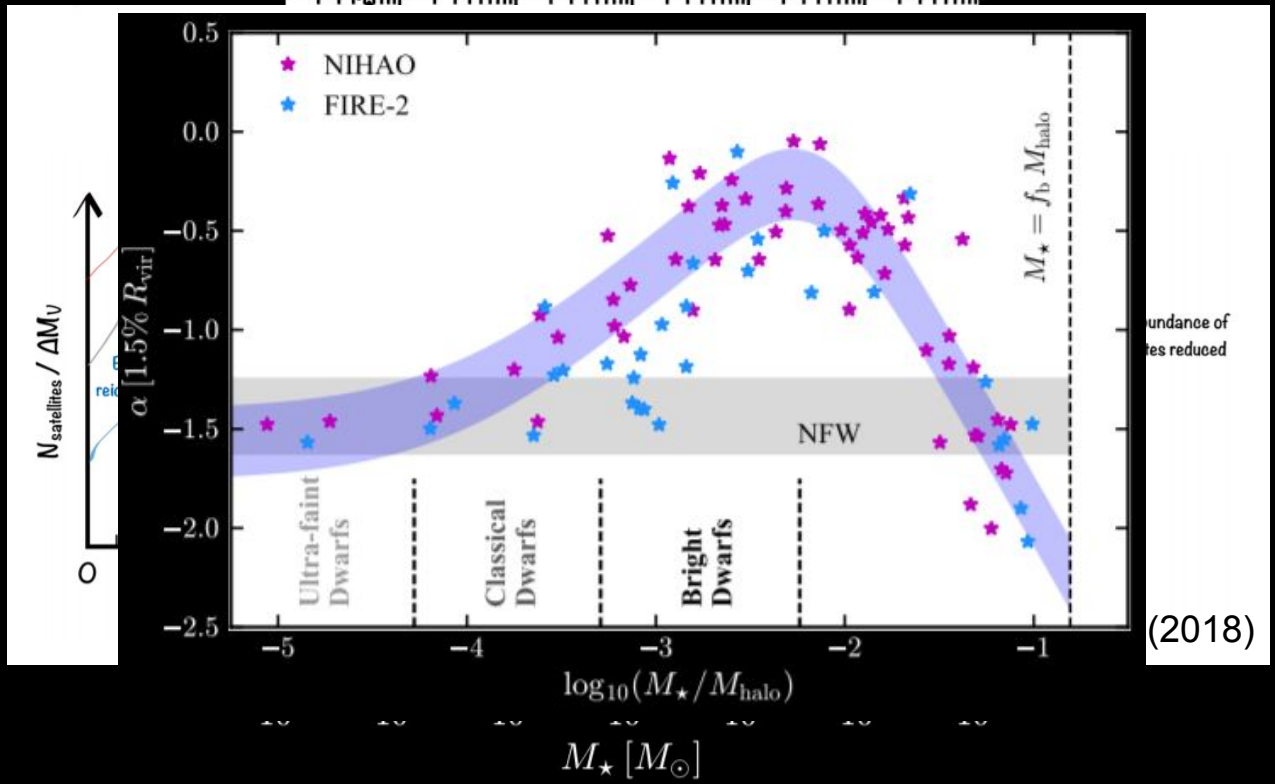
- Some for
- Gas dens
- Reionizat
- SN feedb

Even Numeric



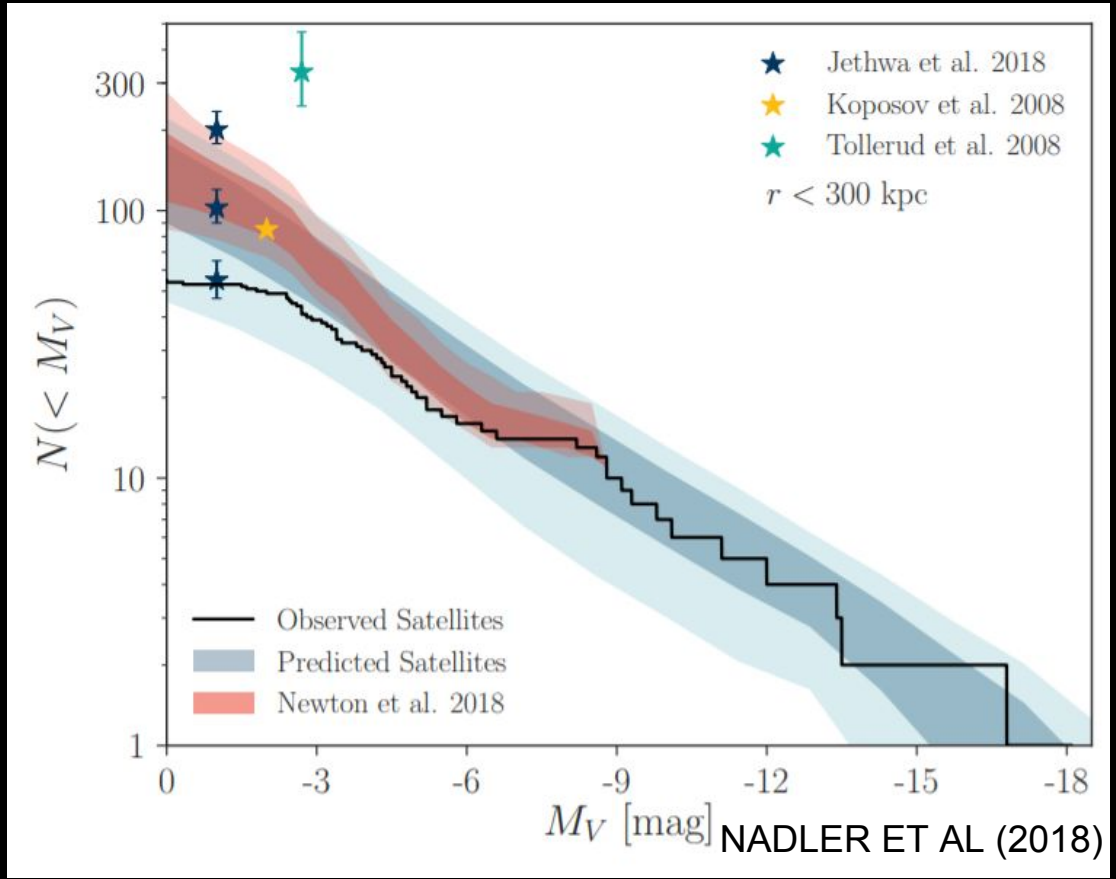
Fits et al (2018)

Faint end is critically important. But the most affected



(2018)

… And provides direct insight into these issues too!

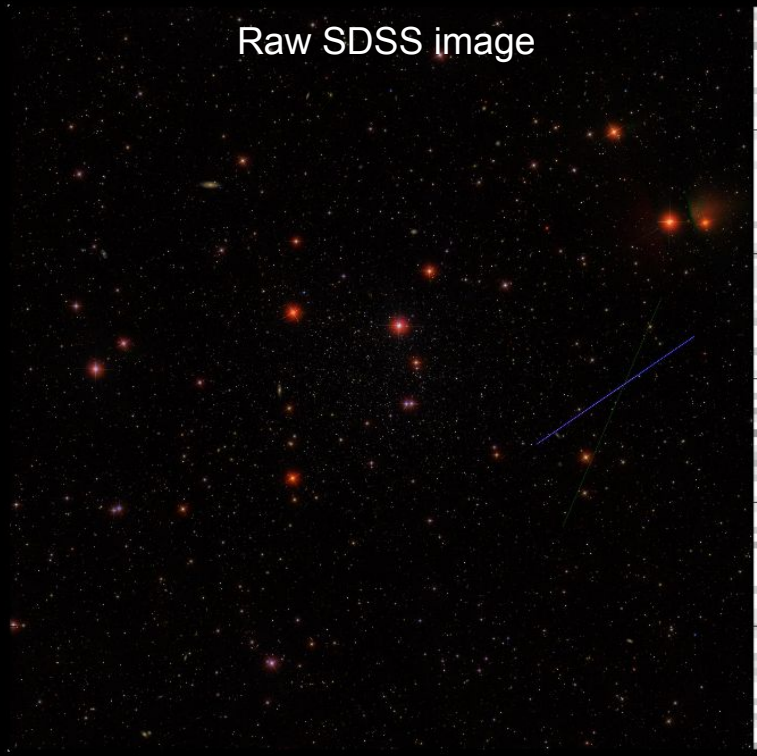


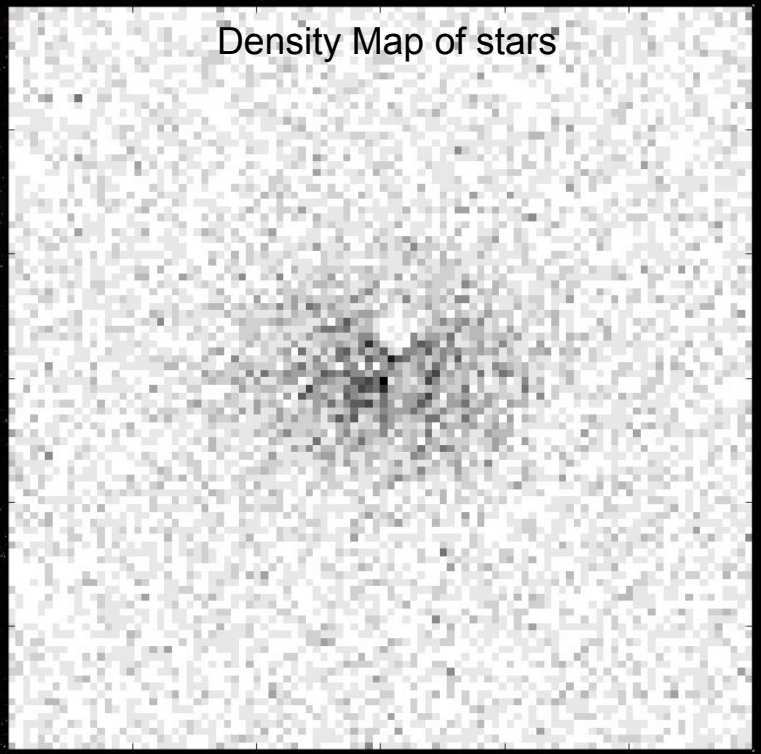
NADLER ET AL (2018)

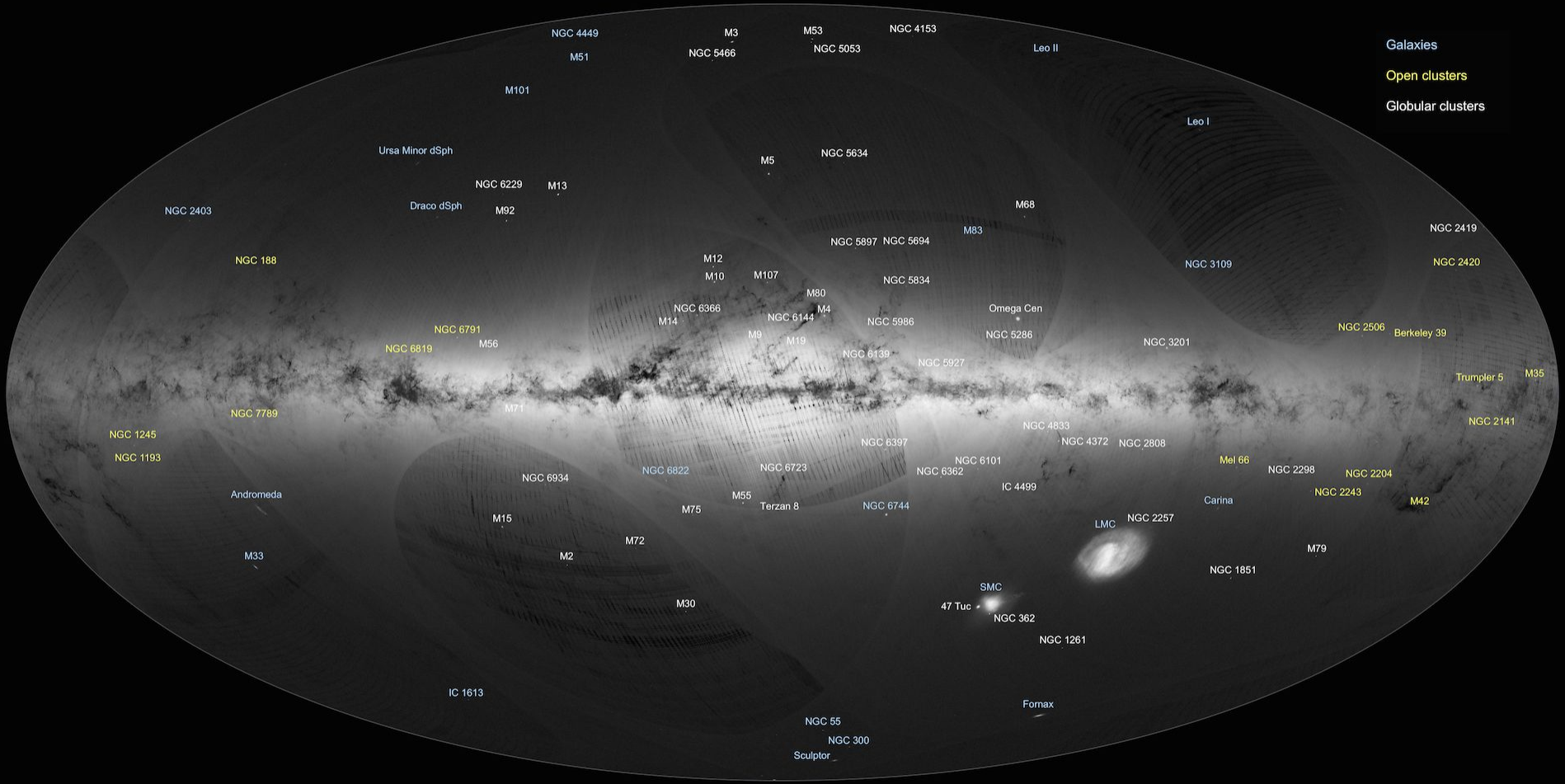
We need a complete census!

- Characterization of the environment is critical!
- Hundreds of galaxies awaiting discovery
- Baryon / DM differentiation
- Find the limits of galaxy formation
- Explore the unexplored!

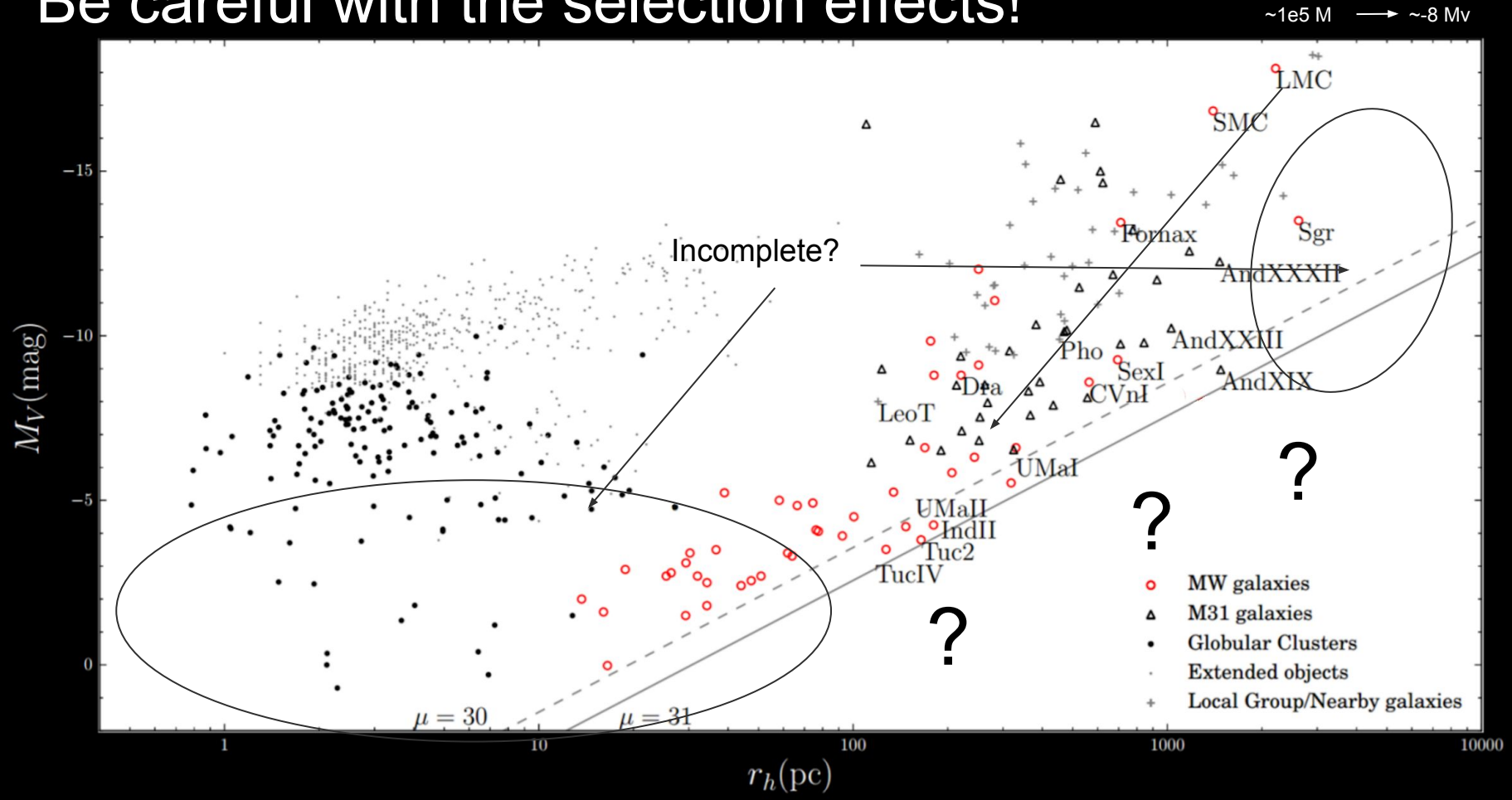
We count stars instead!



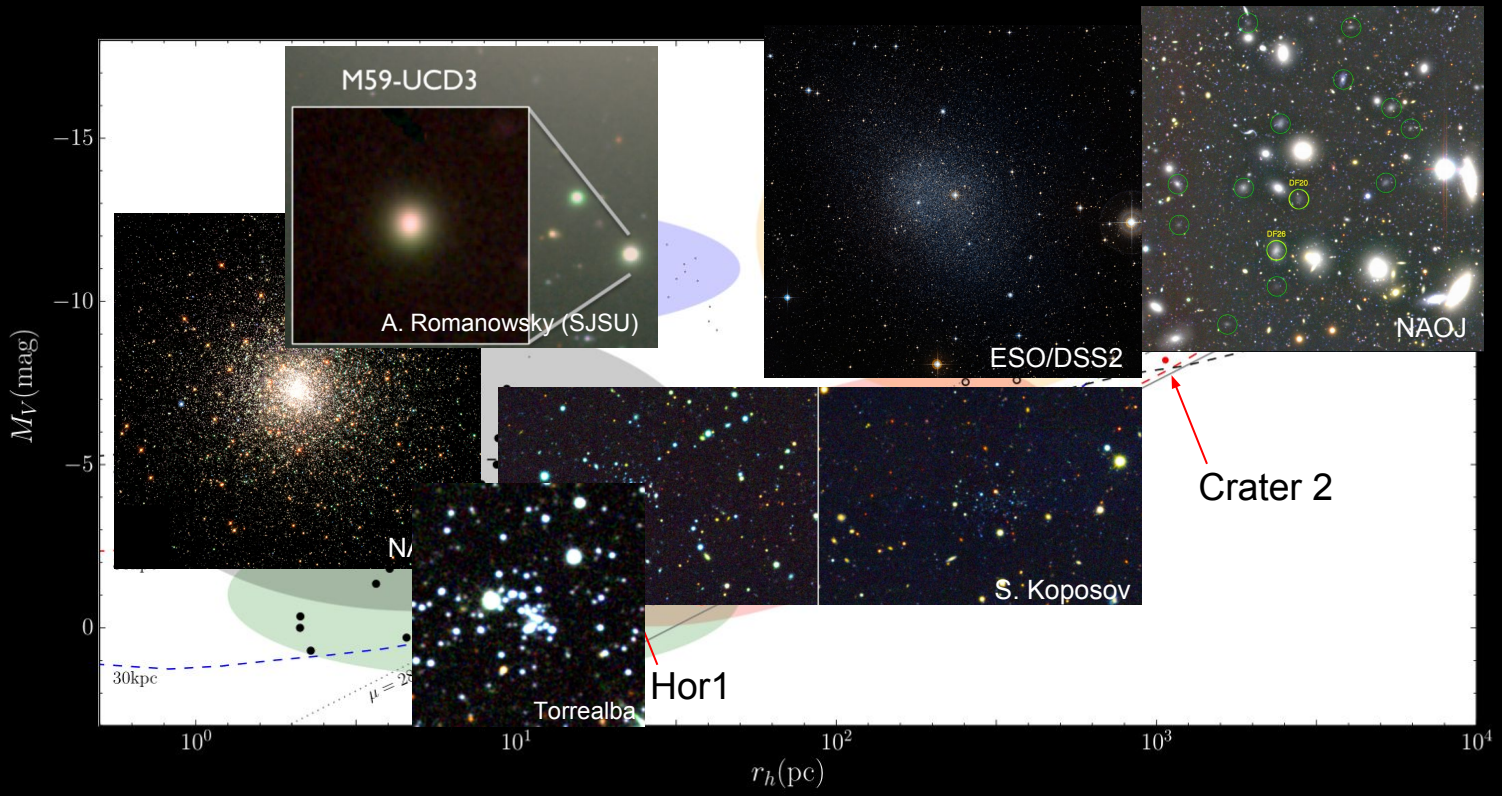



Galaxies
Open clusters
Globular clusters
NGC 4449
M3
M53
NGC 4153
M51
NGC 5466
NGC 5053
Leo II
M101
Leo I
Ursa Minor dSph
M5
NGC 5634
NGC 6229
M13
NGC 2403
Draco dSph
M92
M68
M83
NGC 2419
NGC 5897
NGC 5694
NGC 188
M12
NGC 3109
NGC 2420
M10
M107
NGC 5834
M80
NGC 6366
M4
Omega Cen
M14
NGC 6144
NGC 5986
NGC 6791
M9
NGC 5286
NGC 2506
Berkeley 39
NGC 6819
M56
M19
NGC 3201
NGC 6139
NGC 5927
Trumpler 5
M35
NGC 7789
M71
NGC 2141
NGC 4833
NGC 1245
NGC 6397
NGC 4372
NGC 2808
NGC 1193
NGC 6101
Mel 66
NGC 6822
NGC 6723
NGC 6362
NGC 2298
NGC 6934
NGC 2204
IC 4499
Andromeda
M55
NGC 2243
M42
M75
Terzan 8
NGC 6744
Carina
M15
LMC
NGC 2257
M72
M79
M33
M2
NGC 1851
SMC
M30
47 Tuc
NGC 362
NGC 1261
IC 1613
Fornax
NGC 55
NGC 300
Sculptor

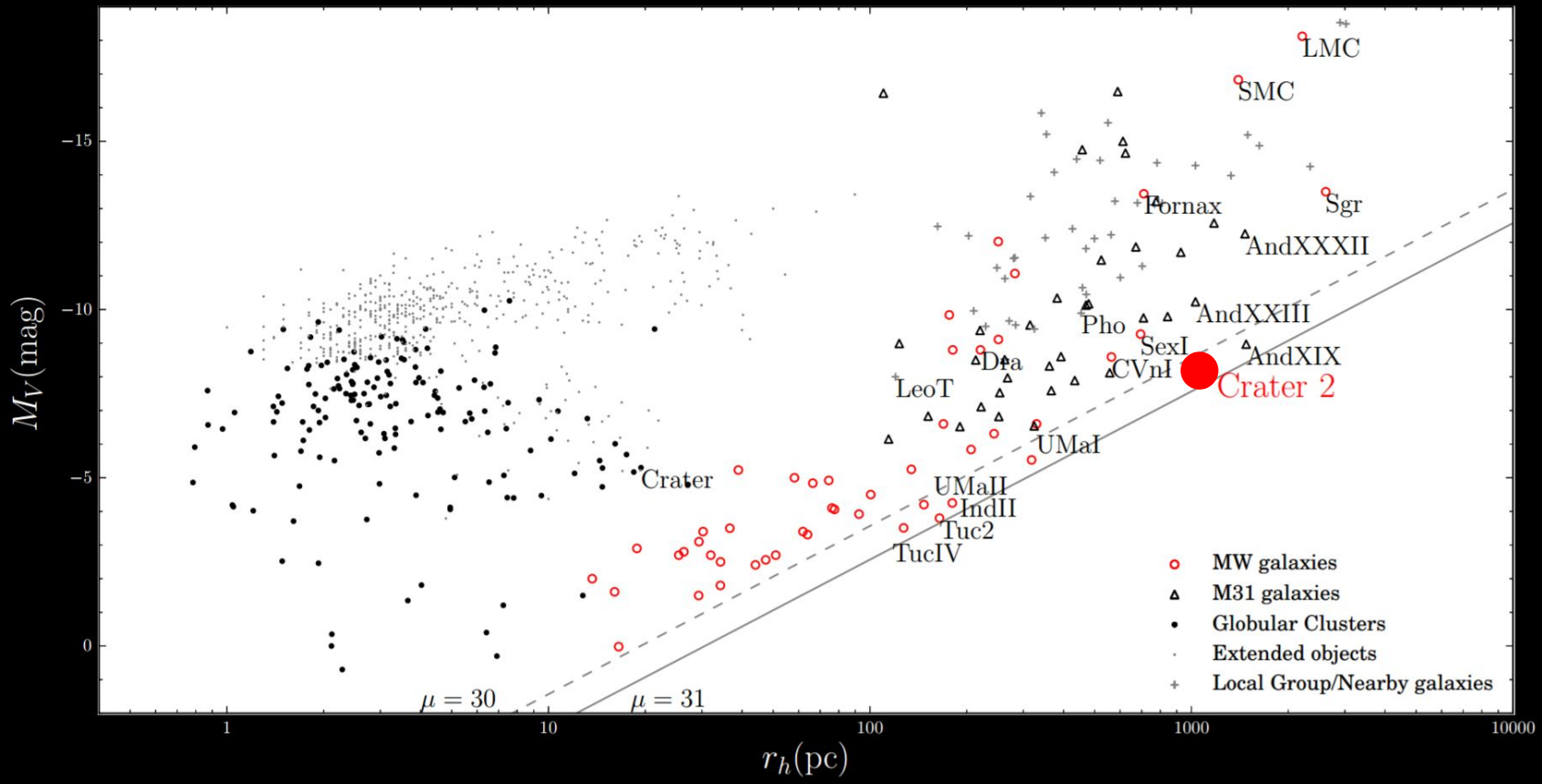
Be careful with the selection effects!



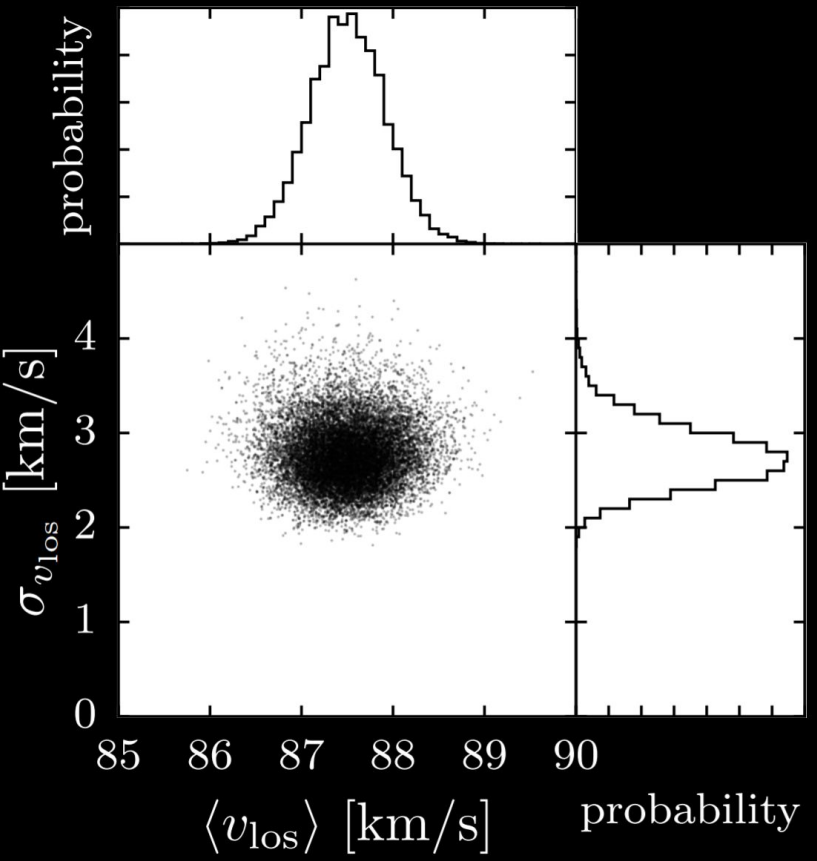
A big insectarium of satellites!



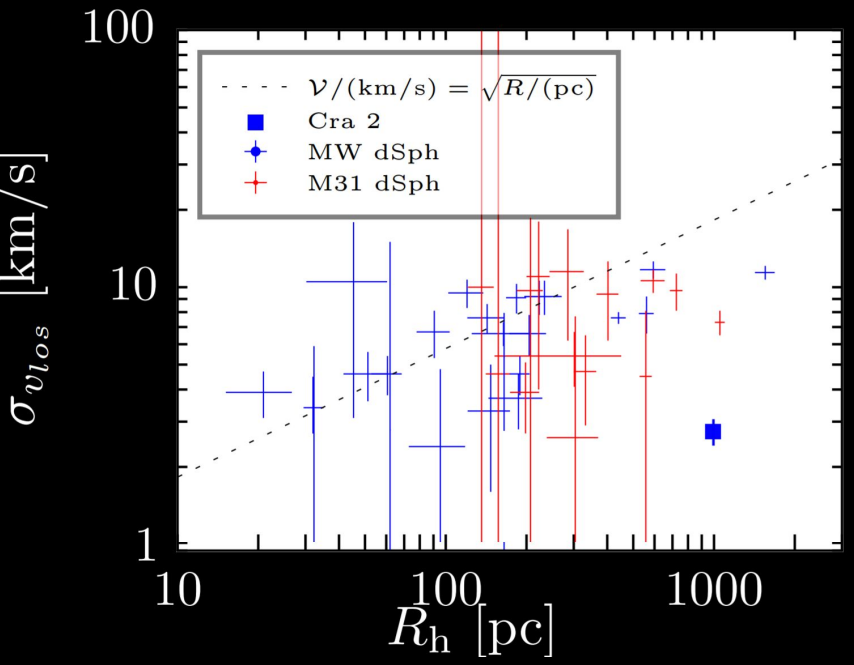
The odd MW satellite Crater 2



Surprisingly Cold!



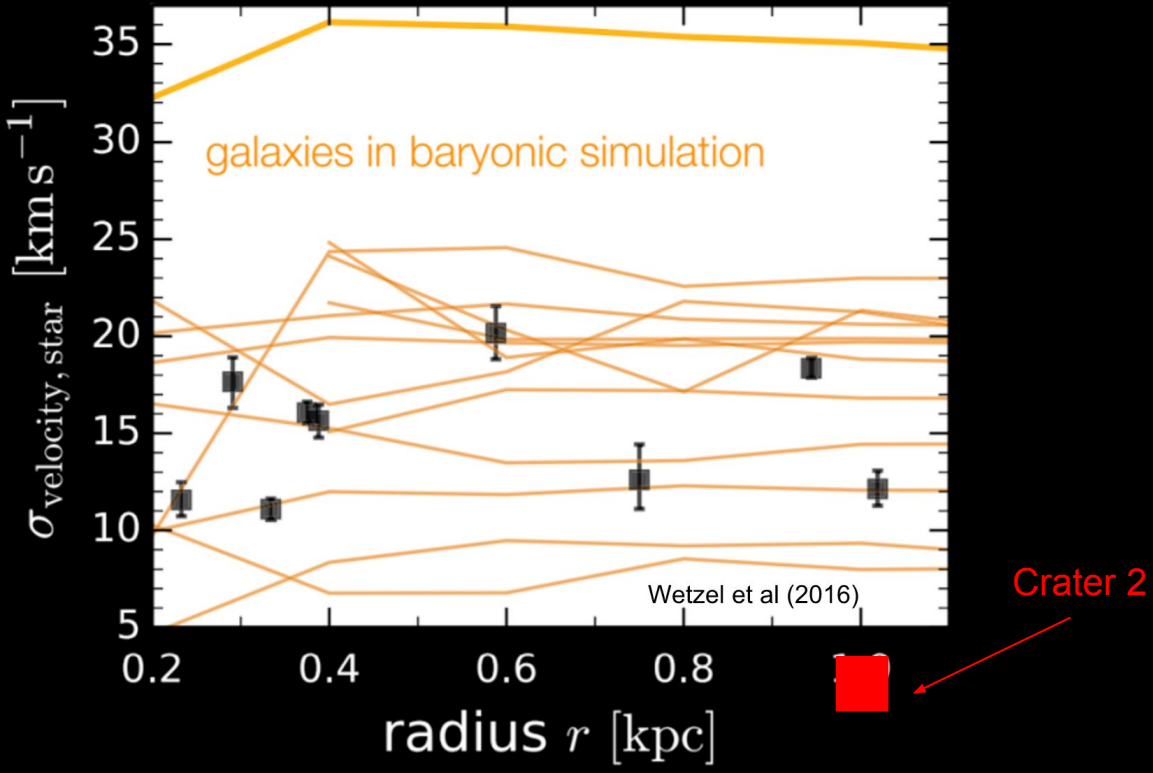
Not only for its size!



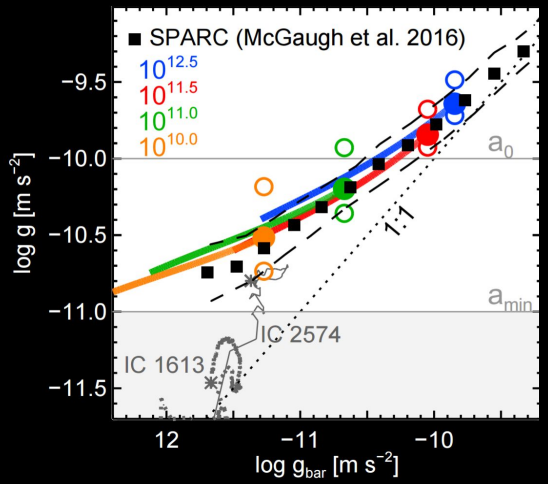
M(r<rh)~5e6

Caldwell et al (2016)

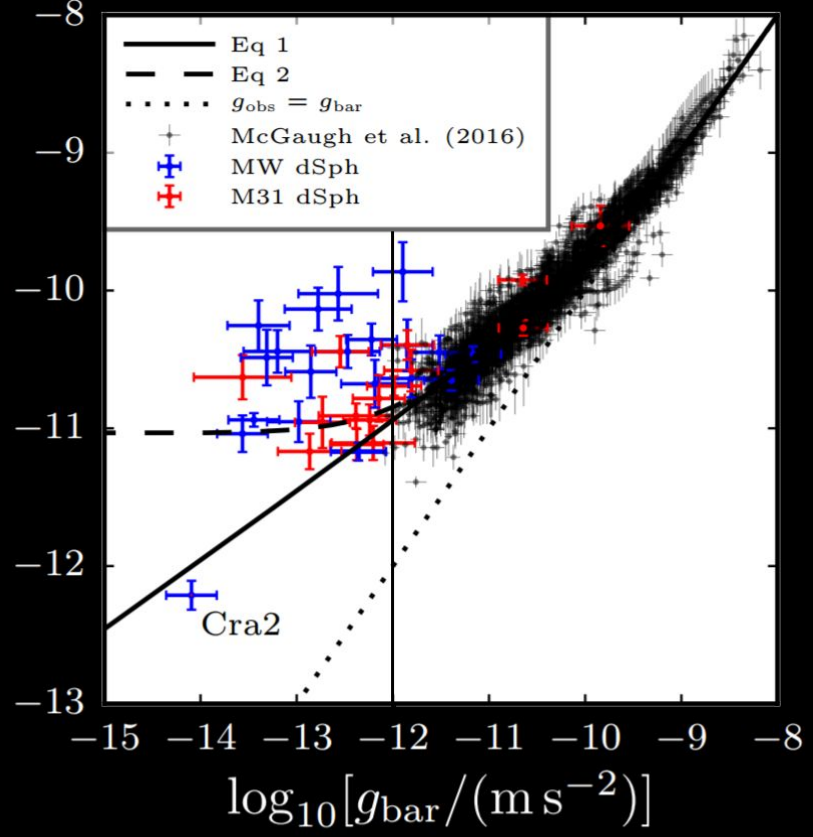
What did we expect?



Possible conflict?

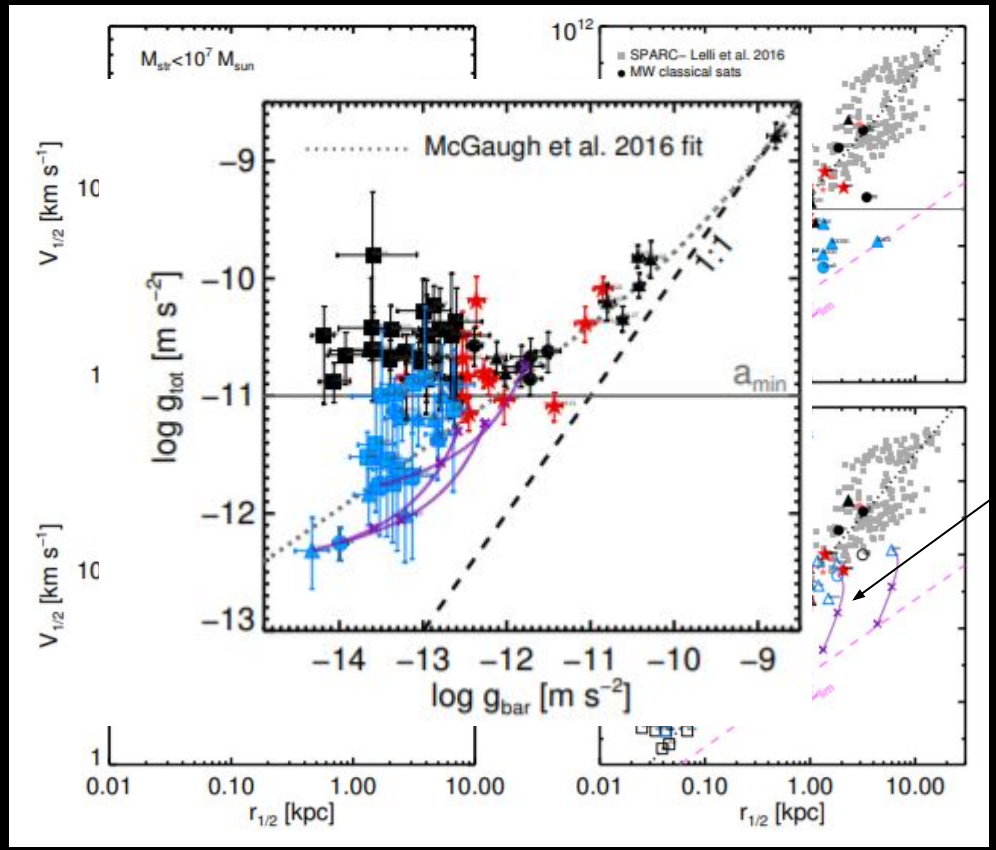


Navarro et al (2016)



Walker et al (priv comm)

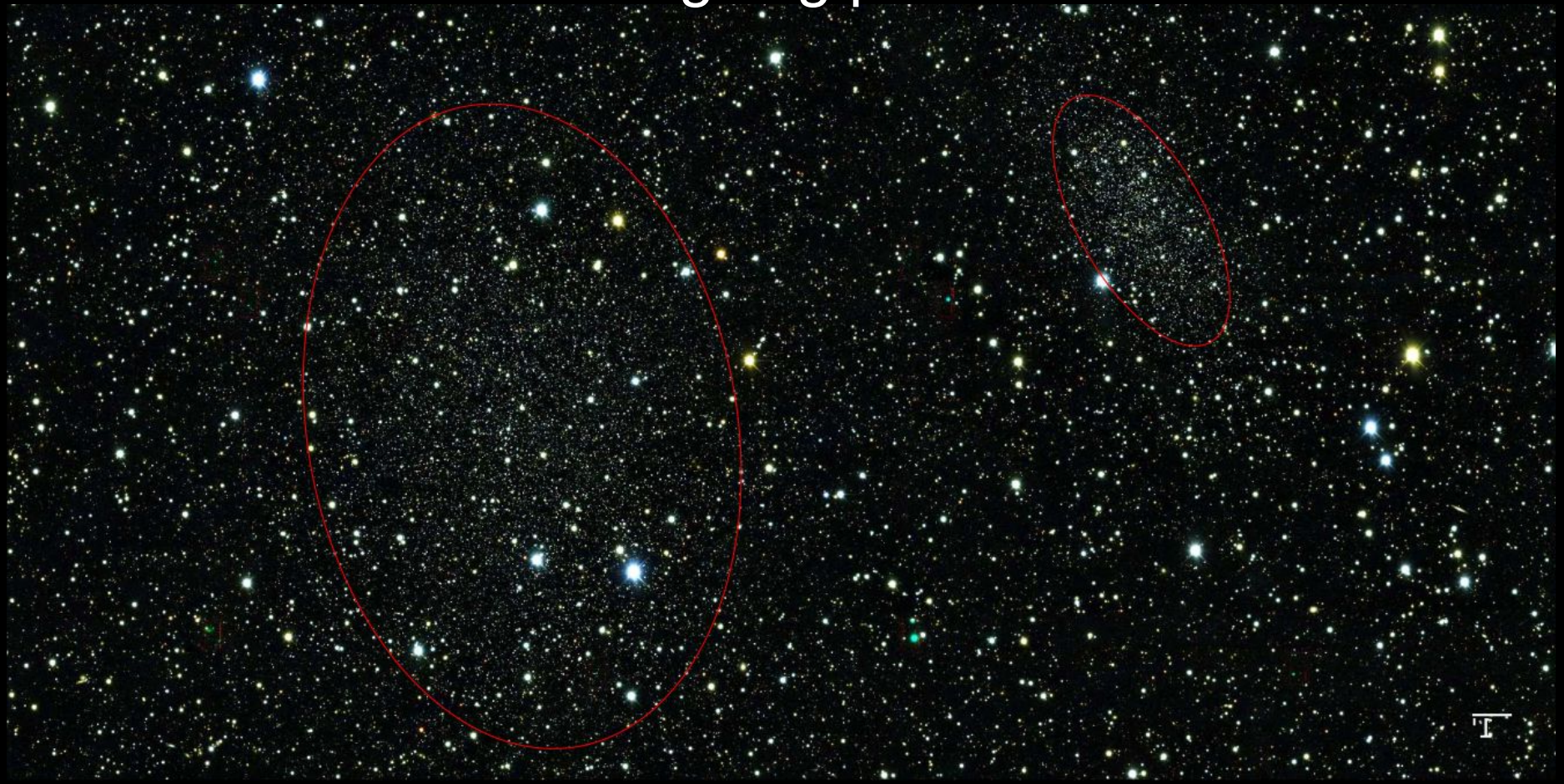
But yet again… baryons

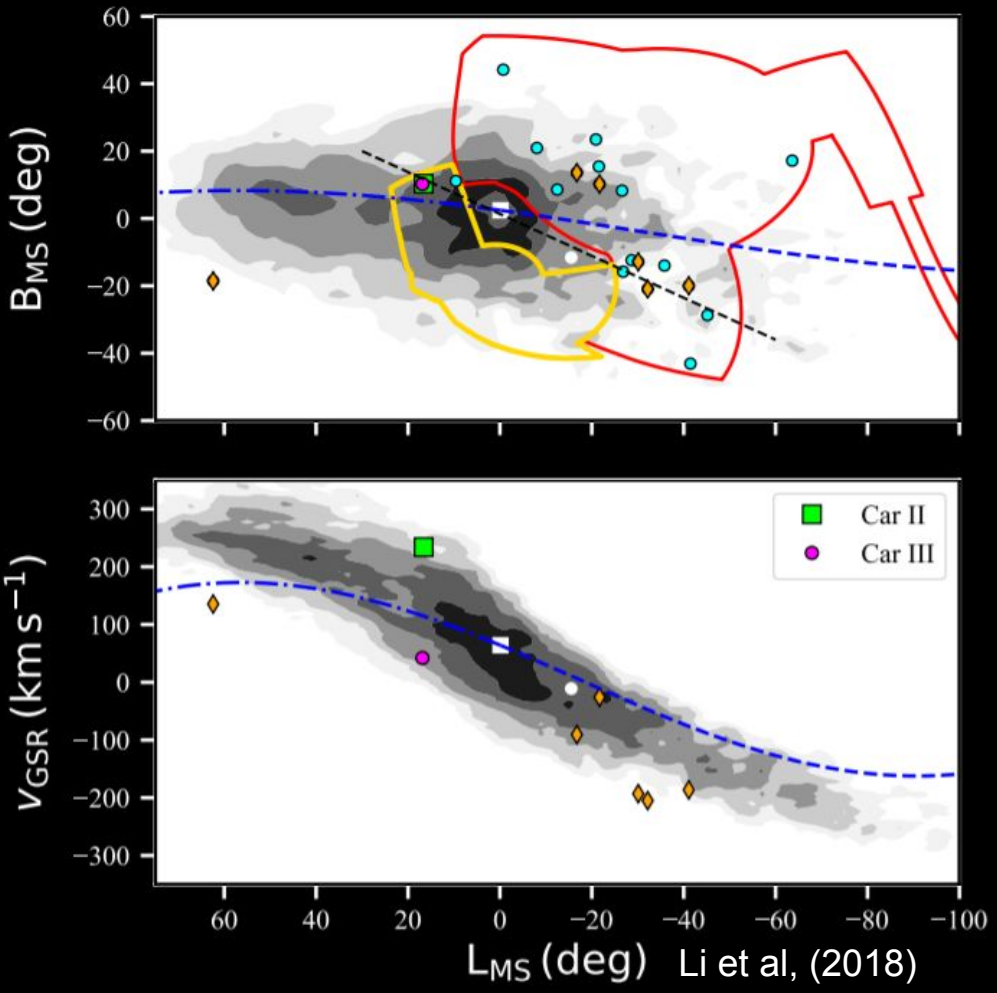


99% of the mass loss with
Zero signs of tidal disruption

Fattahi et al (2018)

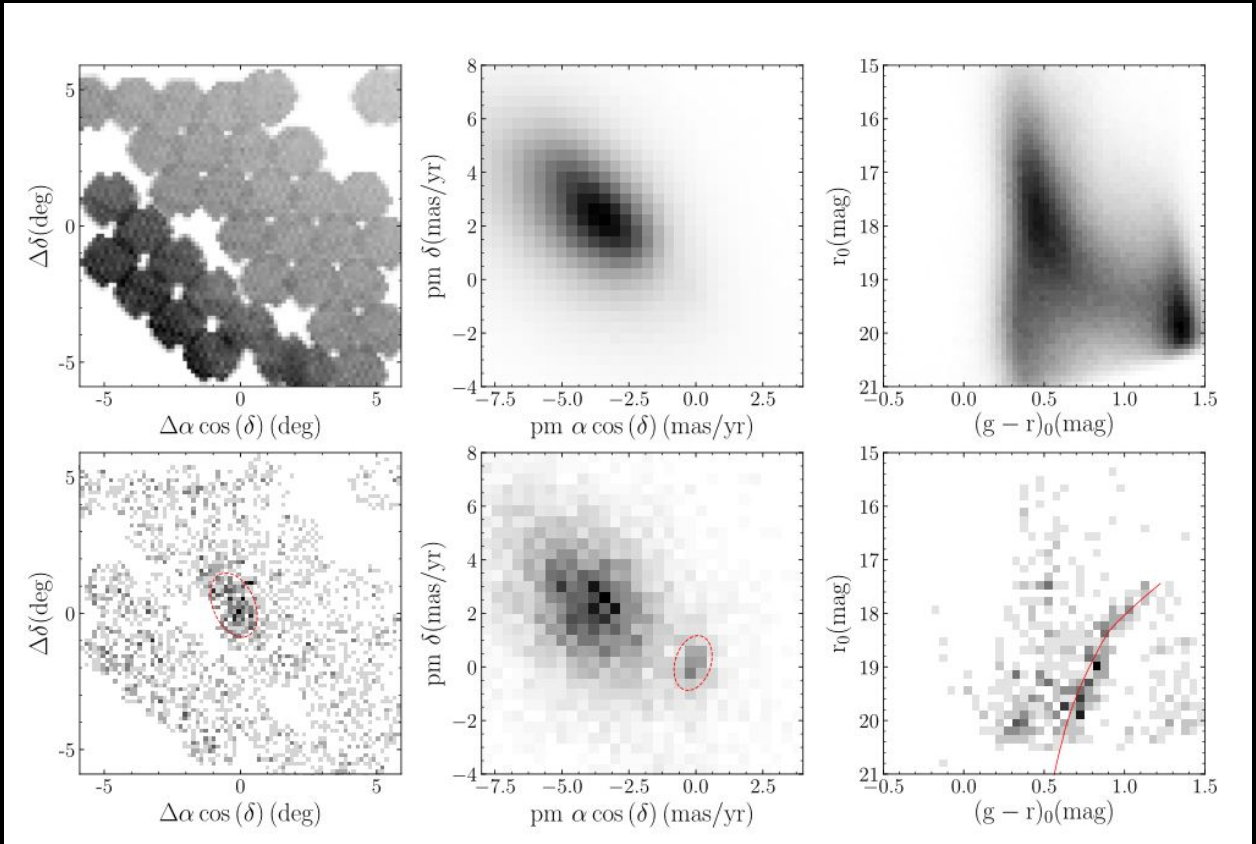
Carina 2 and 3 - An intriguing pair



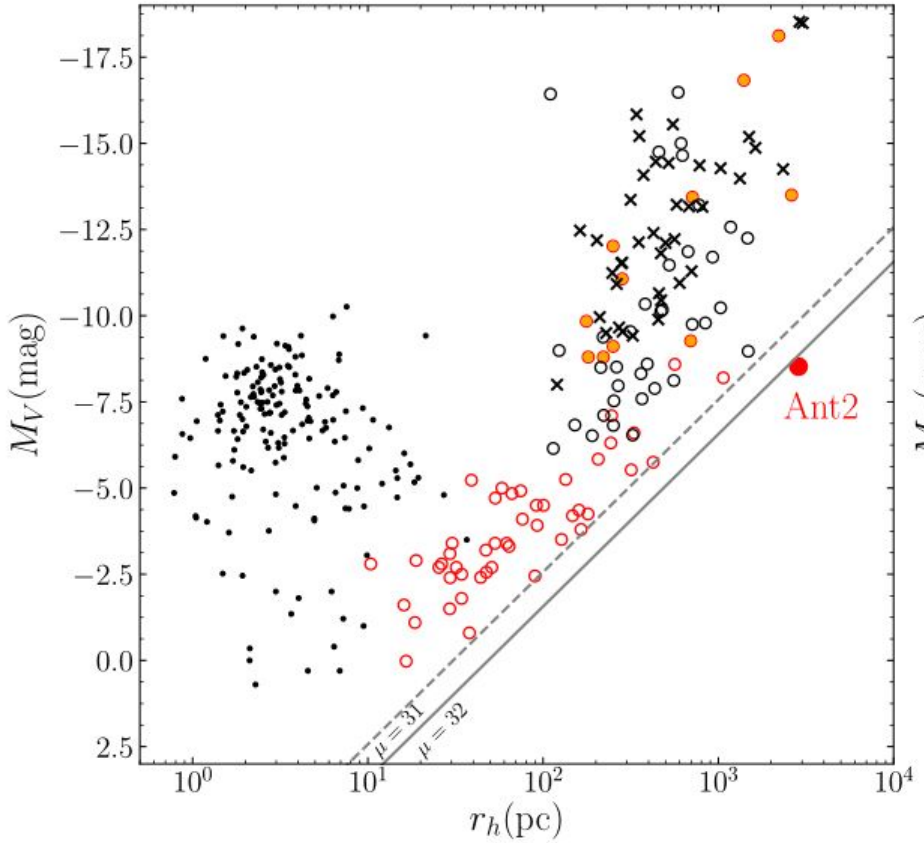

60
40
20
0
−20
−40
−60
B_{MS} (deg)
300
200
100
0
−100
−200
−300
v_{GSR} (km s^{-1})
Car II
Car III
60
40
20
0
−20
−40
−60
−80
−100
L_{MS} (deg)

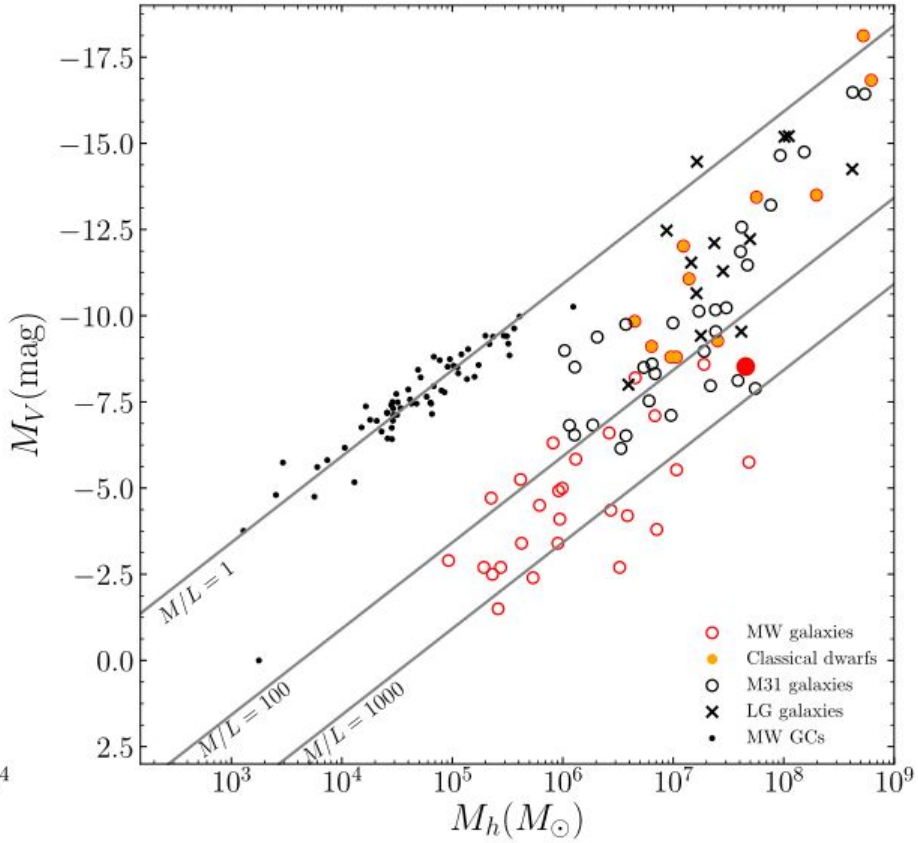
Li et al, (2018)

The missing giant



The missing giant





Summary

- DM shapes our Universe, and LCDM is a great description!
- Small scales are challenging, but critically important to describe DM
- Baryon/DM interplay is messy, but key to the apparent (?) discrepancies
- A full census, and detailed description, of the faintest galaxies is needed!
- Missing giants might be lurking around

In the future

- Find the missing - expected - satellites
- Characterize them in detail
- Find them in the field, and in other galaxies!