

MOONS to study Local Group dwarf galaxies



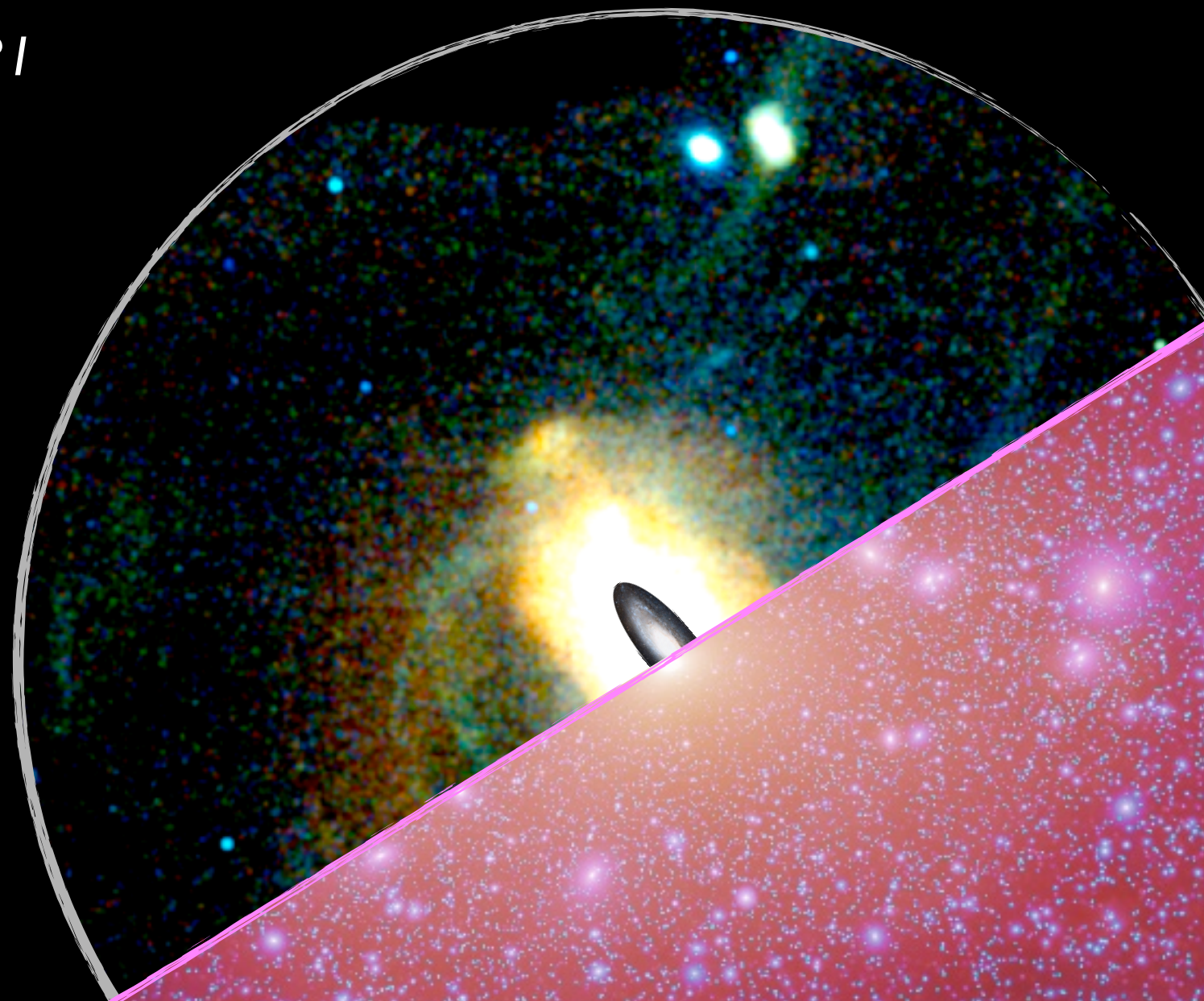
Nicolas Martin
(Strasbourg Obs.
& MPIA, Heidelberg)

@nfmartin | 980

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PAndAS view of M31

Martin et al. (2013)

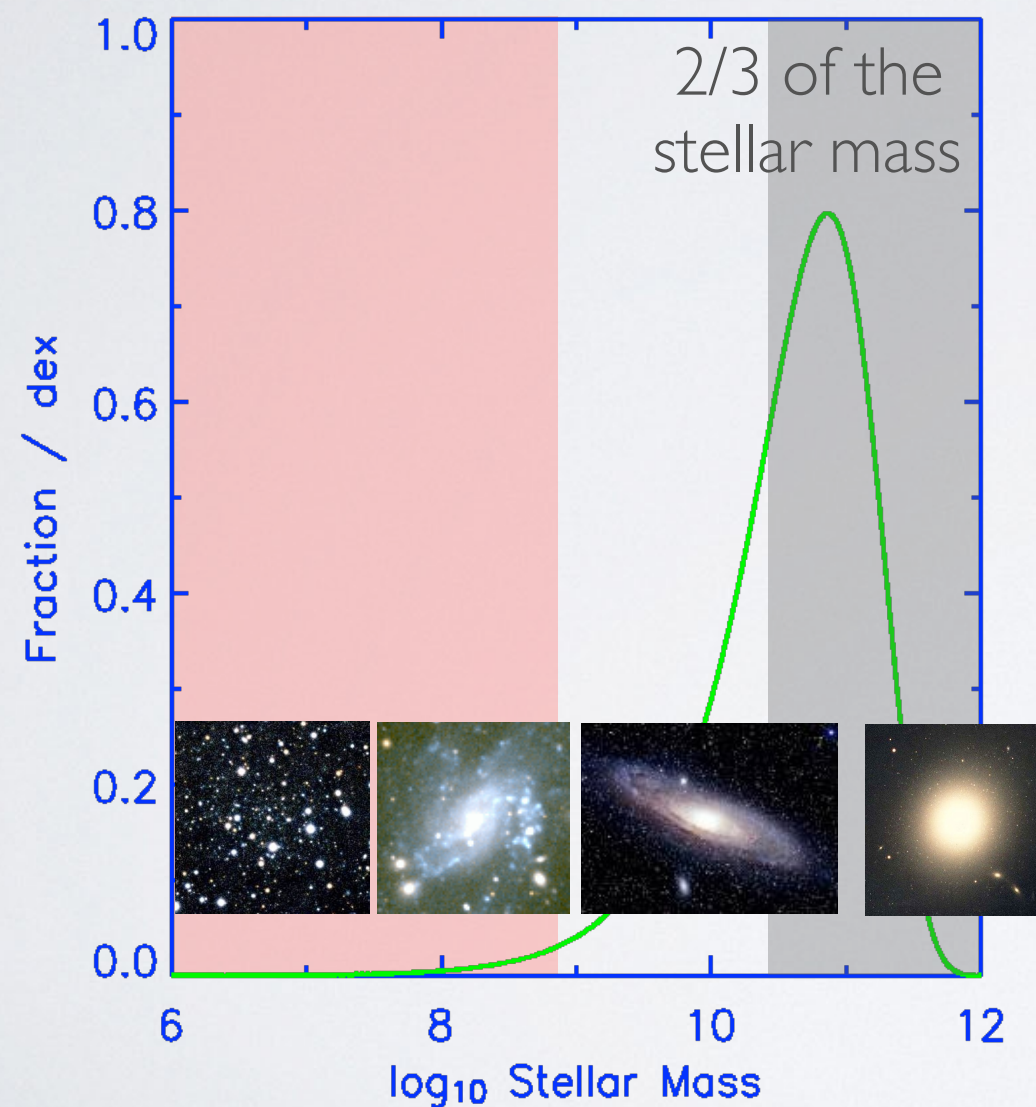


Dark Matter: Aquarius simulations

Springel et al. (2009)

Cosmology on (dwarf) galaxy scales

Contribution of galaxies of mass M
to the universe's stellar content



- Dwarf galaxies are the most dark-matter dominated systems
 - insight into small-scale DM distribution
 - low end of halo mass function
 - baryons have small impact on system (high M/L)
 - study of faint-end galaxy formation: hierarchical? SN feedback? reionization?

Which dwarf galaxies and why?

- MOONS' small field of view, number of fibers, southern hemisphere
 - brightest Milky Way dwarf galaxies (Carina, Fornax, Sculptor, ... 4–5 in total)
 - **chemodynamics** of 1000s of stars to:
 - constrain the mass and shape of DM halo (detection of DM annihilation, core/cusp)
 - study the presence of stellar sub-structures (hierarchical formation, dwarf-dwarf mergers)
 - carefully study impact of binaries stars (mainly unknown)
 - **chemodynamical** decomposition of LMC/SMC outskirts
 - hierarchical formation of their stellar halo?
 - study of a on-going dwarf/dwarf interaction
- More difficult but possible (***and should be done!***)
 - M31, M31 dwarf galaxies, M33, isolated Local Group dwarf galaxies (Sextans A, B, NGC 3109, ...)

A hope for DM direct detection

● Faintest (most-DM dominated) dwarf galaxies may be best but

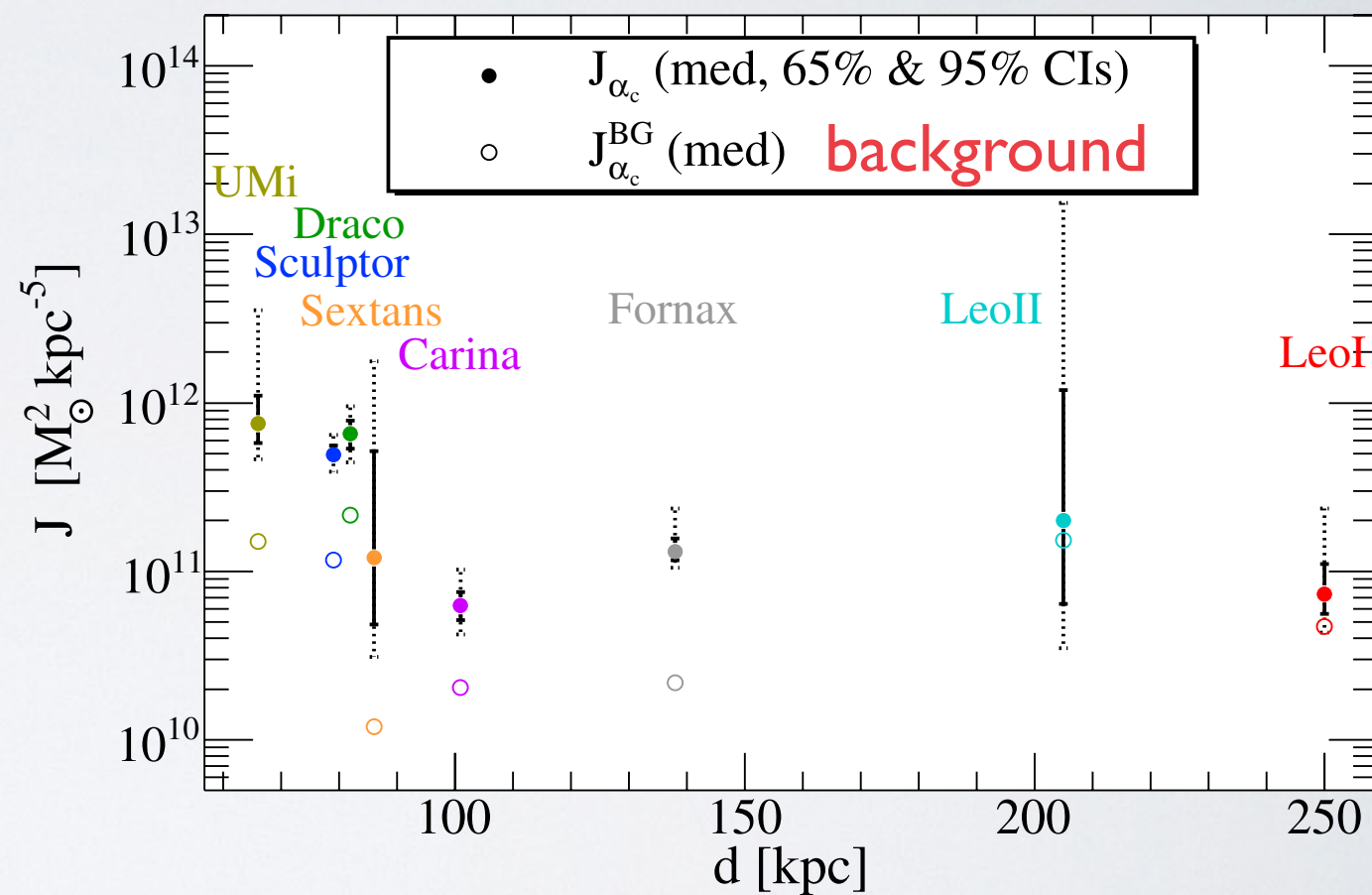
- small number of observable member stars, doubts on virialization, ...

→ *better to observe brighter systems*

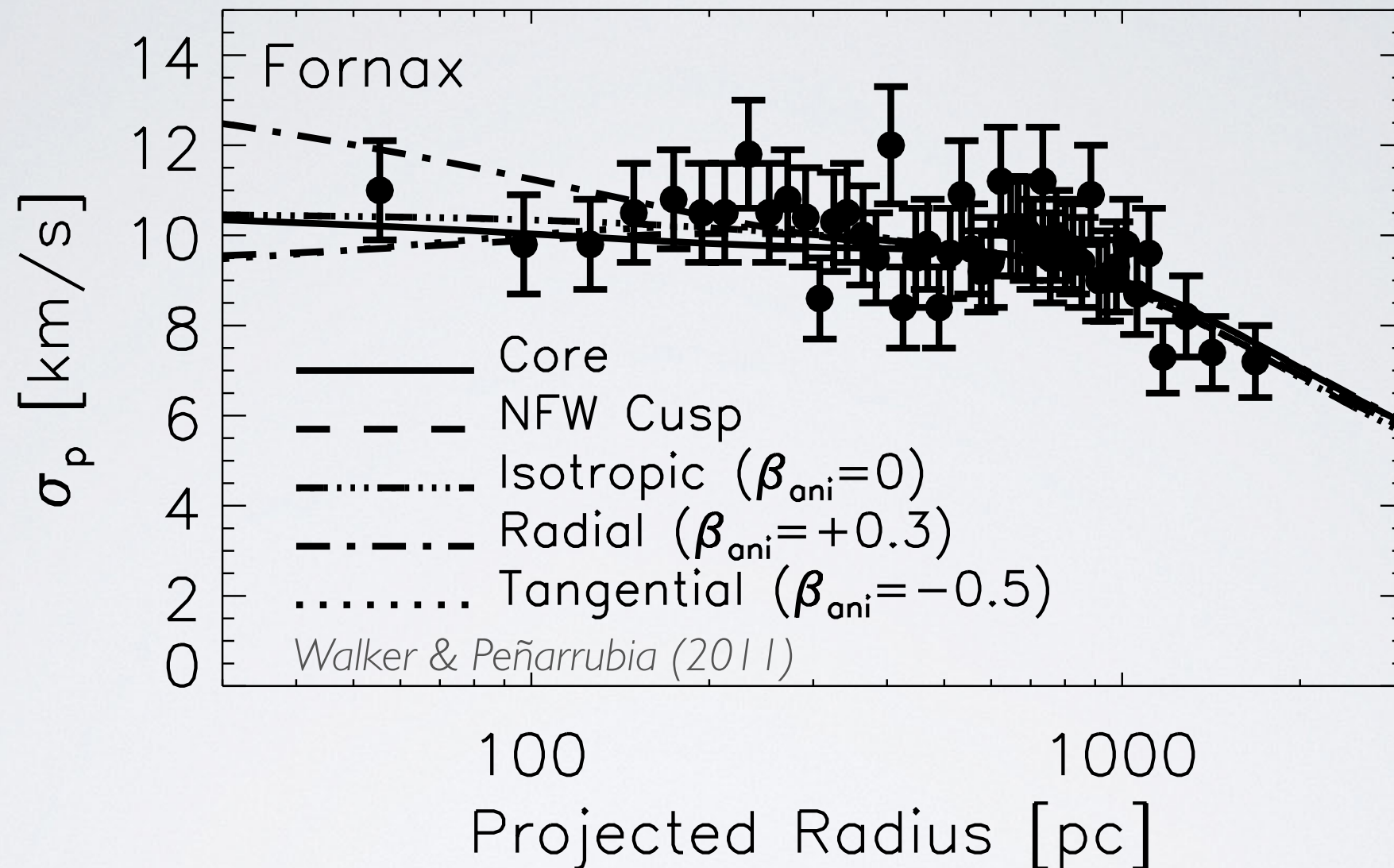
● Now systems with 1k–2k observed velocities (Fornax, Sculptor)

- significantly above background estimations but still large uncertainties on modeling
- need more data, more galaxies for stacking, ...

Ease of detecting a DM signal



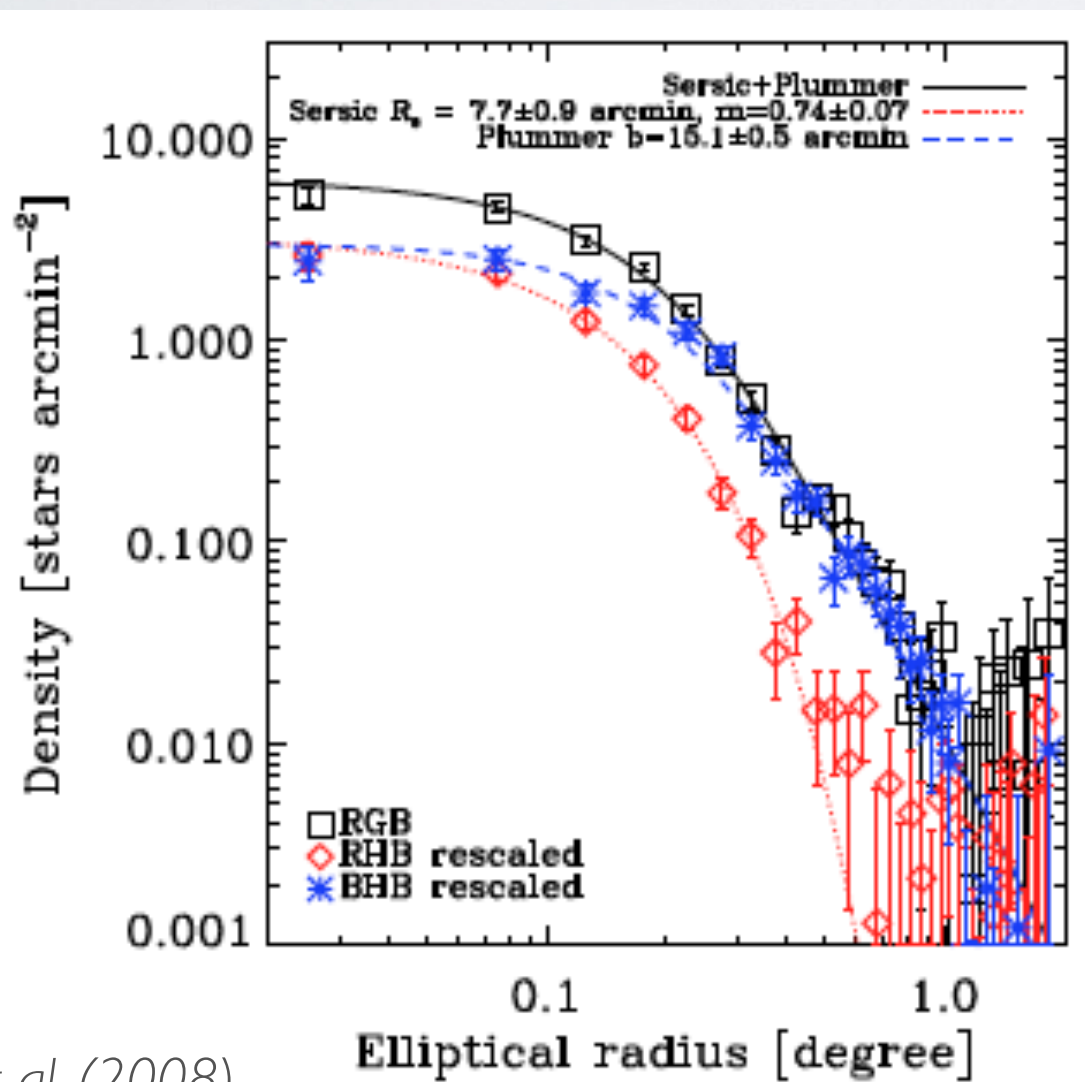
Revisiting the cusp-core issue



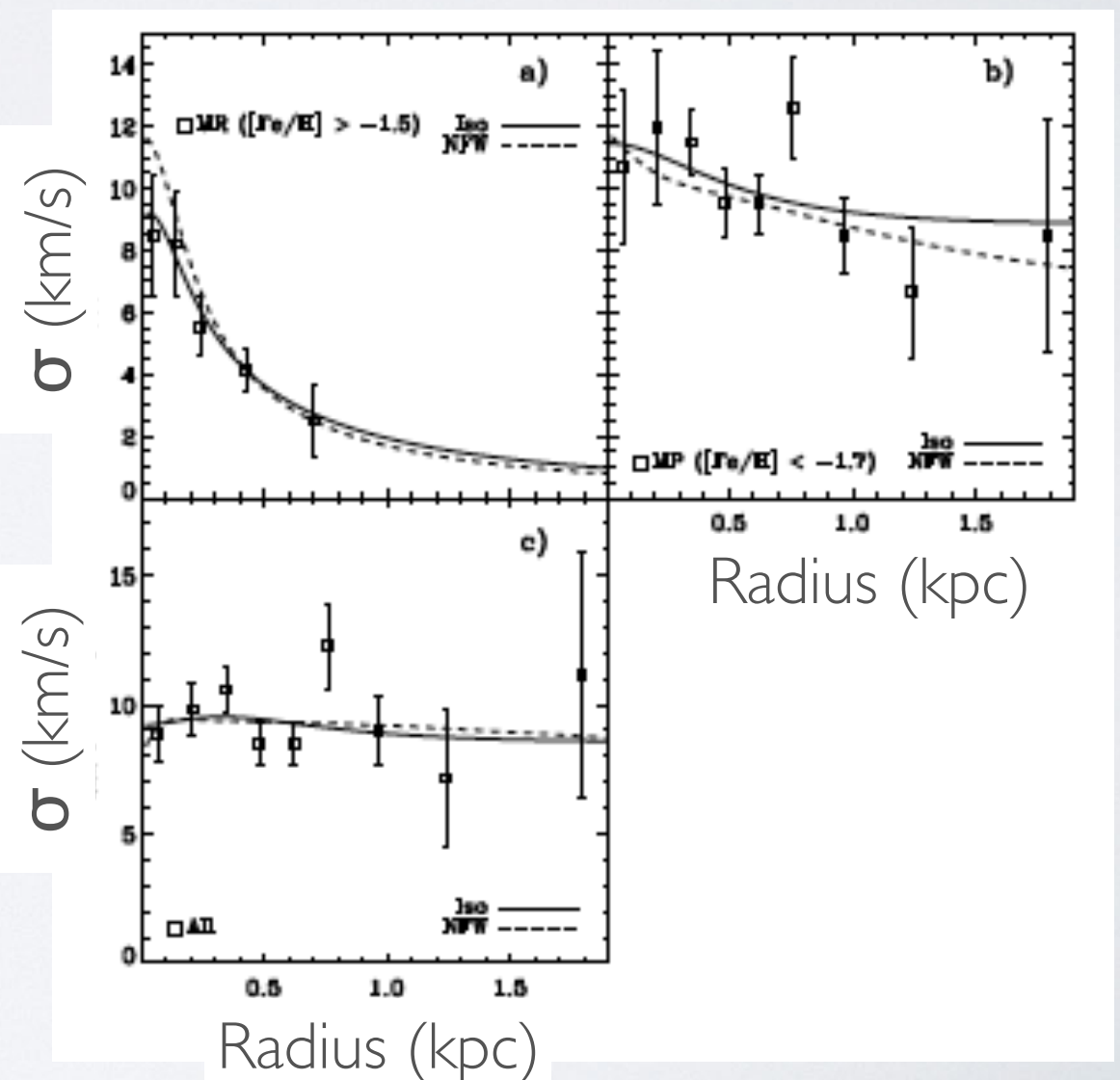
- Internal dynamics of multiple stellar populations → differential tests of DM mass within r_h of population → slope of DM profile
 - currently done in 2 dwarf galaxies with 1,000+ good quality velocities and metallicities.

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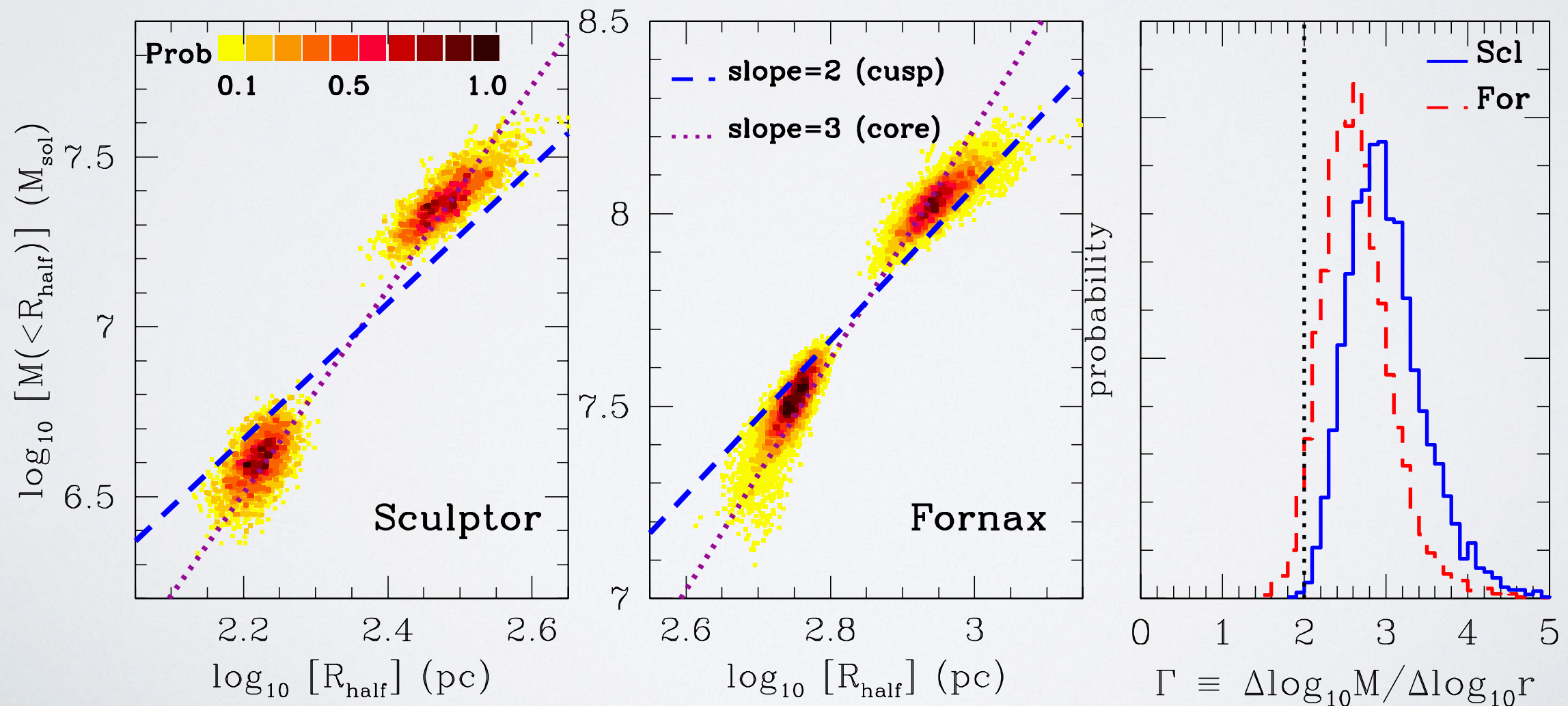


Battaglia et al. (2008)



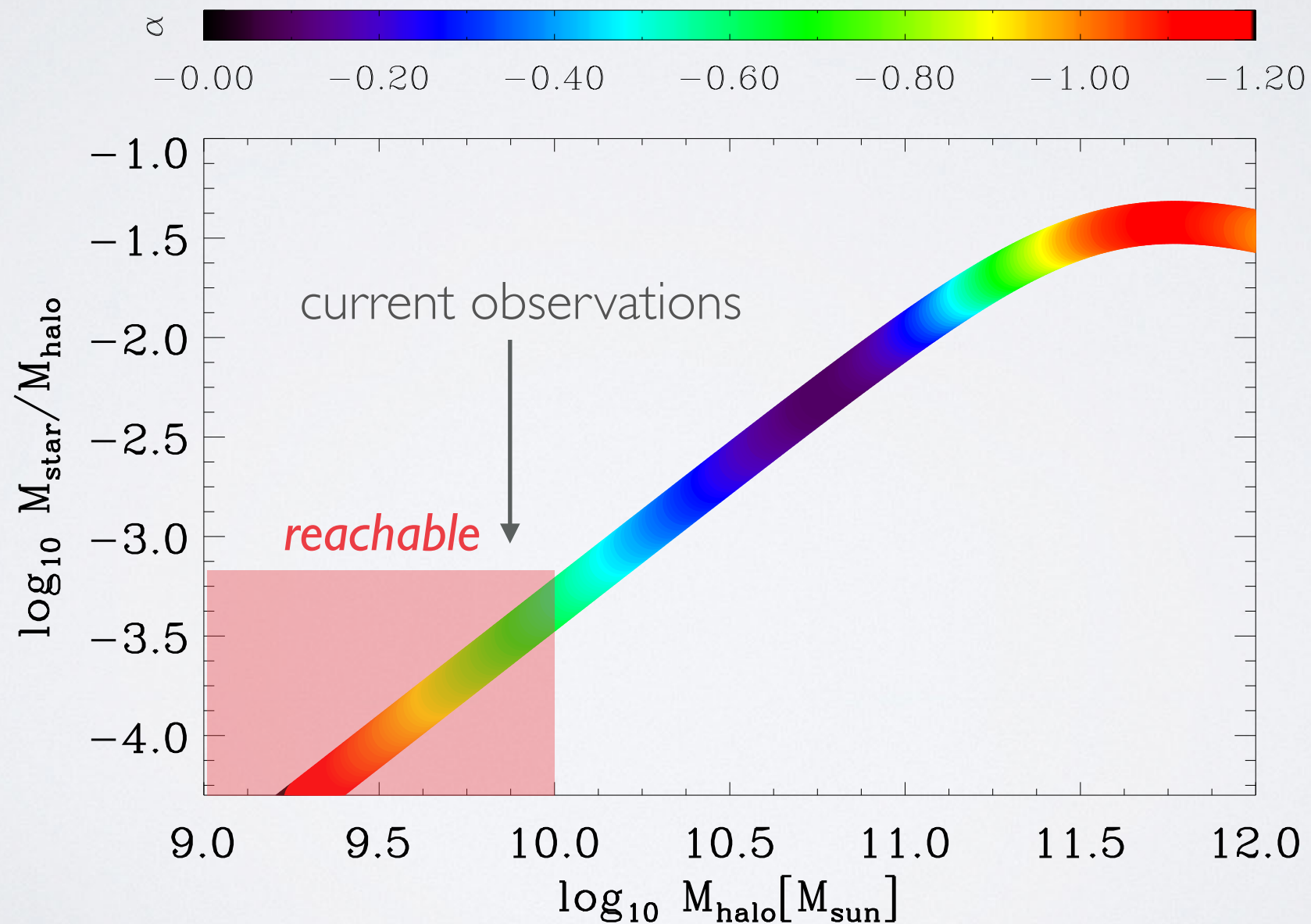
Revisiting the cusp-core issue

- Internal dynamics of multiple stellar populations → differential tests of DM mass within r_h of population → slope of DM profile
 - currently done in 2 dwarf galaxies with 1,000+ good quality velocities and metallicities. Still uncertain...



Revisiting the cusp-core issue

- Need more tests and a mass-range as baryons expected to flatten central DM slope

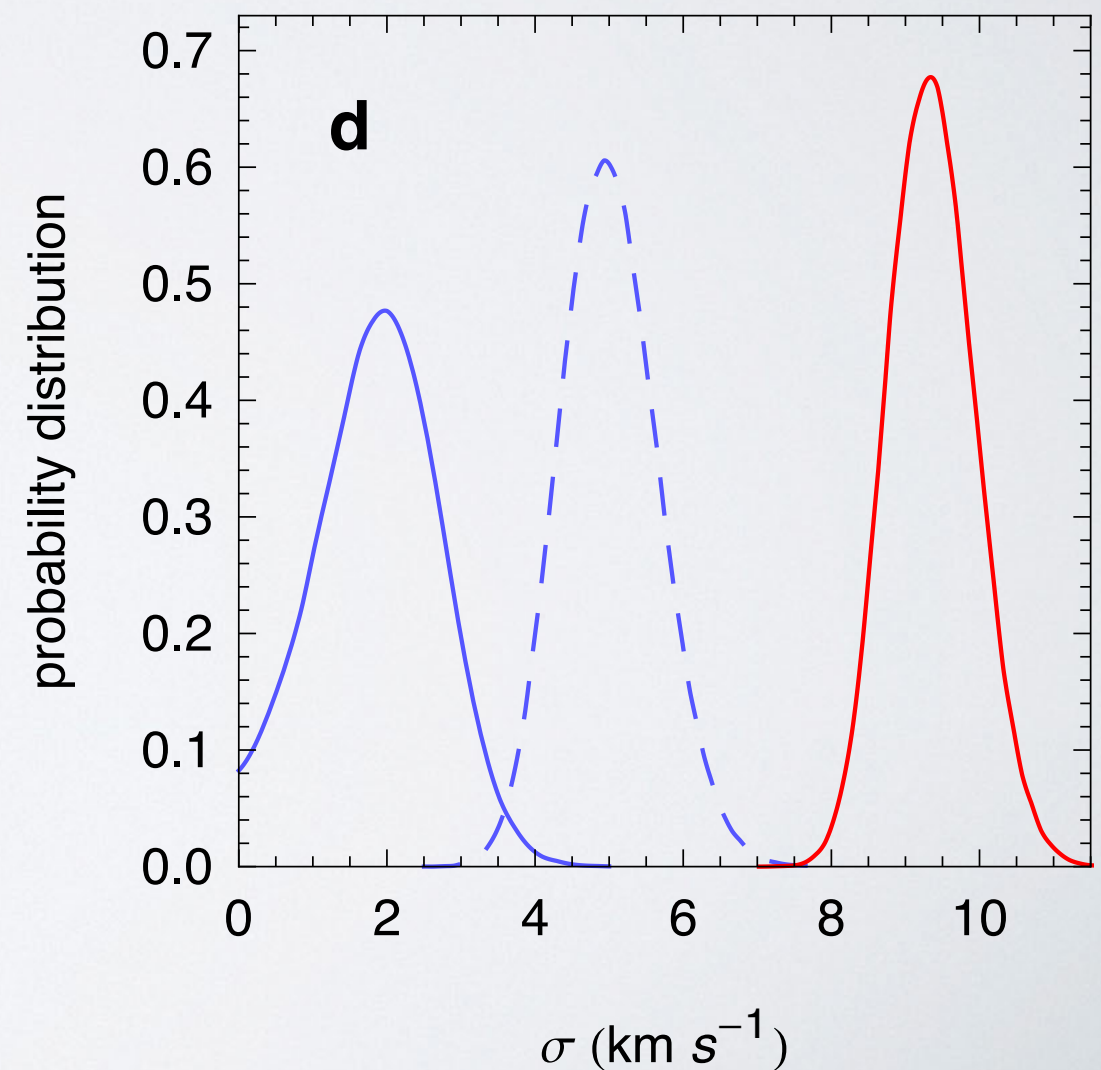
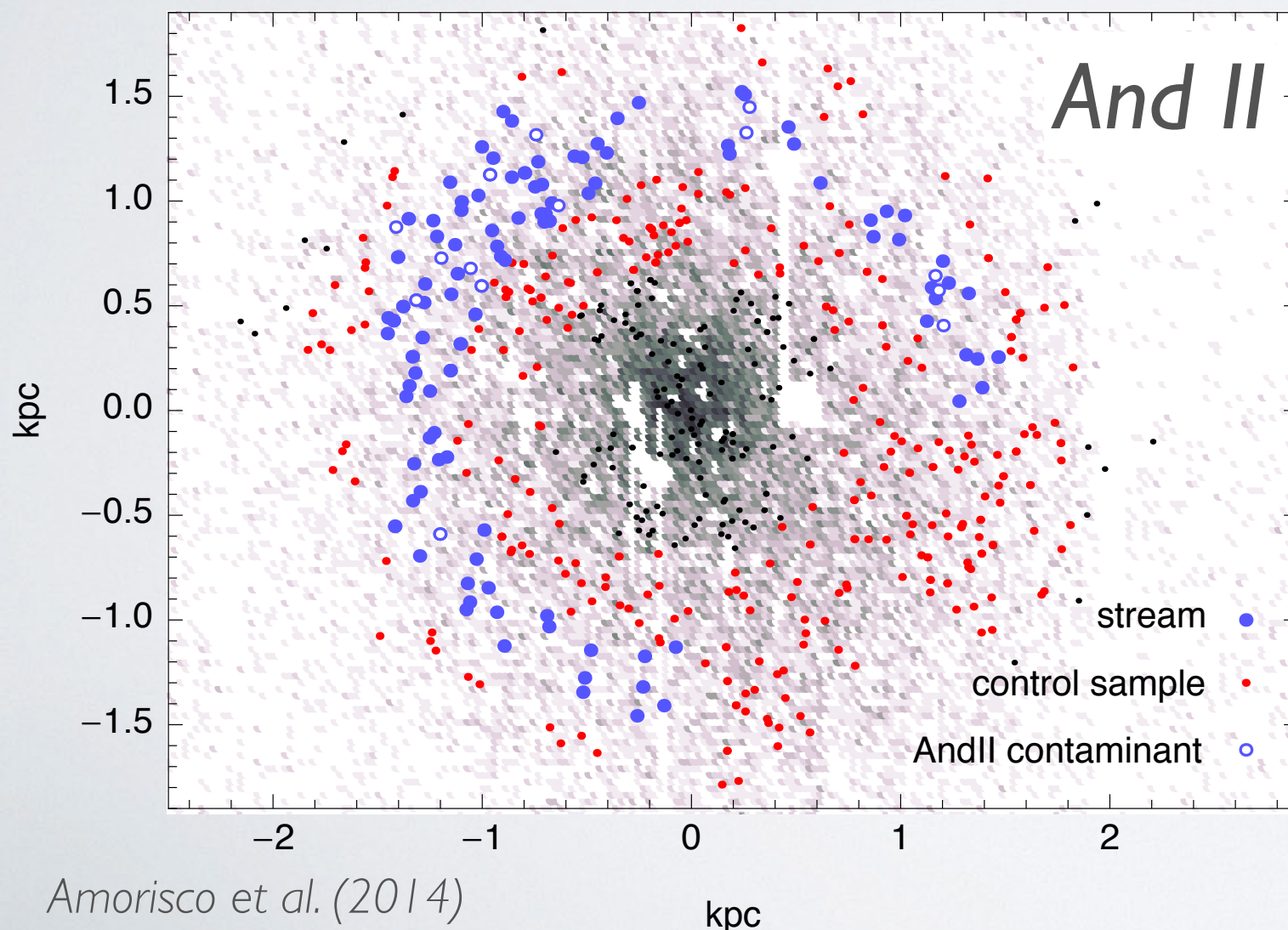


The hierarchical formation of dwarf galaxies

© Mounting evidence that dwarf galaxies aren't simple systems

- multiple stellar populations
- presence of sub-structures

→ evidence of hierarchical formation?



What is needed?

- © Samples of 1–10k radial velocities and (at least) [Fe/H]
 - red giant branch stars in Fornax, Sculptor, Carina, Sextans(, Sagittarius)
 - calcium triplet observations
 - medium resolution for most ($g < 23$)
 - high resolution for brighter stars (chemical abundances → Vanessa's talk)
 - 100s stars/deg², especially since numerous foreground contaminants
- © Need *heavily multiplexed*, *wide field of view* spectrograph on *8m-class* telescope → **MOONS**

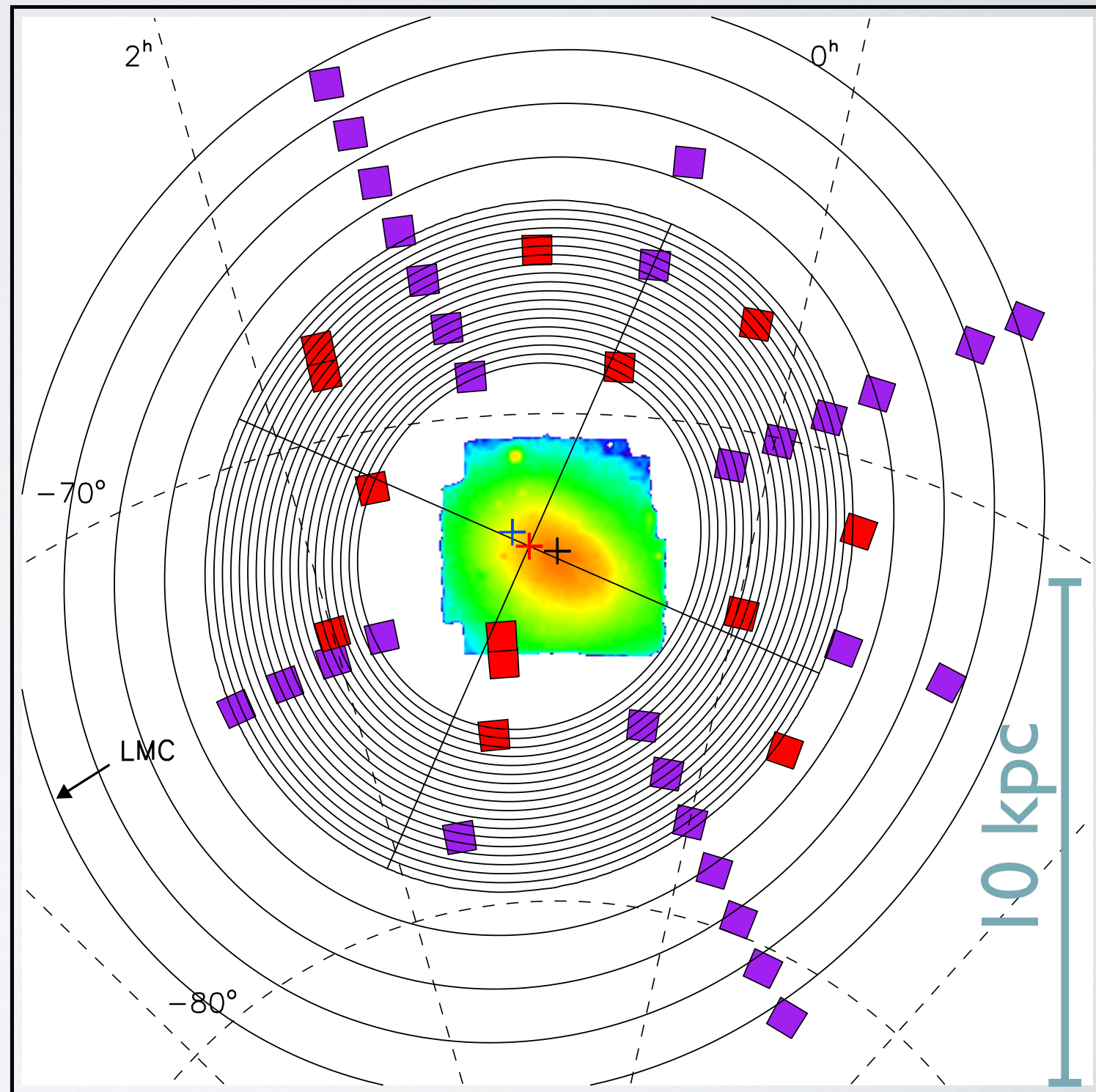
The SMC/LMC system

- Evident hierarchical formation of stellar halos of L^* galaxies.
- What about lower mass systems?
 - LMC/SMC have cohort of faint dwarf galaxies
 - Interacting system
 - Stellar halos observed over 10+ kpc?



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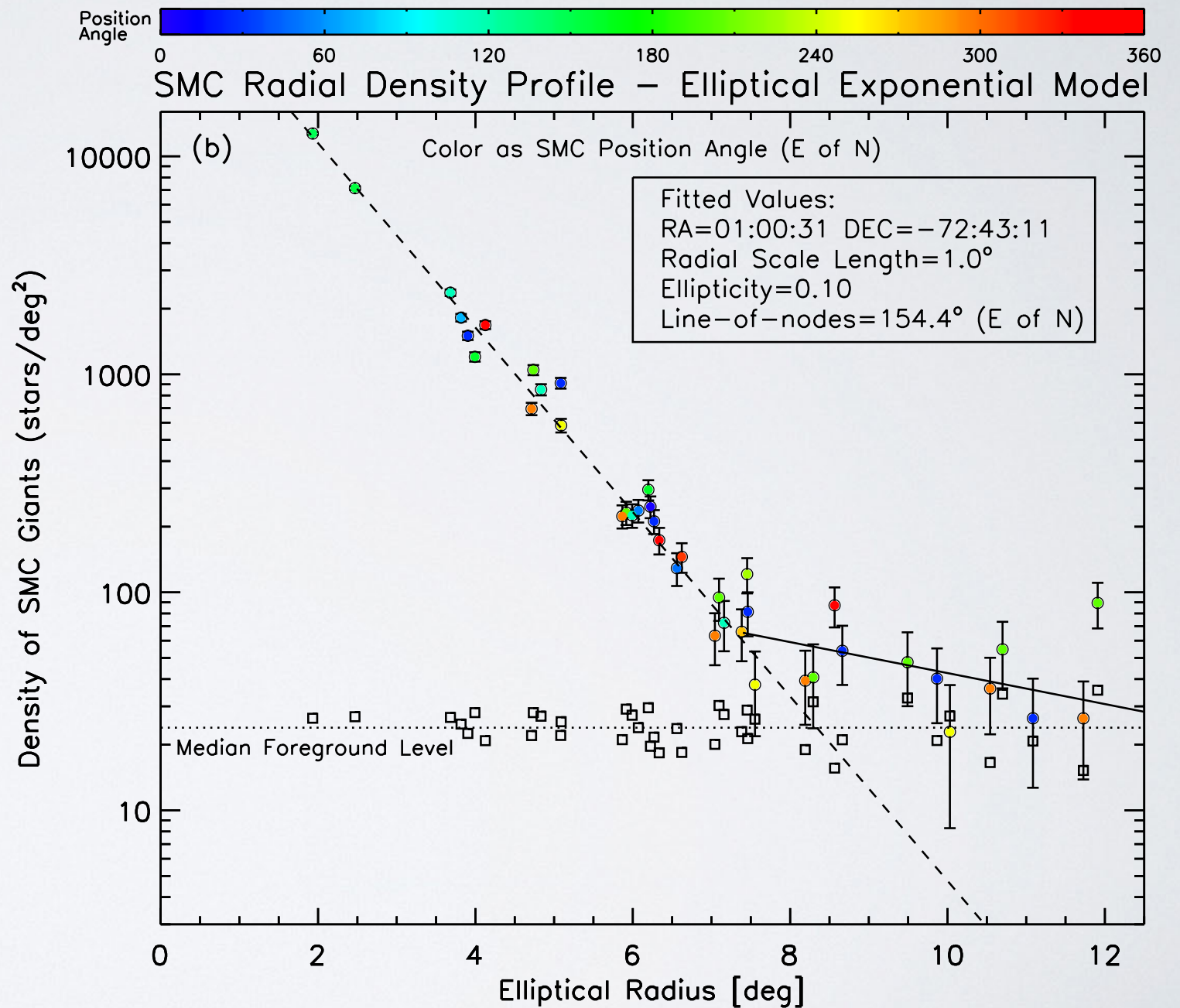
Evidence for SMC & LMC stellar halo

● From photometry alone

- Kinematics of disk? halo?
- Sub-structure?
- Origin?
- How does it fit in hierarchical universe?
- How does it fit in SMC/LMC interaction?

● *Need phase-space study*

- but swamped by foreground
- need southern, wide-FoV, MOS on 8m class telescope
→ **MOONS**



MOONS & Local Group dwarf galaxies

- MOONS perfect for *chemodynamical* study of dwarf galaxies to:
 - provide better constraints of astrophysical uncertainty on *indirect DM annihilation signal*
 - constrain presence of *core/cusp* in most DM-dominated systems
 - constrain presence of *predicted dwarf/dwarf mergers*
 - study impact of binaries
- MOONS perfect for *chemodynamical* study of SMC/LMC outskirts:
 - halo? consequence of SMC/LMC interaction → constraints on low-mass hierarchical formation
- Other targets are possible:
 - M31 + M33 + their bright satellites (And II, ...)
 - Dwarf irregular galaxies at edge of Local Group
