

Isolated dwarf galaxies as probes of dark matter

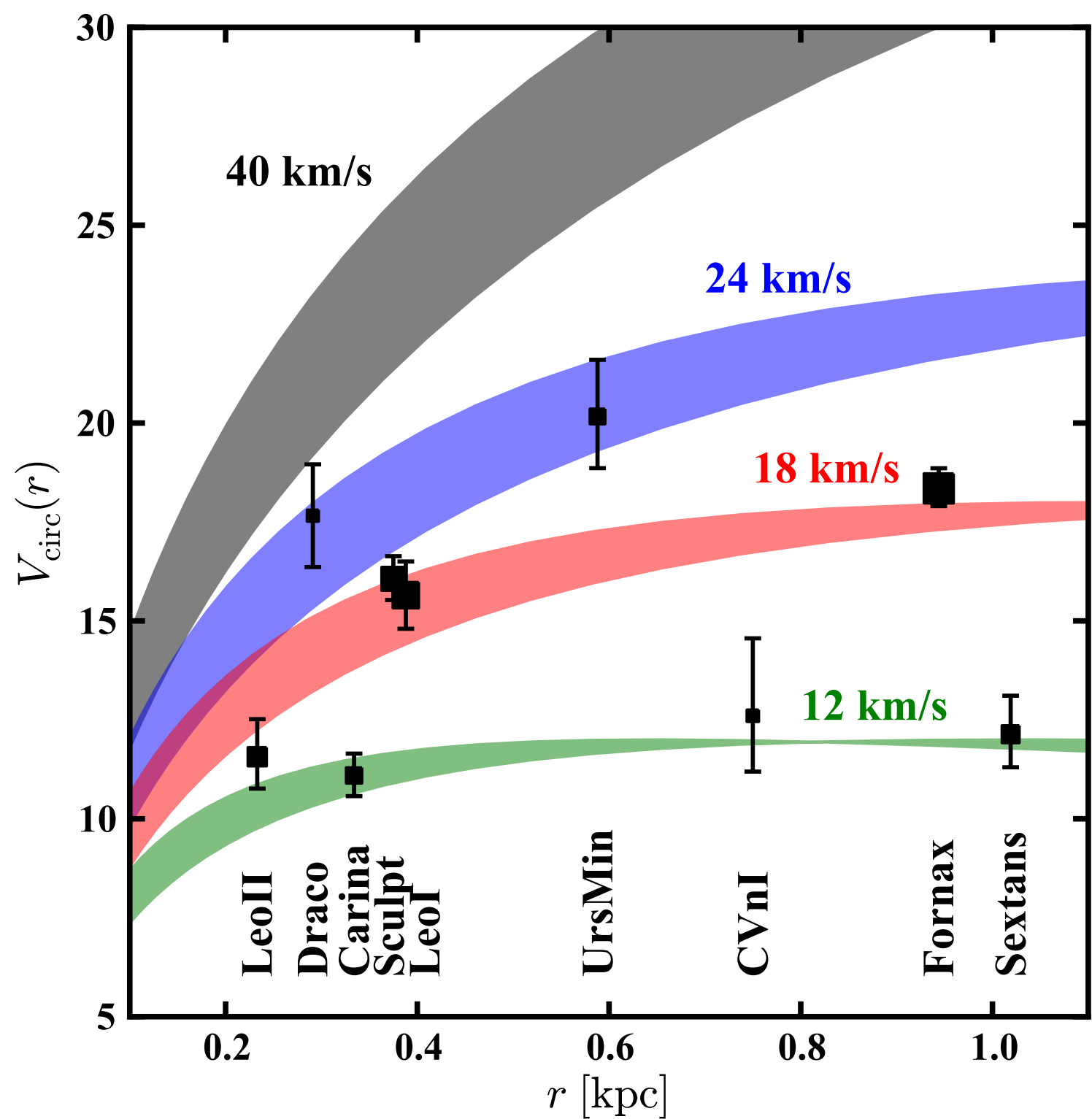
Michelle Collins
University of Surrey

Isolated dwarf galaxies as probes of dark matter

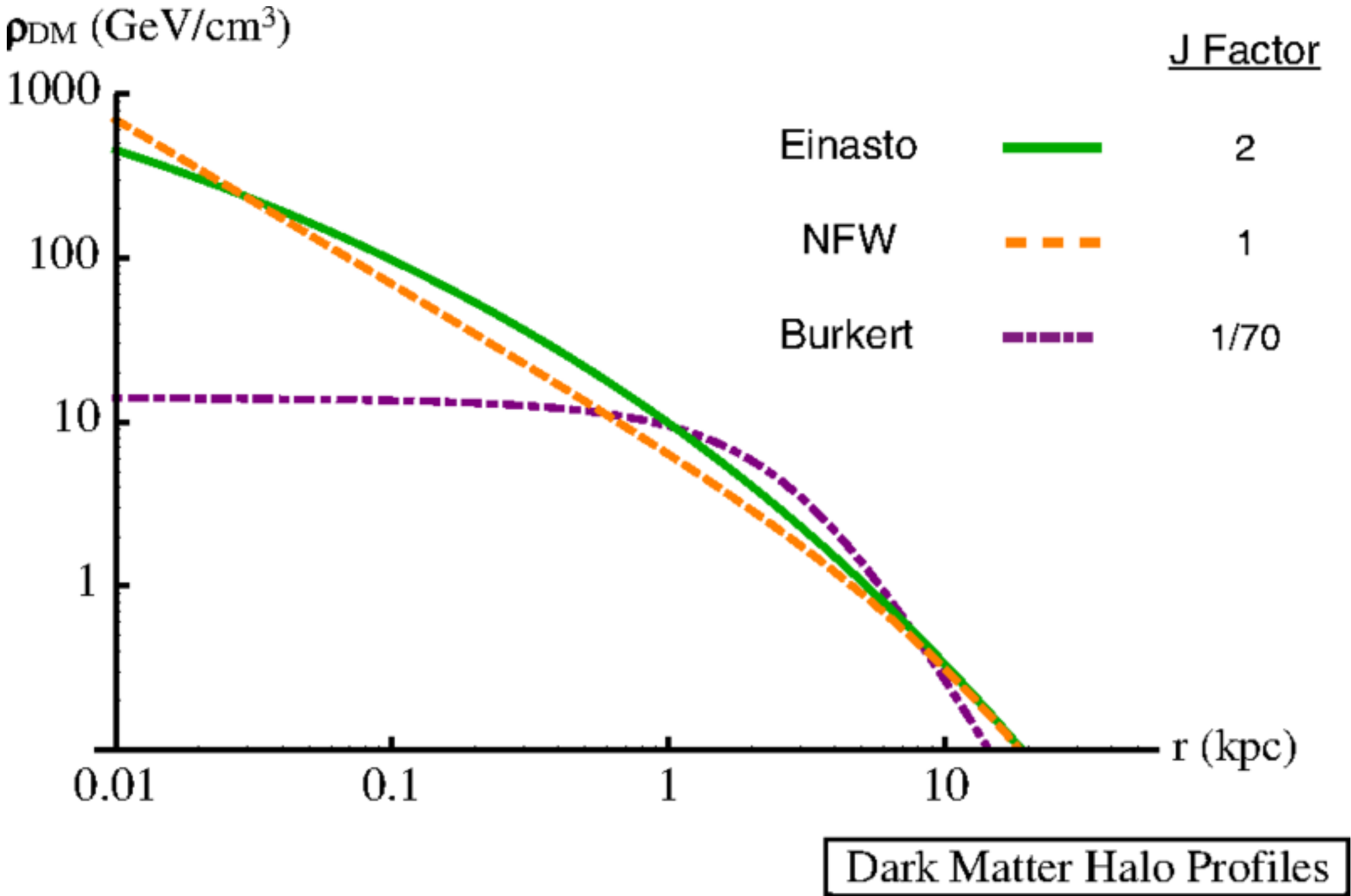
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Low density dark matter halos

‘Too big to fail’

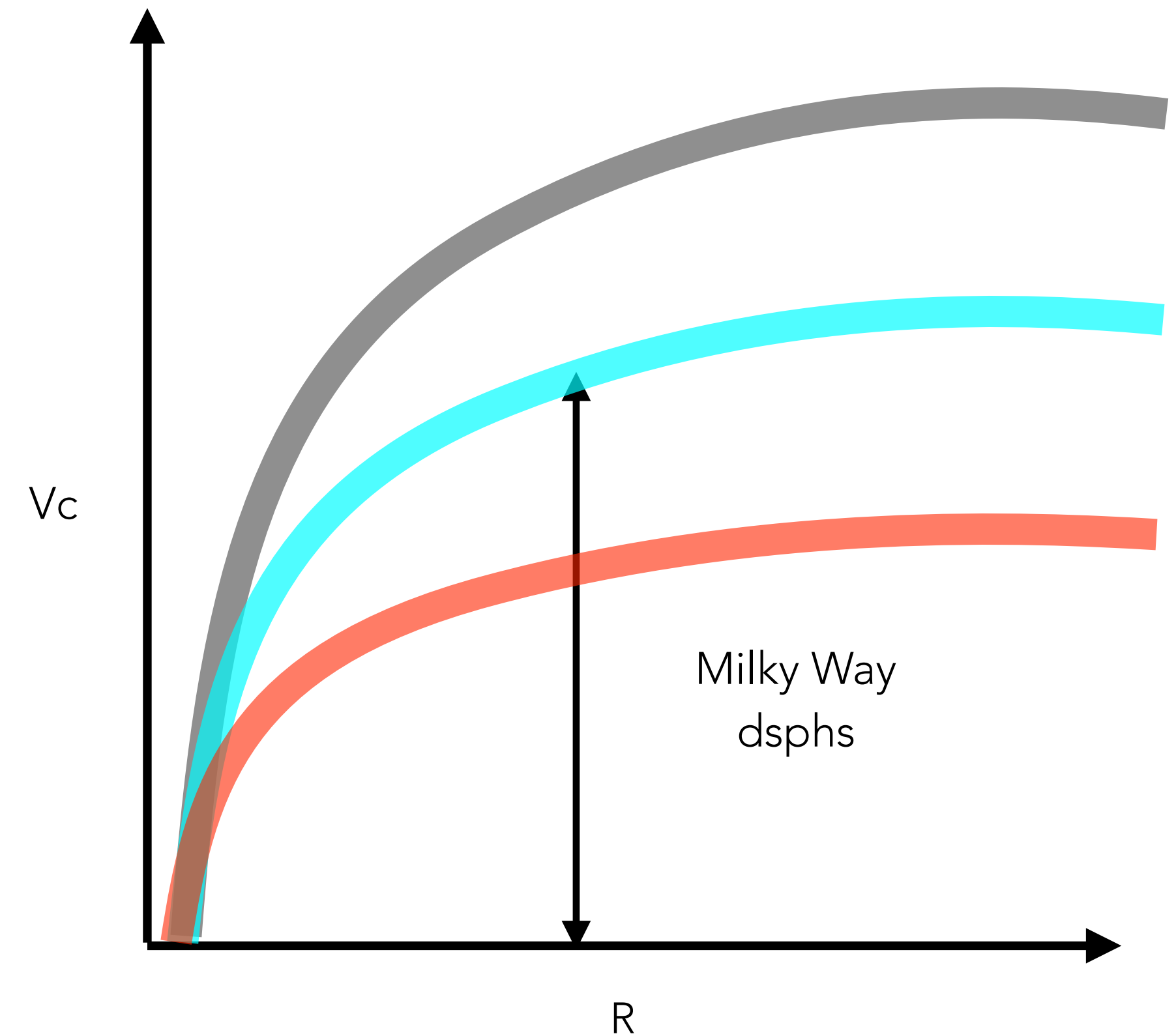


‘Cusp-Core’



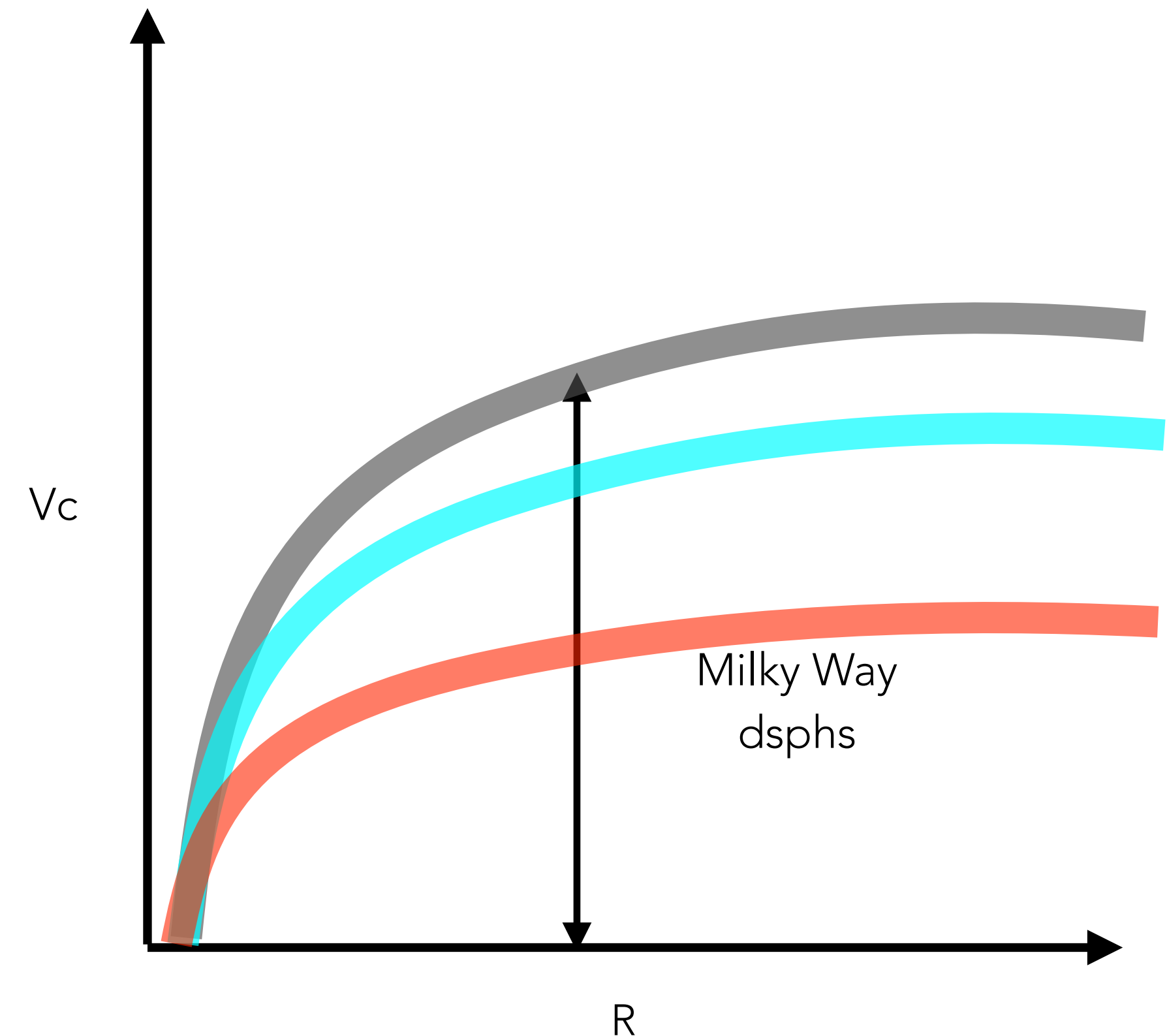
A problem for CDM? Or fixed by baryons?

- Importance of feedback effects
Supernovae feedback can 'smooth' density profiles - e.g. Pontzen & Governato 2012, Brooks et al. 2015, Read, Agertz & Collins 2016, Wheeler + 2015
FIRE, LATTE, APOSTLES, CLUES...



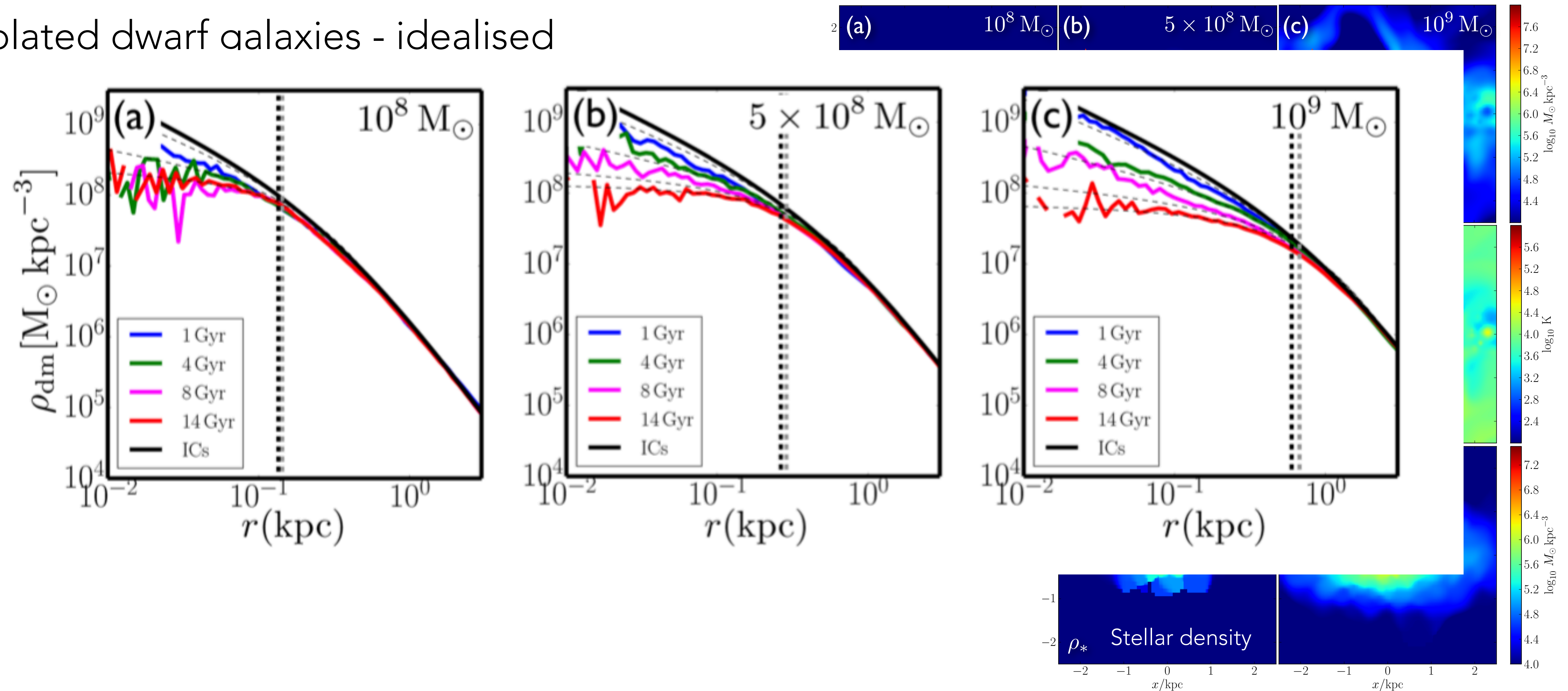
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Dark matter ‘heating’ - testing with high resolution simulations

Isolated dwarf galaxies - idealised



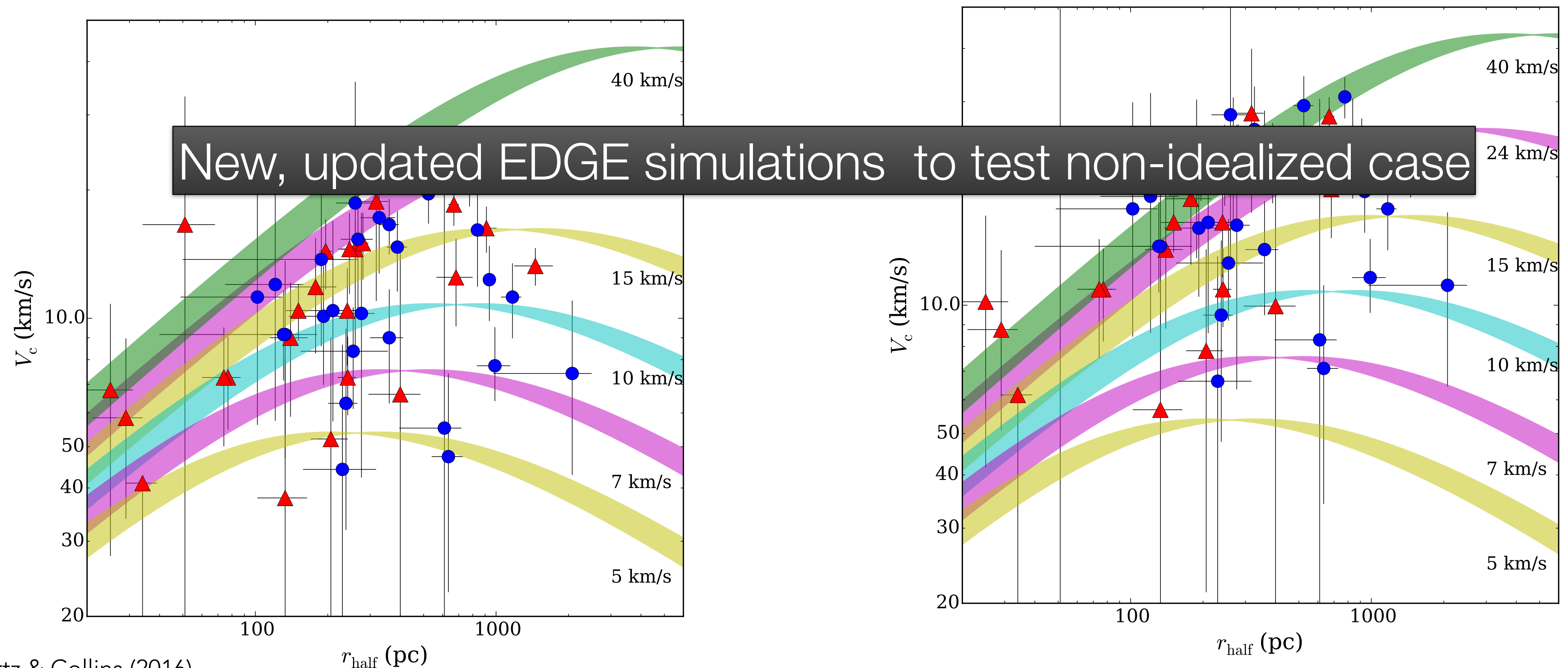
Have lower masses than dark matter only

Can reduce central densities of DM halo, **even at low stellar masses**

Cores can be formed

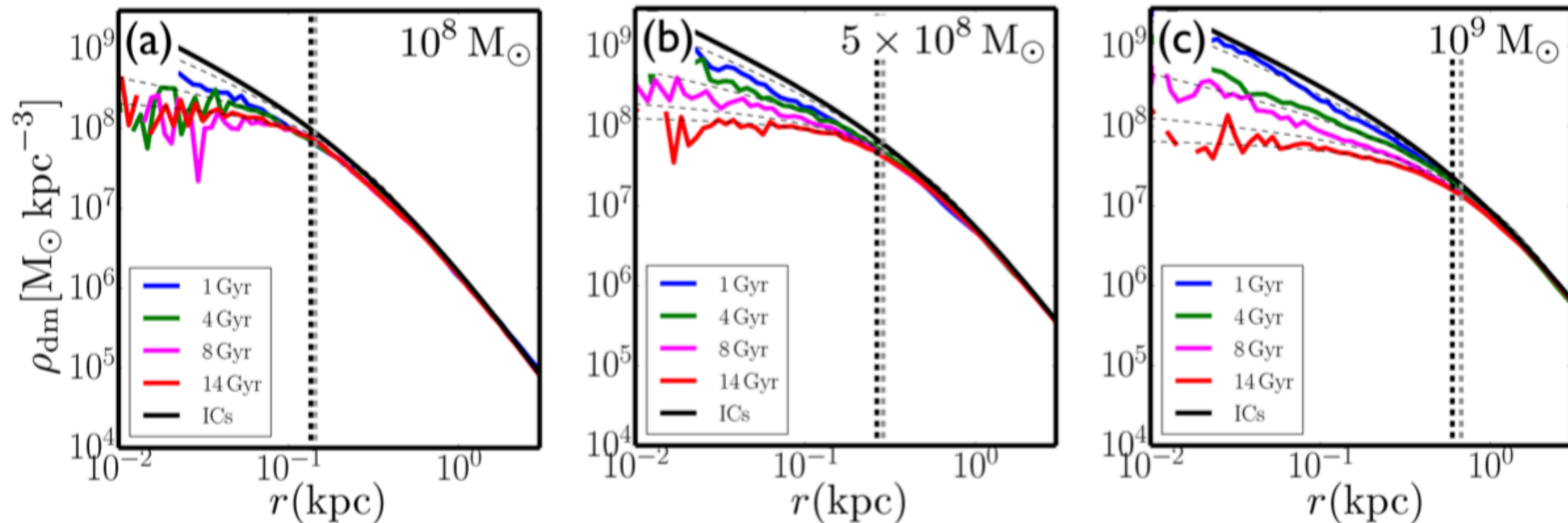
Lowers central mass by factor ~ 4

Can 'correct' measured circular velocities

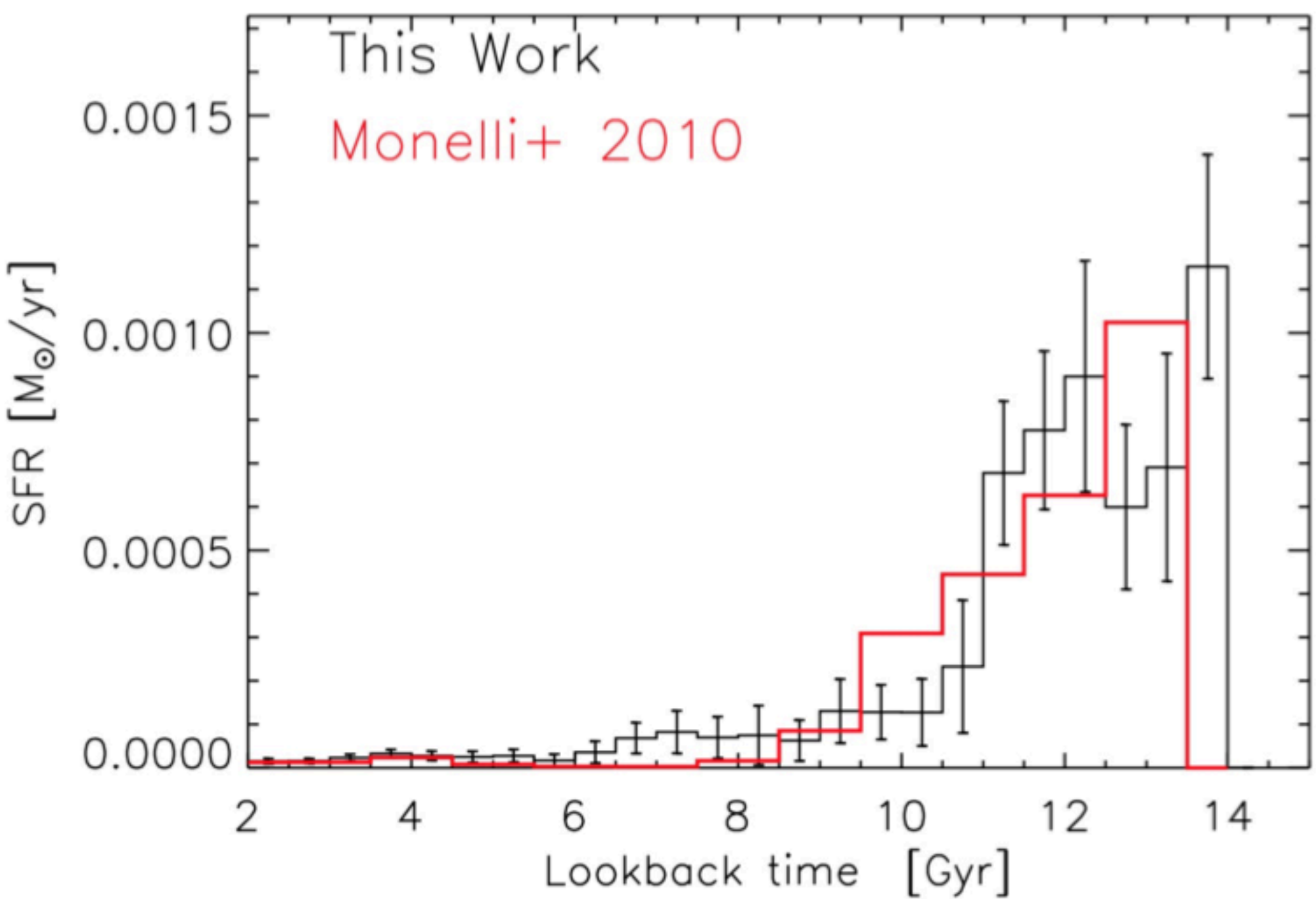
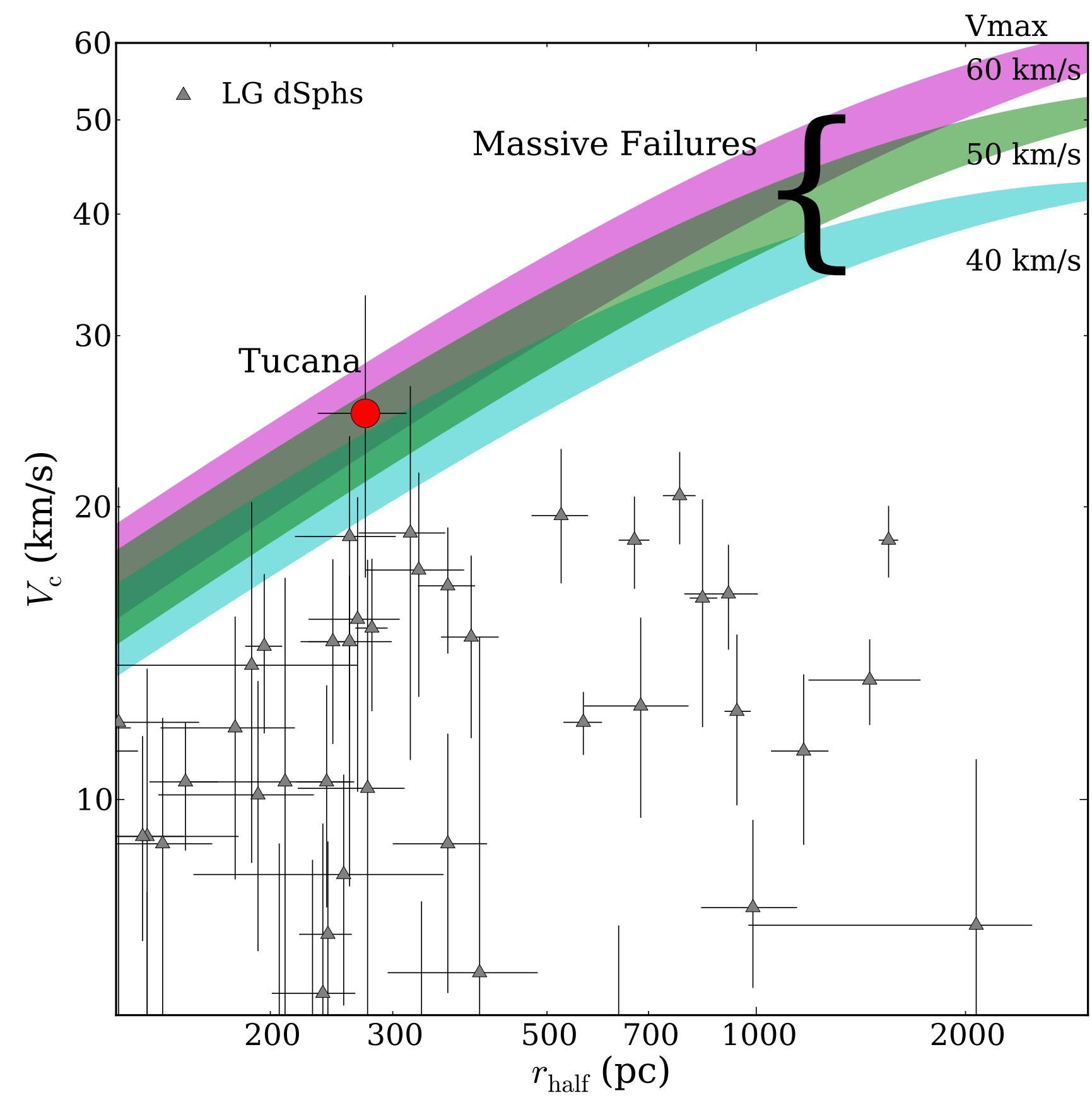


Implies there should be high density/cusped dwarfs

- Significant ‘heating’ of dark matter can only occur if star formation is extended ($t_{\text{sf}} > 4\text{-}5$ Gyrs)
- Expect some dwarf galaxies to retain their cusps
- If galaxies found with cores, but little star formation, need other mechanisms



Searching for cusps - Tucana



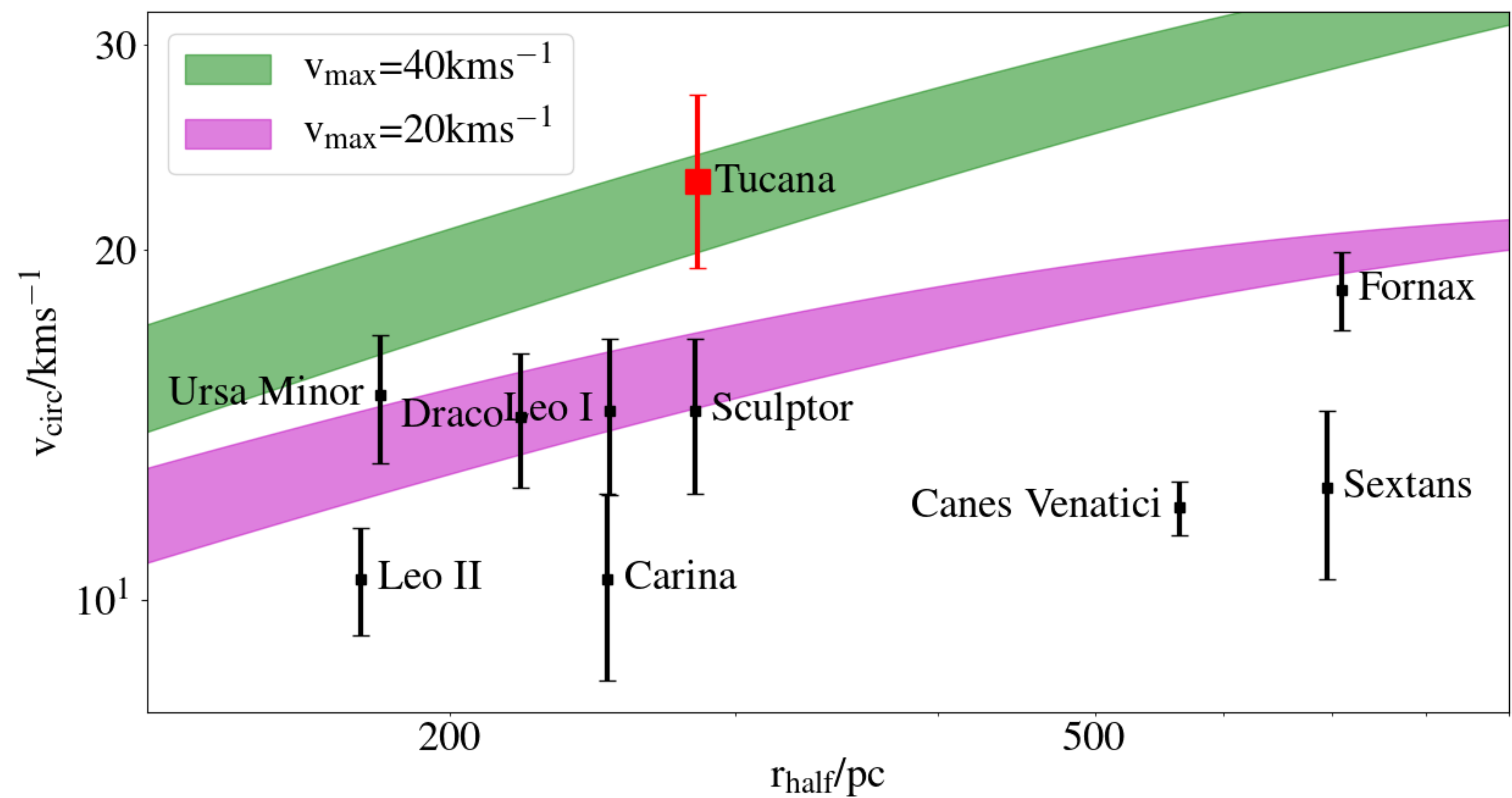
Tucana potentially in a
'massive failure' halo.

But, could be much lower
mass.

Star formation mostly
quenched ~ 10 Gyrs ago
(Savino +19)

Revisited with FLAMES

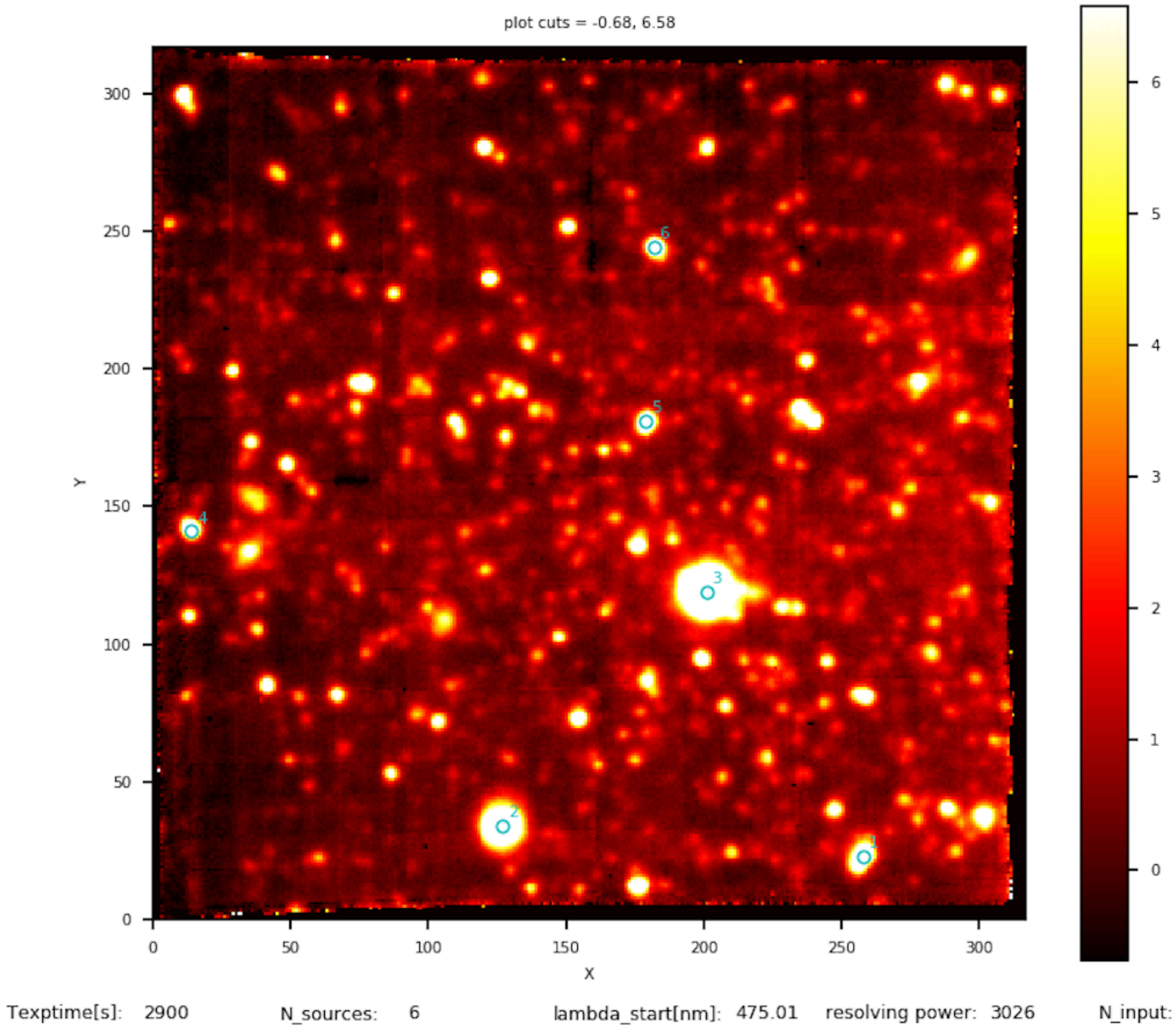
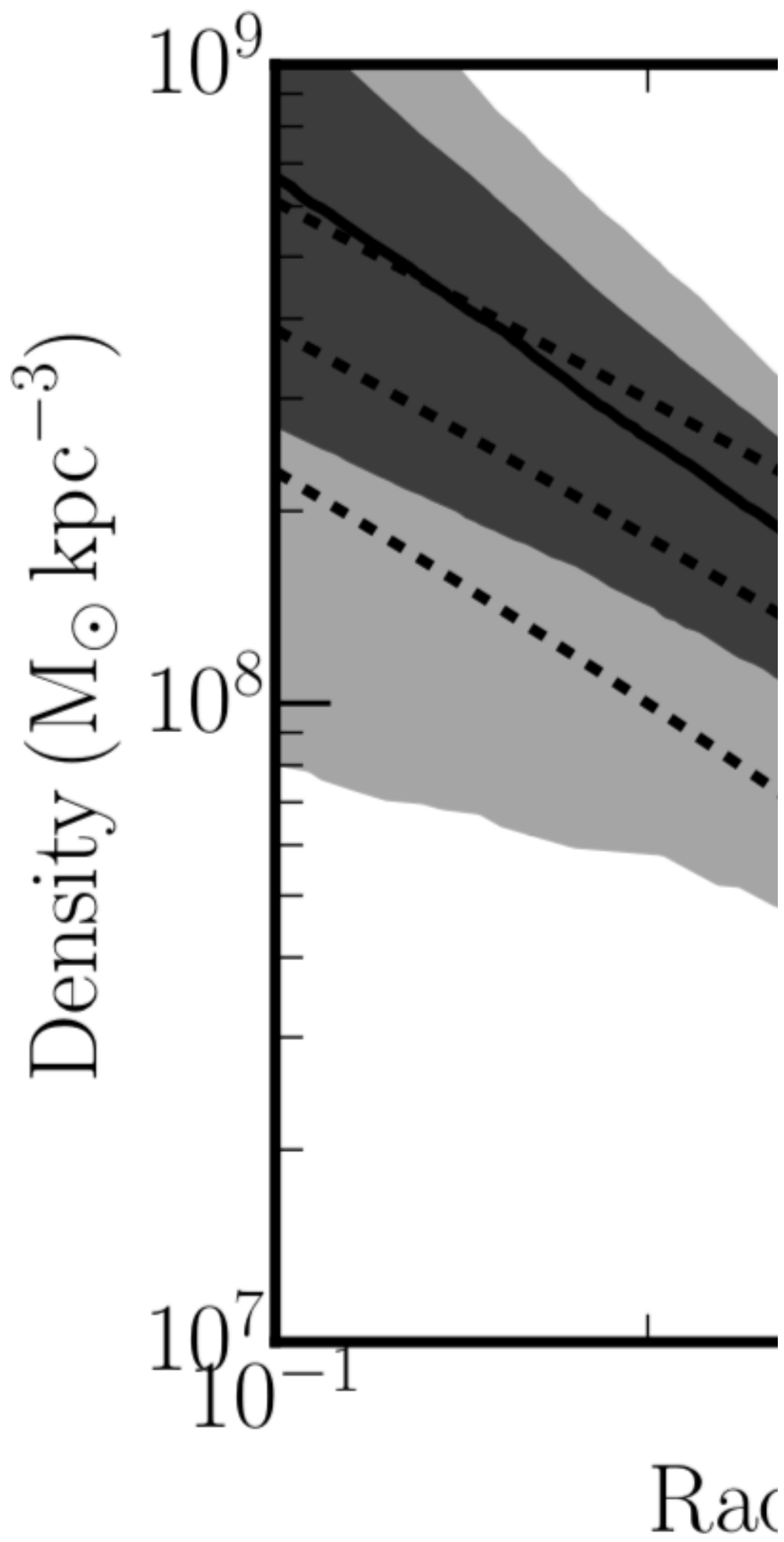
Searching for cusps - Tucana



With velocities for more member stars, Tucana still resides in a high density halo

Searching for

MUSE data product preview		r.MUSE.2019-07-05T06:00:11.531_tpl_0000.fits	
product:	DATA_CUBE_COMBINED	setup:	WFM-NOAO-N
OBS_ID:	2313674	RUN_ID:	0103.B-0212(A)
MJD_OBS:	58669.25013346	OB_name:	WFM_Tucana_+30ra_1
DPR_TYPE:	OBJECT	target:	Tucana



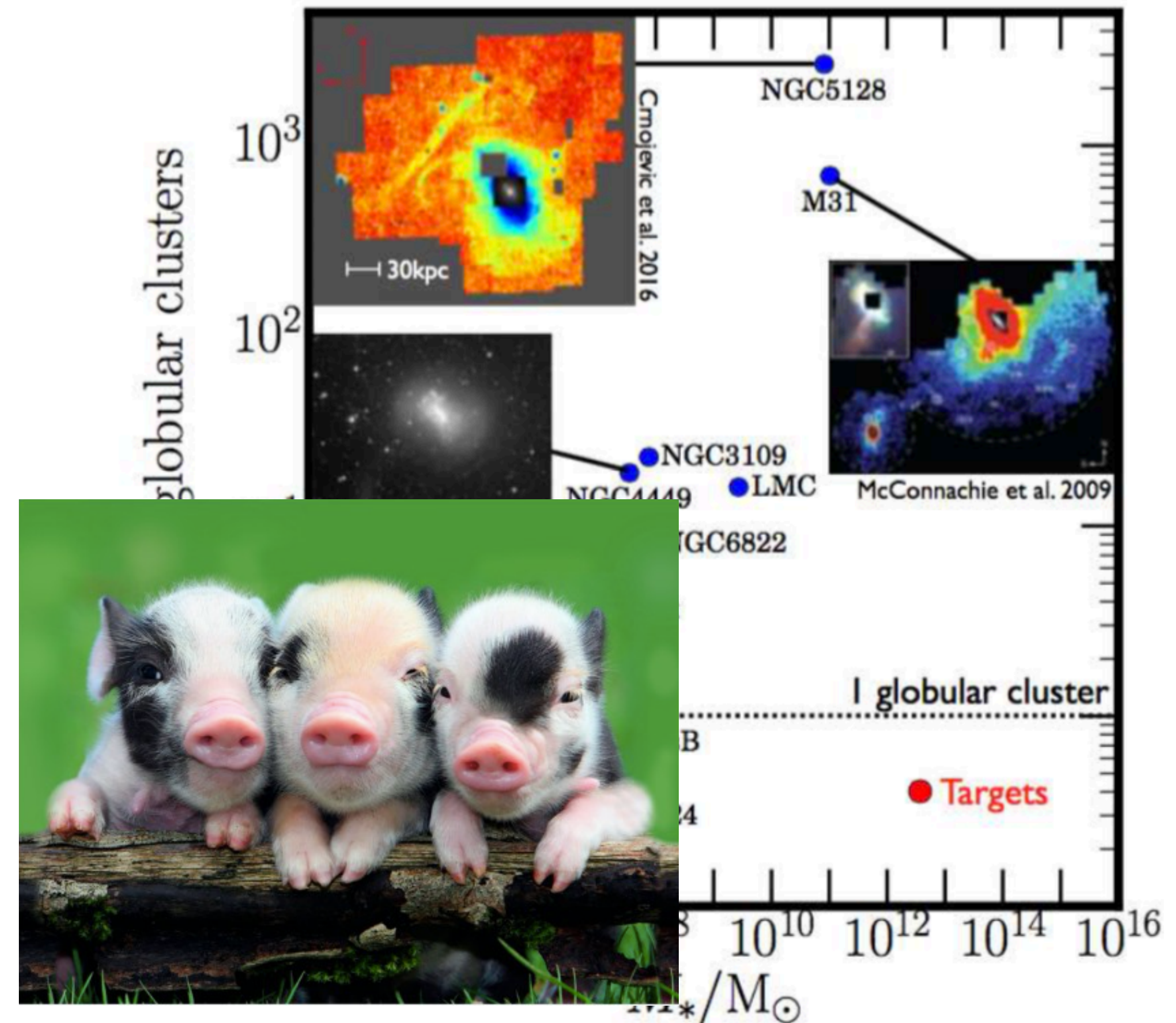
gravSphere
as it is

the centre of

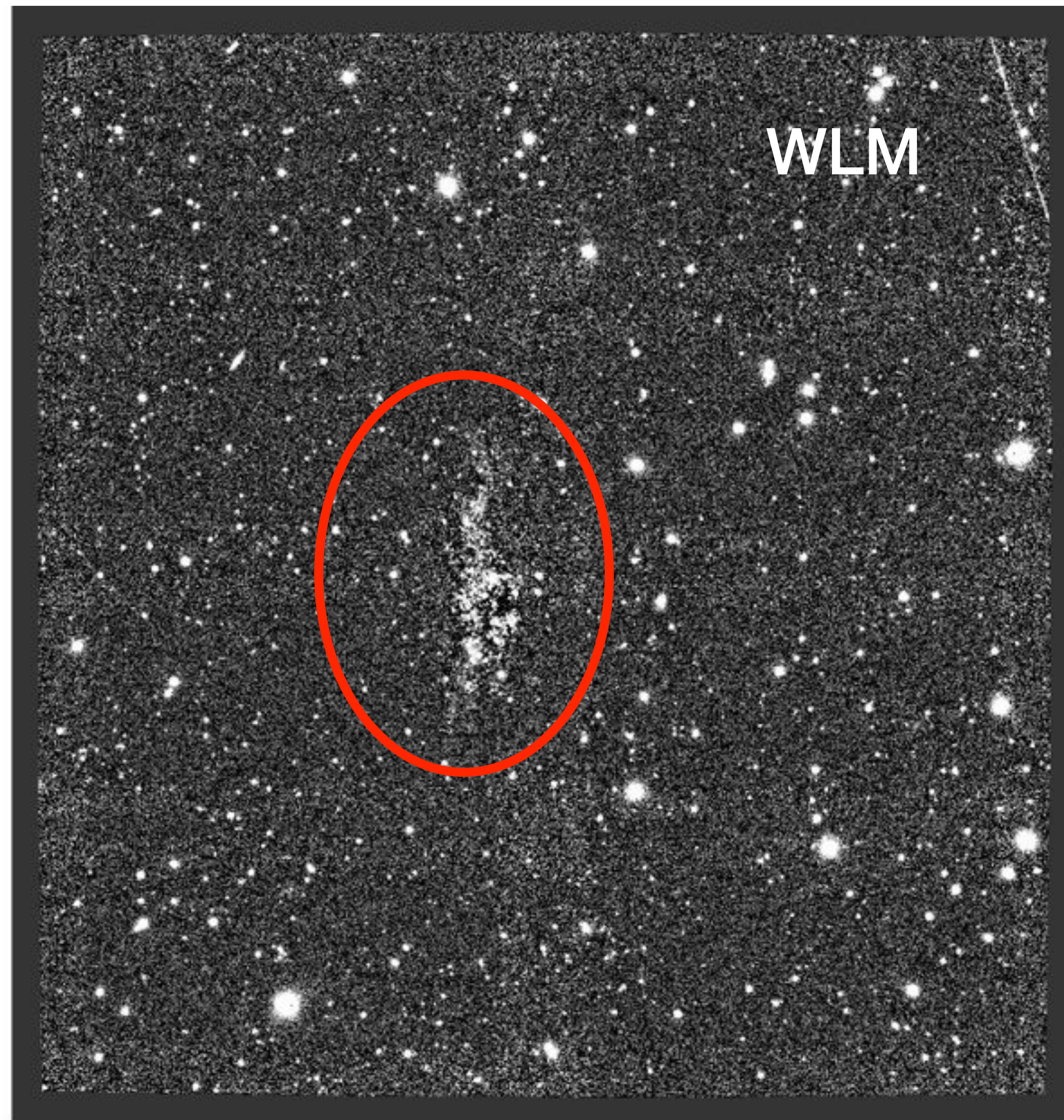
regory et al. 2019

Using the halos of isolated dwarfs to probe dark matter

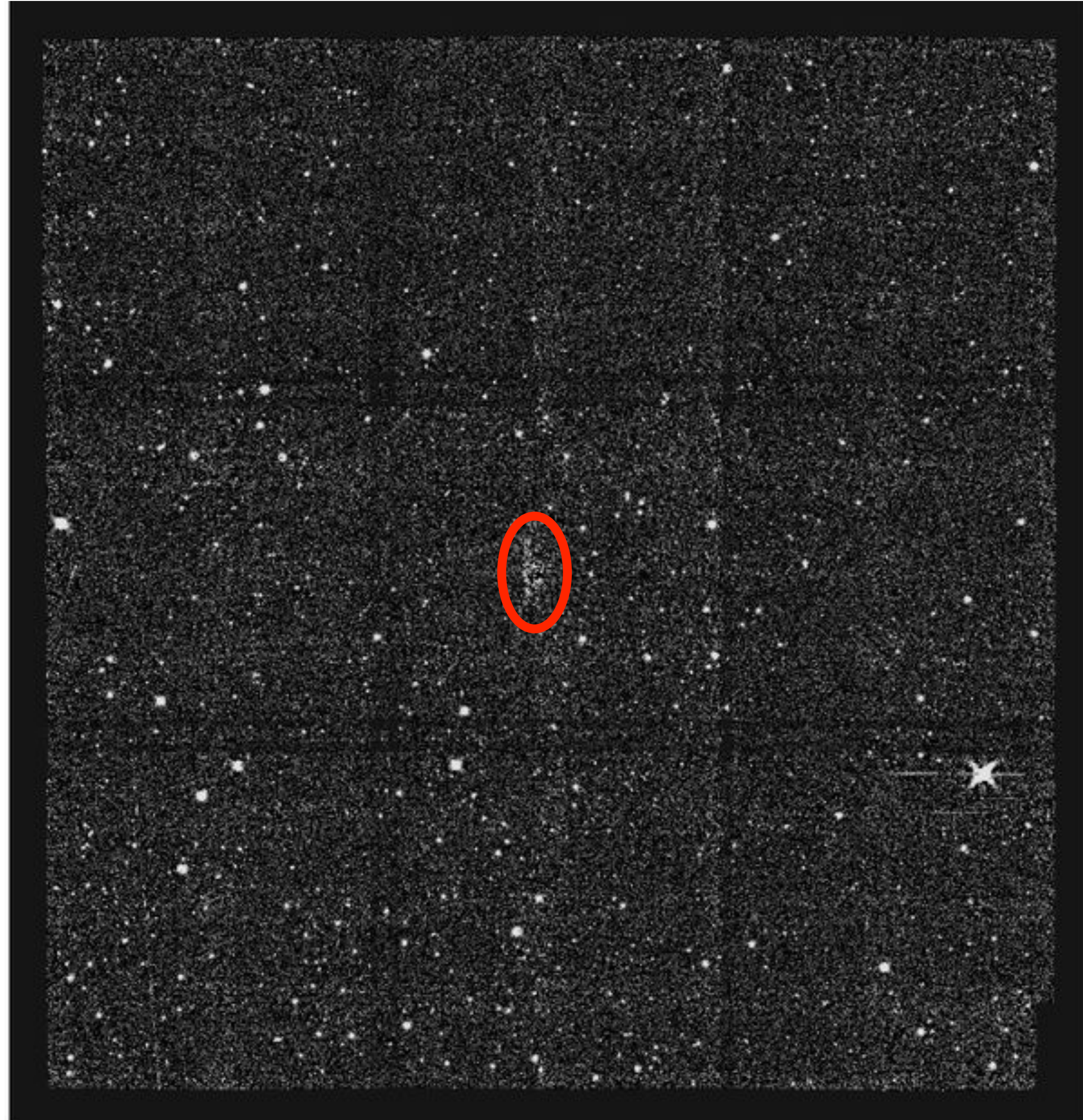
- How important are mergers for dwarf galaxies?
- Do isolated dwarfs have satellite galaxies?
- Can we use their halos to learn about the properties of dark matter, reionisation and galaxy formation?
- Test using the WHT: The PAUCam Isolated Galaxy Survey (PIGS)



Using the halos of isolated dwarfs to probe dark matter



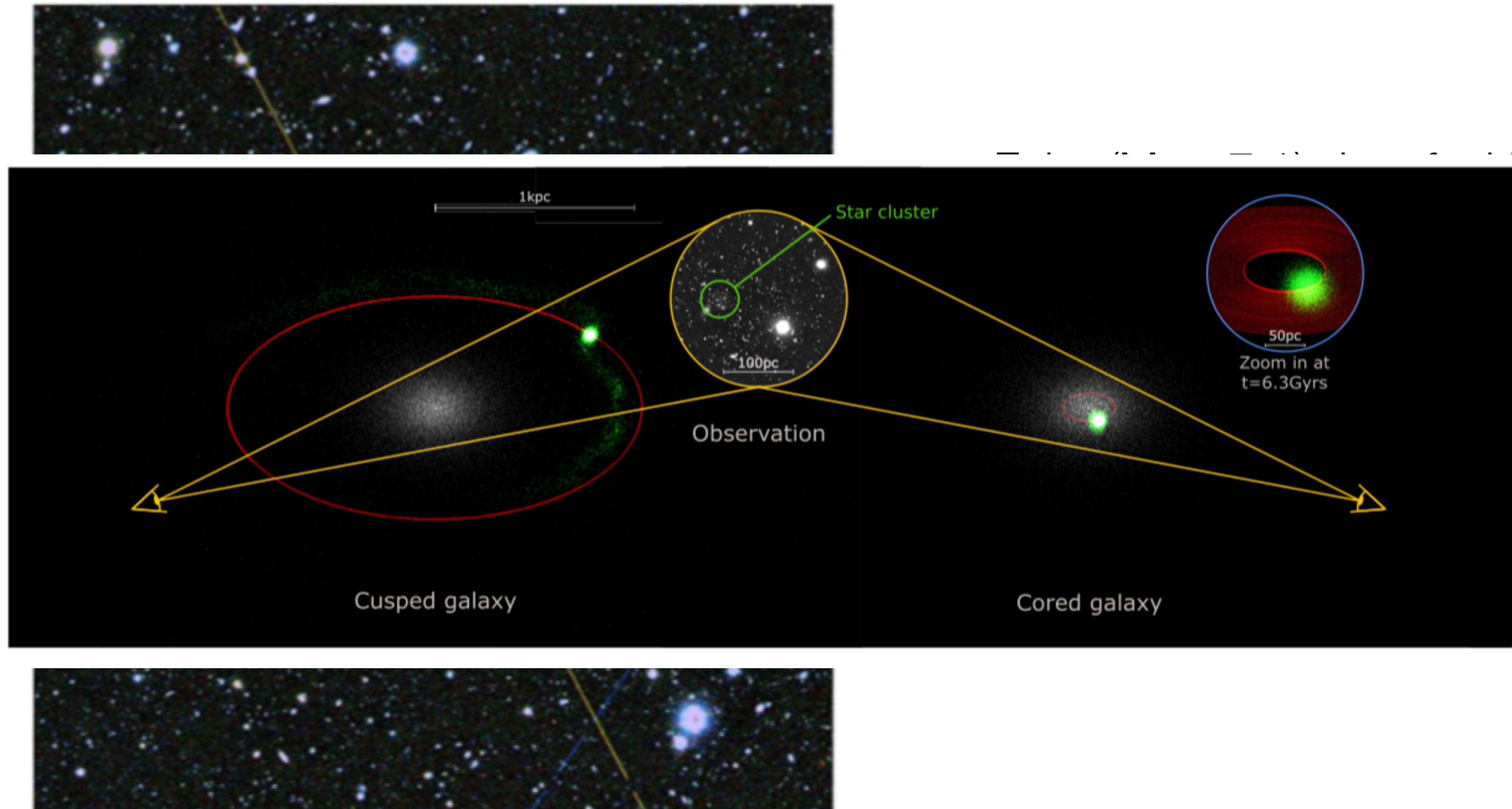
Using the halos of isolated dwarfs to probe dark matter



Searching for cusps: Eridanus II

- Non-isolated systems are interesting too!
- At some point, not enough stars to provide feedback to erase cusp
- By measuring density profiles of lowest mass systems, can see how far down cores go
- Technically challenging: no gas and few stars bright enough for spectra
- Enter Eridanus II

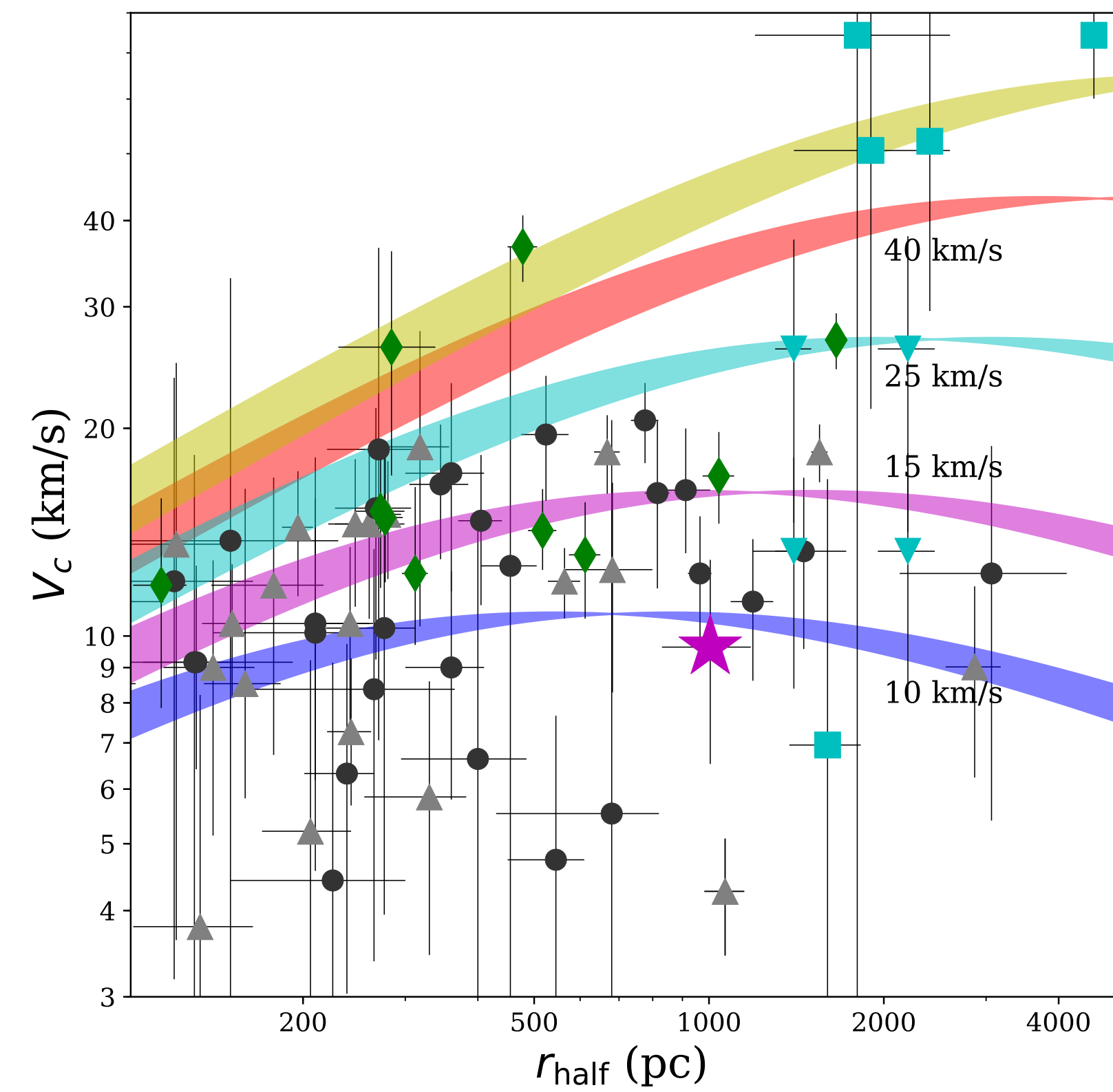
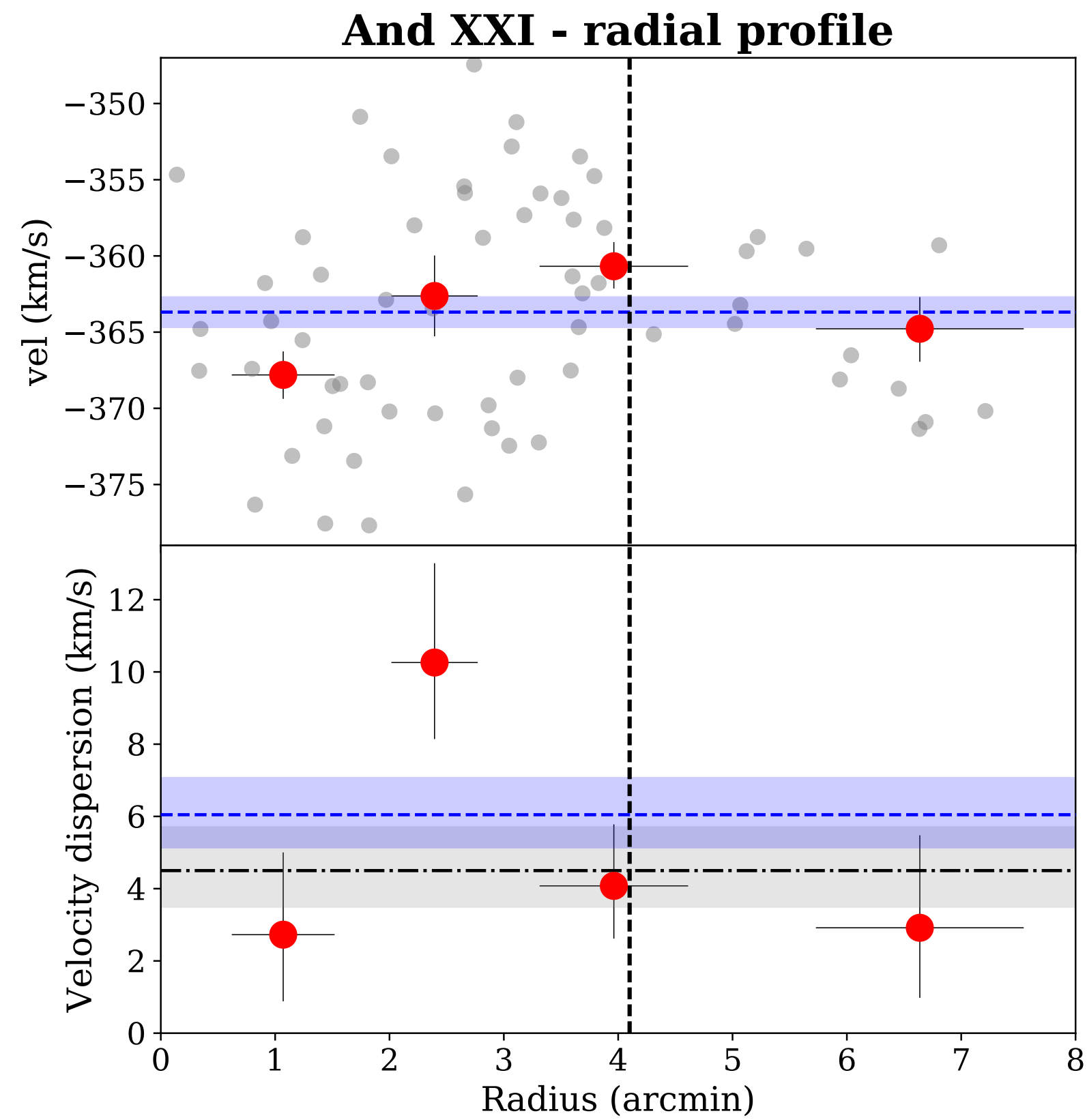
Searching for cusps: Eridanus II



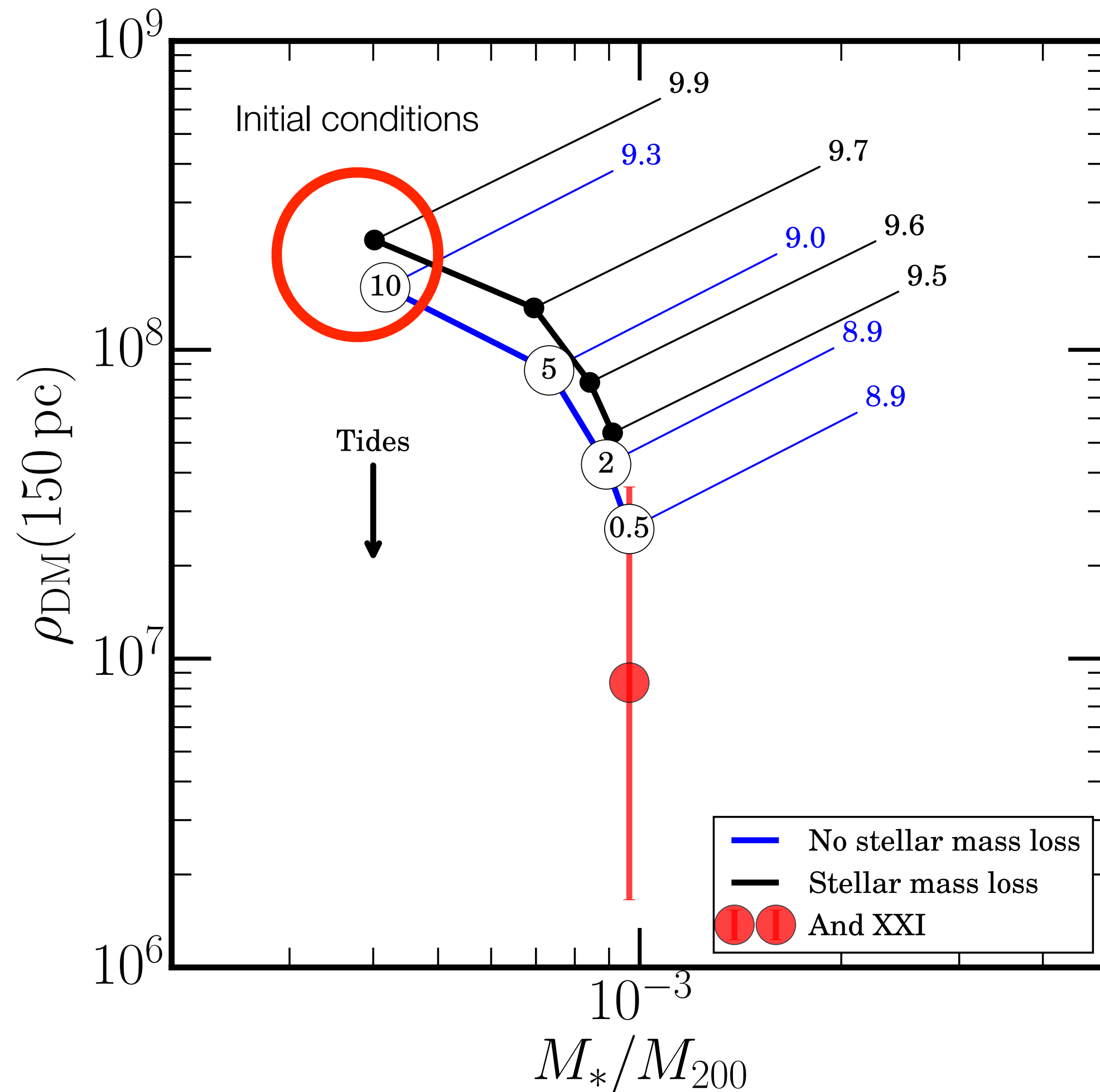
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A low density dwarf in Andromeda

Andromeda XXI



Why so low mass? Prolonged star formation, or tides?



Consistent with a cored halo

Would need to form stars for
a Hubble time to explain
density

Shallow HST imaging shows
star formation quenched ~6
Gyr ago

Tidal effects?

Summary

- If CDM (and stellar feedback models) are right, expect to find cusps
- Tucana is an excellent candidate for a cusped galaxy
- Can low mass cores be understood?
- How important are tidal interactions..?