Unravelling the Andromeda galaxy's most massive merger

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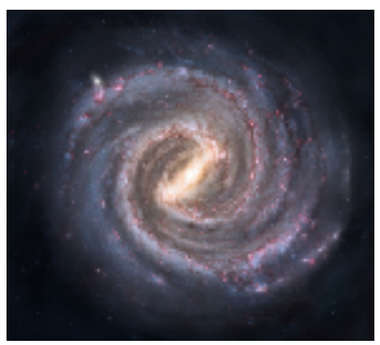
With Eric Bell

Stellar Halos 2018

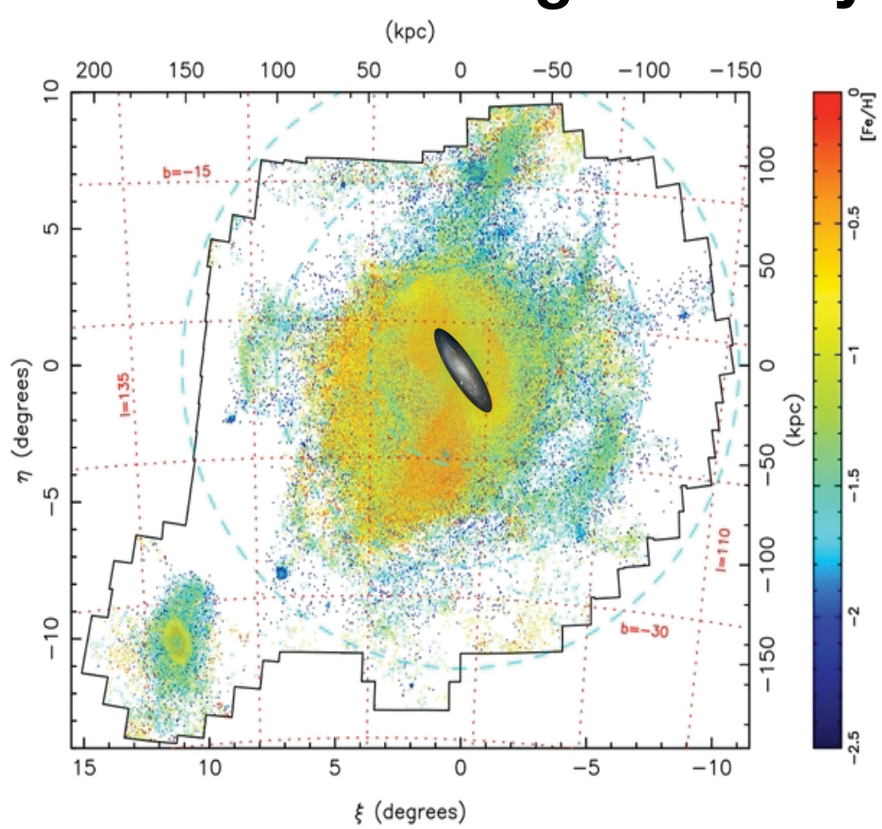
Motivation

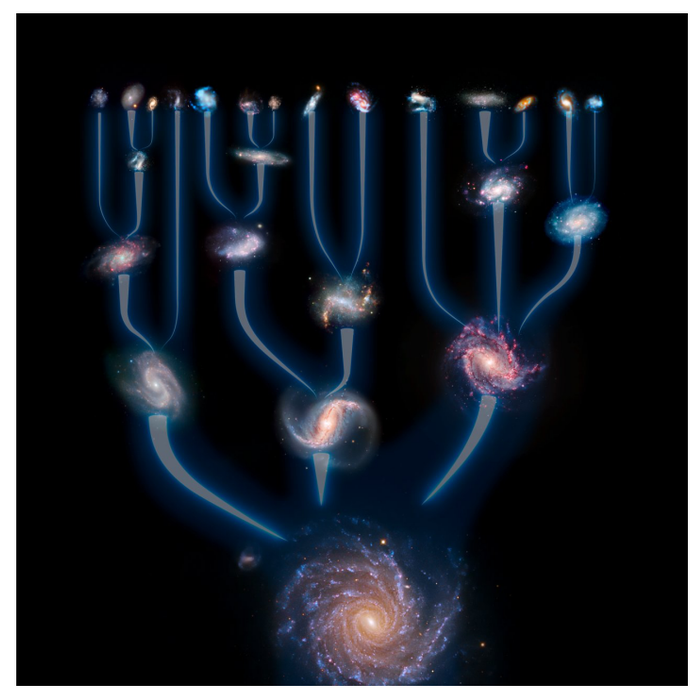
Do mergers affect galaxy properties?



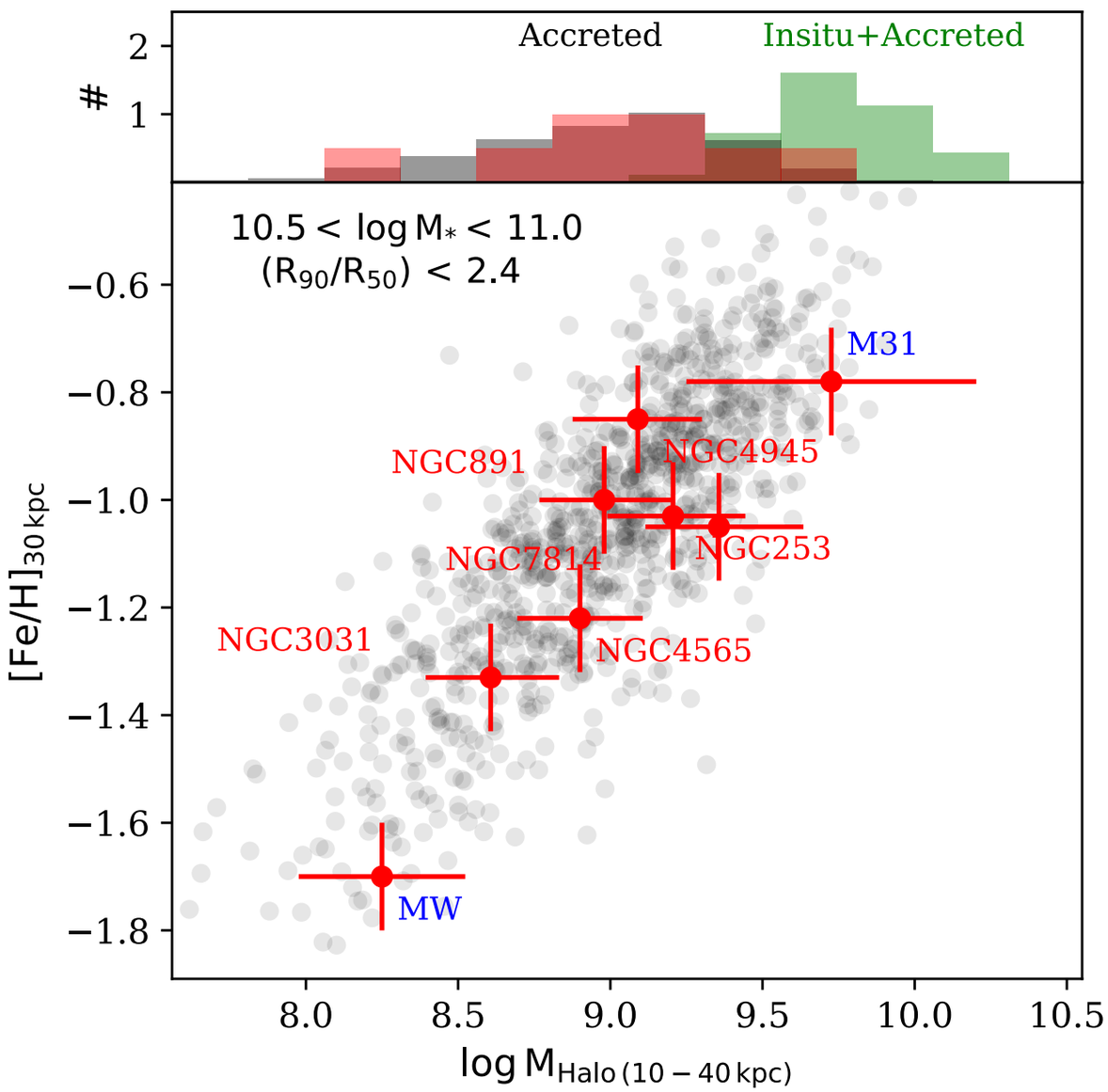
Which properties of M31 were caused by mergers?

Can we derive a merger history from the stellar halo of a galaxy?



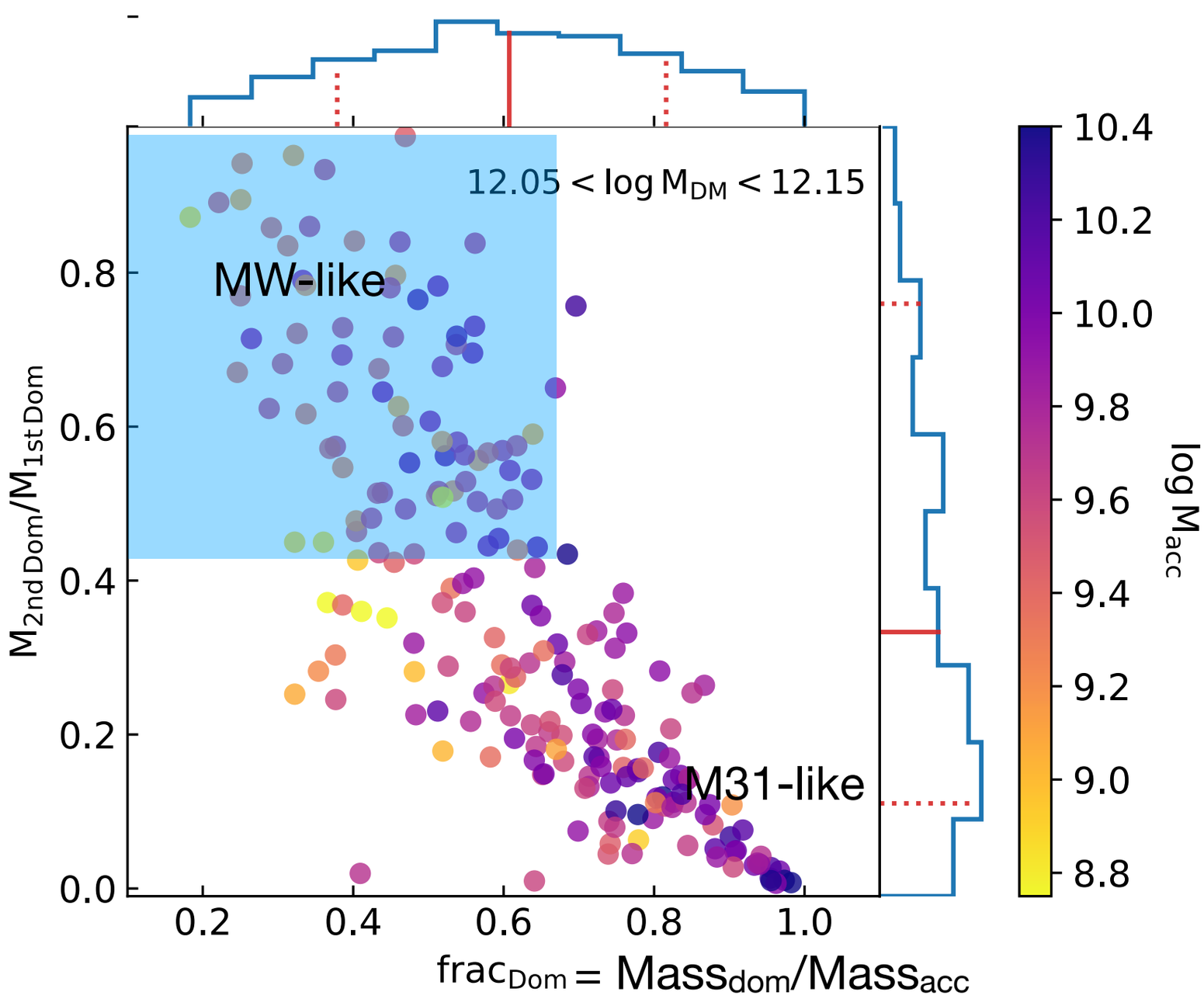


M31 in comparison with other galaxies



- Require new set of models encoding a diversity of accretion histories
- Deason et al. 2016;Cooper et al. 2013; Illustris/Eagle suite of simulations

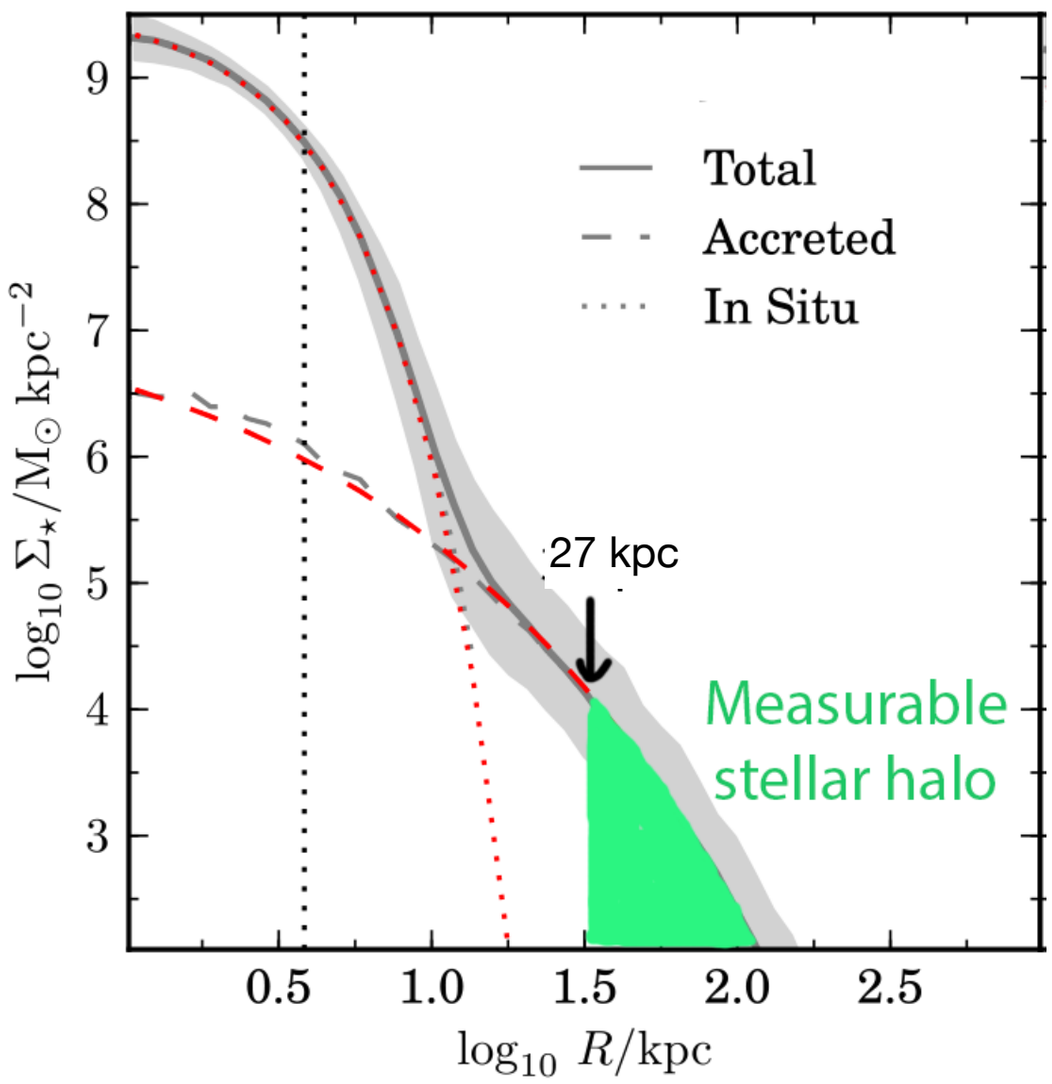
Building Intuition from Models



Large stellar halos are dominated by a single massive accreted progenitor

Bell et al. 2018

Constrain the total accreted stellar component of M31 from observations of the outer stellar halo (>27 kpc)

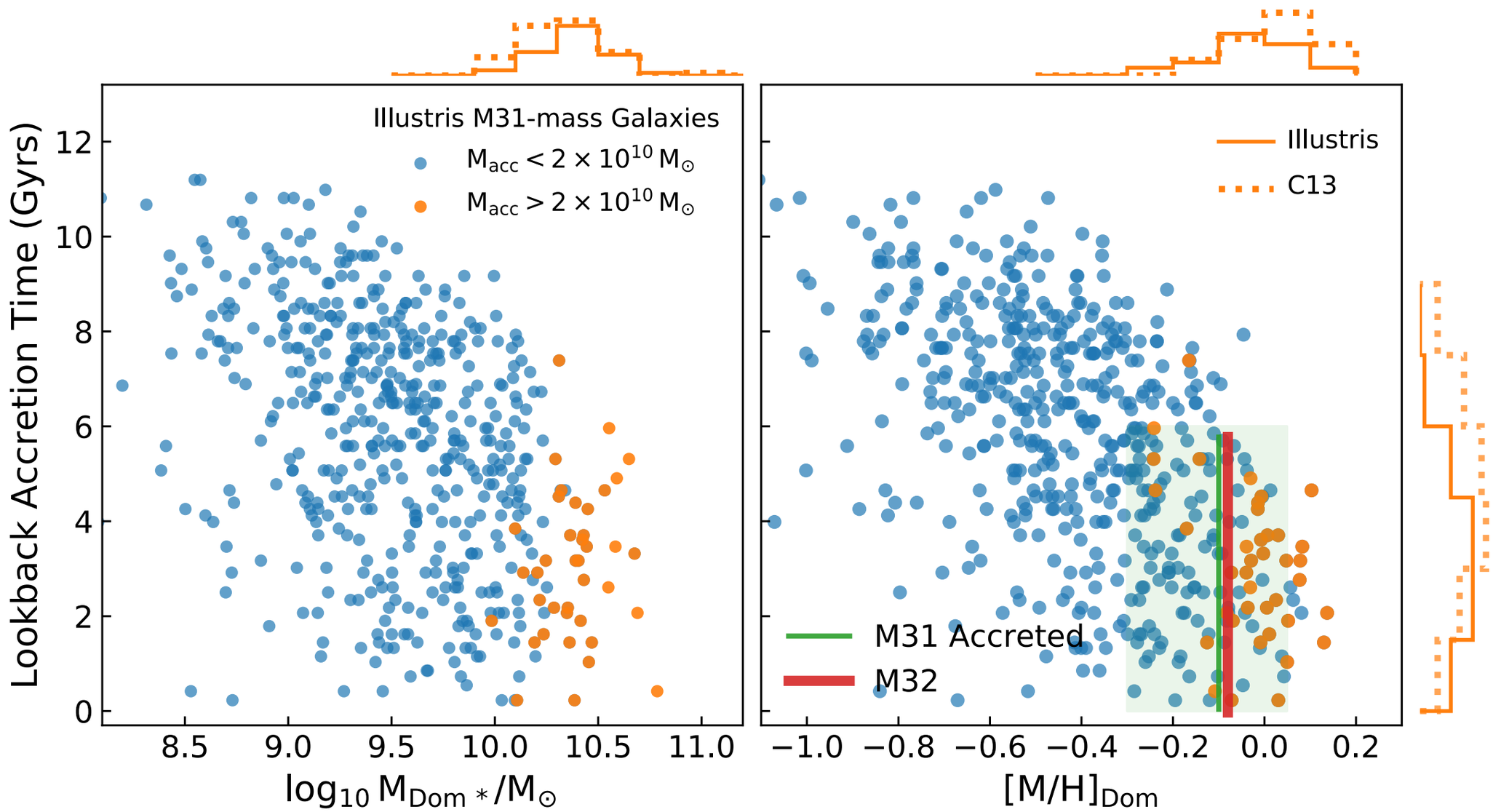


modified from Cooper et al. 2013

If the accreted component of models are robust, then we can estimate:

- M31's total accreted stellar mass log M_{acc*} > 10.3 (PAndAS)
- M31's accreted metallicity $[Fe/H]_{acc}$ > -0.3 (SPLASH)

M31's large accreted stellar mass constrains its possible massive progenitors



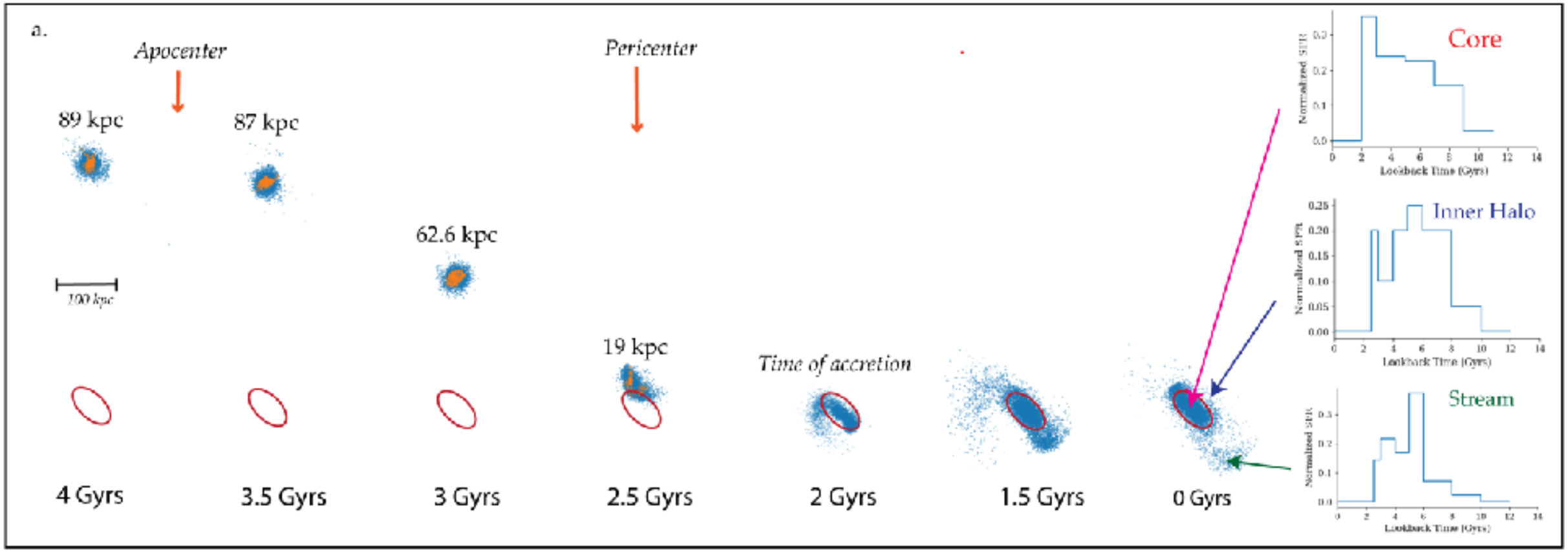
D'Souza & Bell 2018

M31 accreted a satellite of mass log M_{Dom} ~ 10.3 in the last 5 Gyrs.

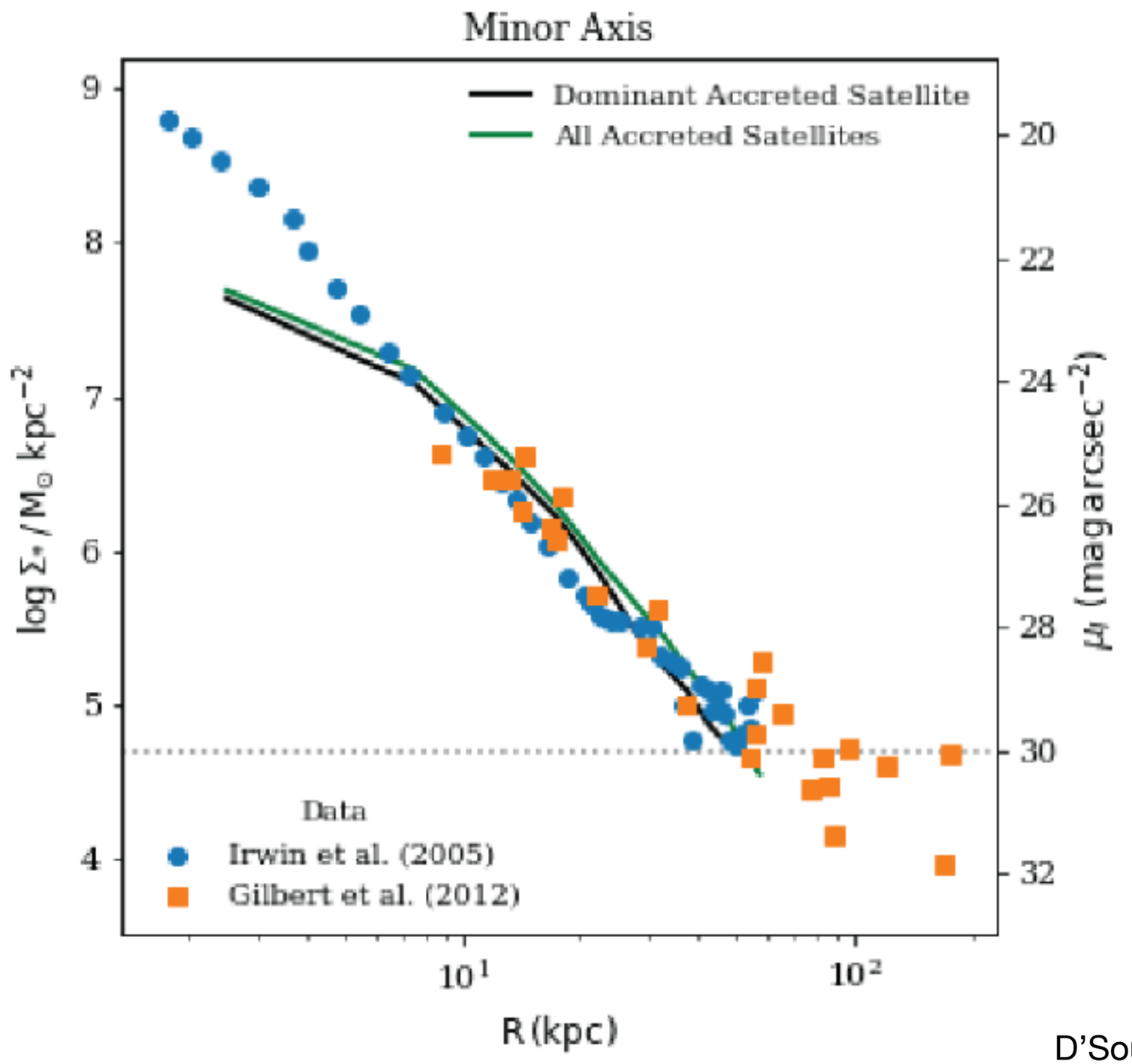
The high mass and metallicity of M31's stellar halo suggests it accreted a single large progenitor (log M_* ~ 10.3) in the last 5 Gyrs.

Can we narrow down the range of the time of accretion using the debris of the progenitor?

Building intuition on the debris field of the progenitor

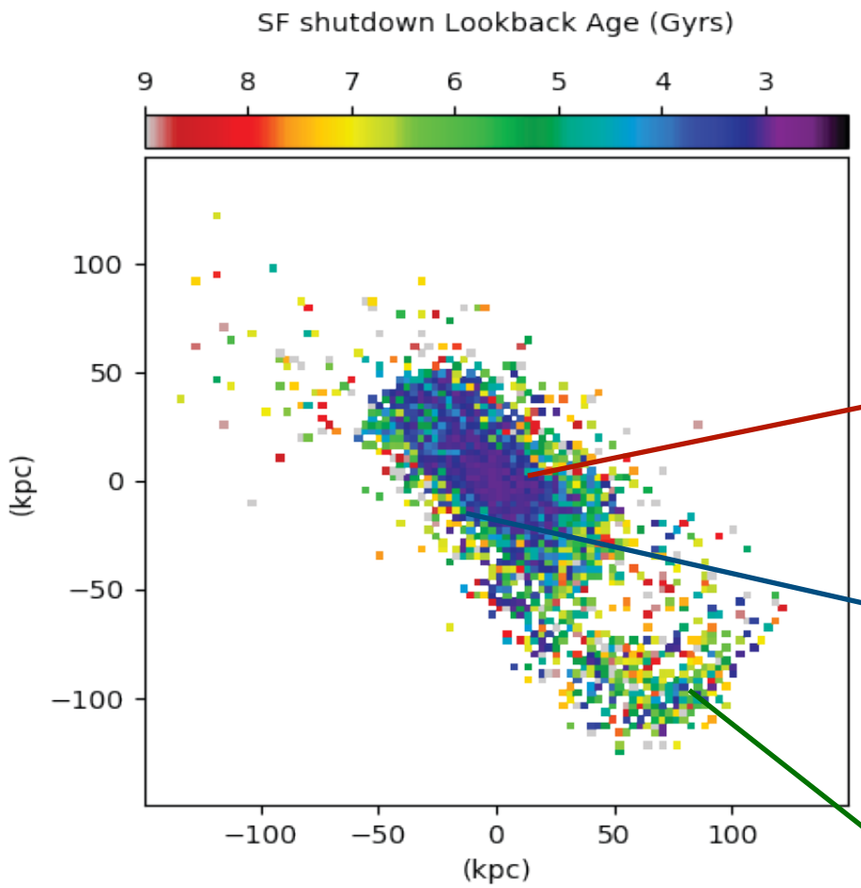


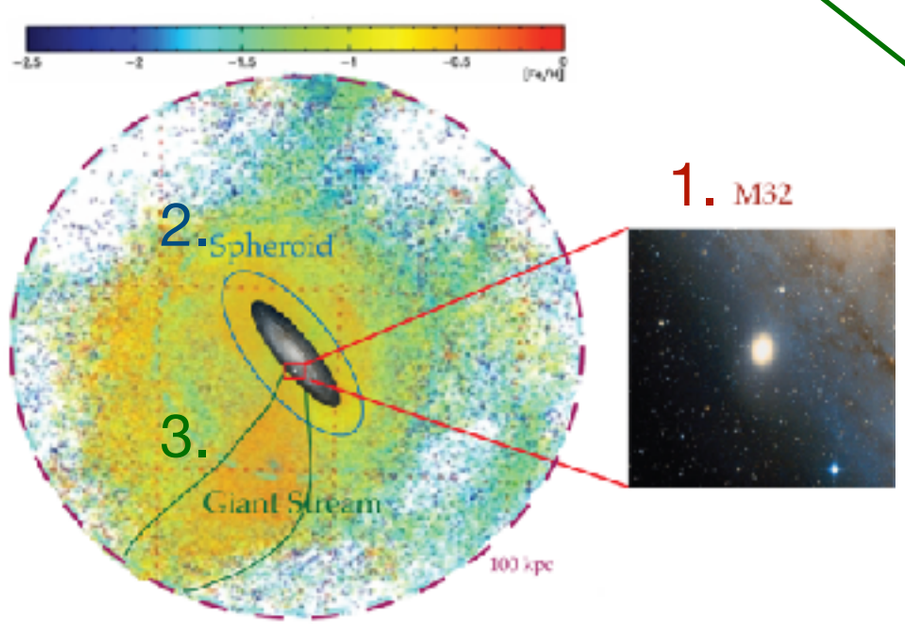
Radial Distribution of the Debris



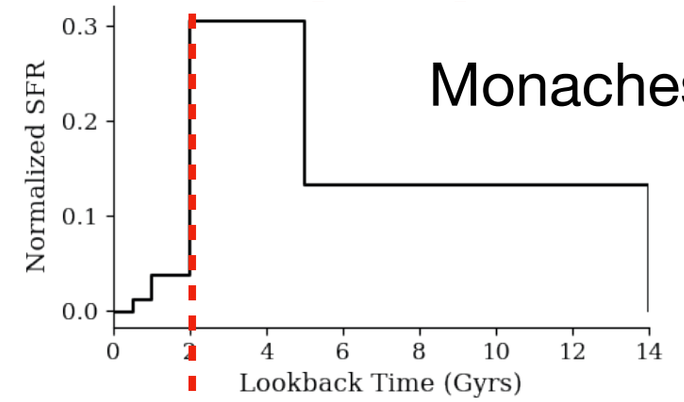
D'Souza & Bell 2018

Identify possible metal-rich debris of the massive progenitor



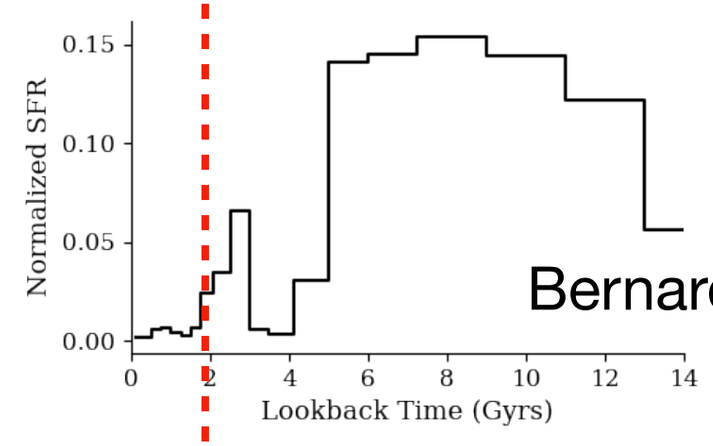


1. M32 [Fe/H] ~ -0.1



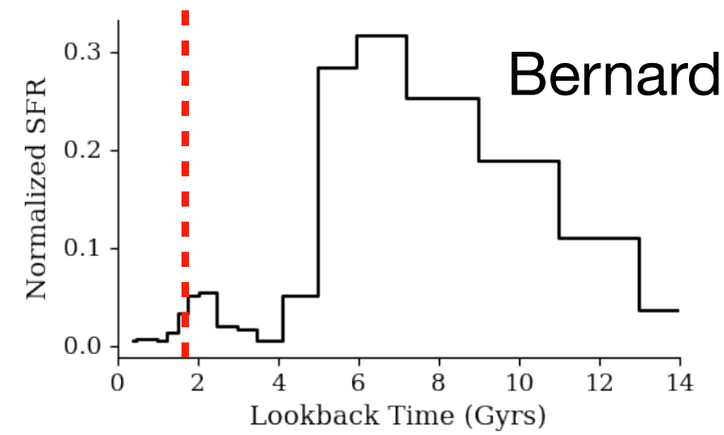
Monachesi et al. 2012

2. Inner Spheroid [Fe/H] ~ -0.5



Bernard et al. 2015

3. Giant Stream [Fe/H] ~ -0.3



Bernard et al. 2015

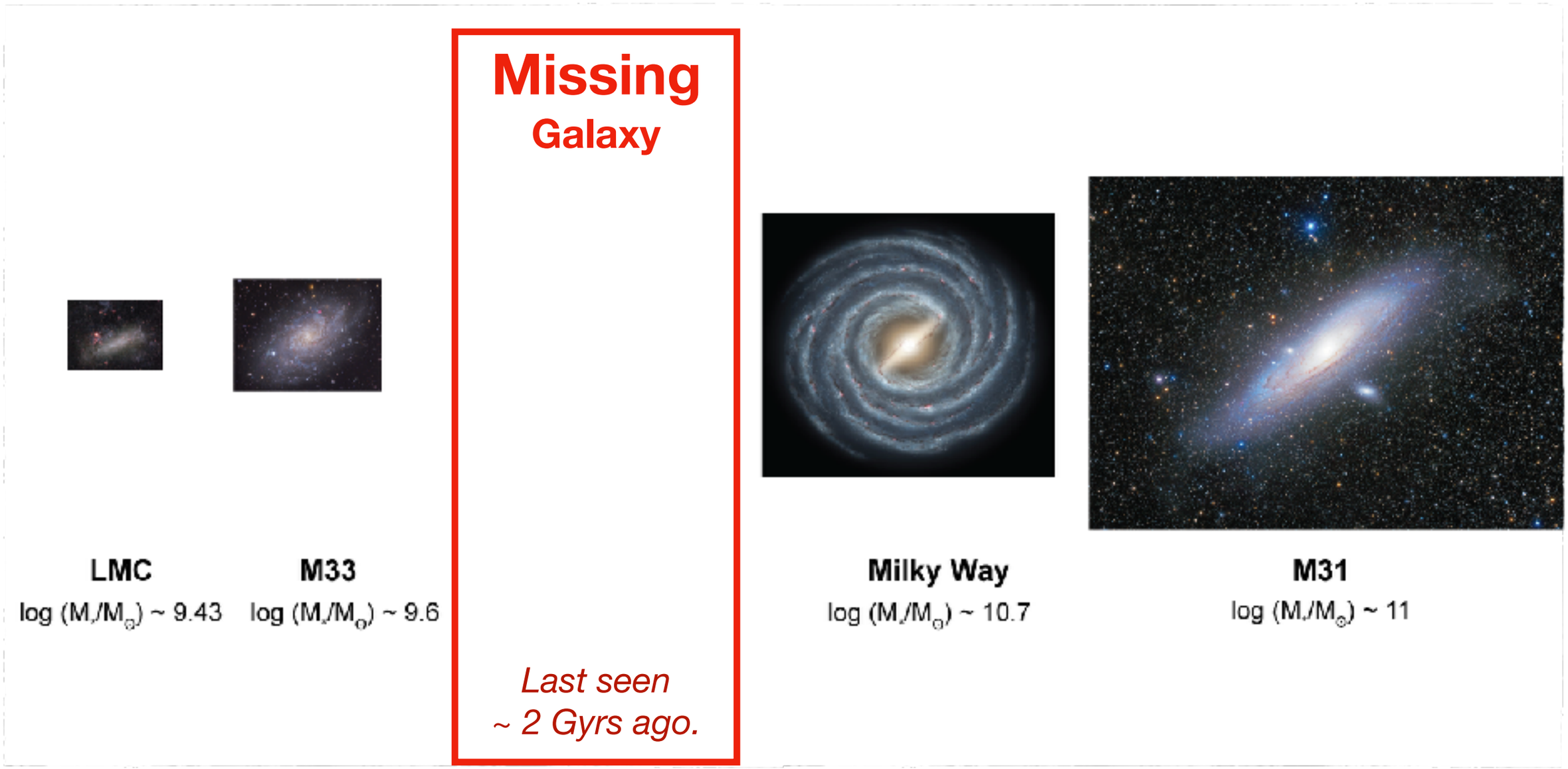
M31 accreted a large gas-rich progenitor (log M_* ~ 10.3) ~2 Gyrs ago, called M32p.

M32 is likely the core of M32p, which had a small bulge.

The inner stellar halo contains the debris of the rest of the accreted progenitor.

The giant stellar stream was likely caused by the accretion of M32p.

The family portrait of the Local Group

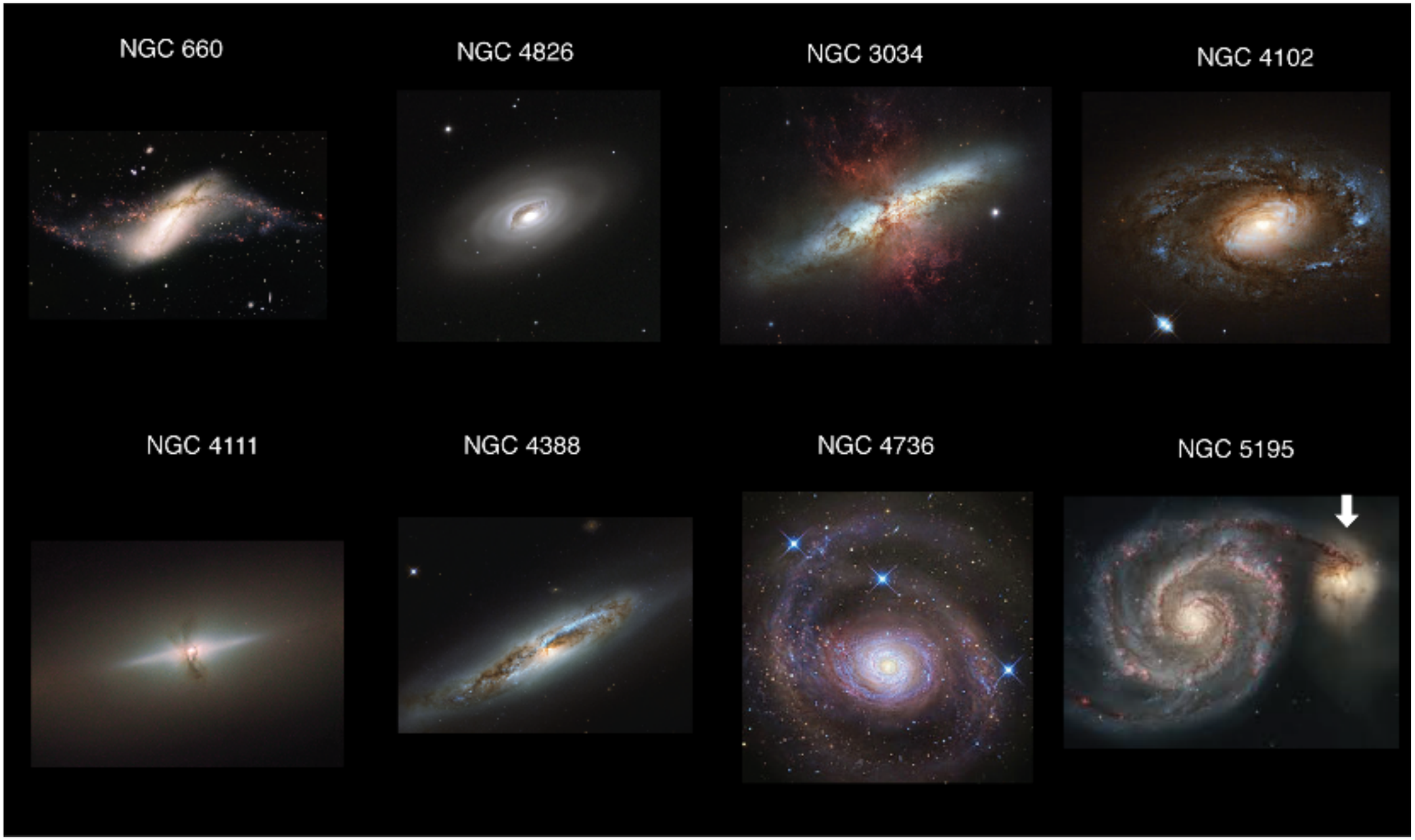


M32p was the third largest member of the Local Group!

Nearby galaxies with the mass of M32p and the central surface brightness of M32

M32p analogues in the local Universe

S4G survey out to 24 Mpc



Can explain the low number density of M32-like objects!

What did the merger of M32p do to M31?

- M31's disk predates the merger, and survived a 0.1 to 0.3 merger.

- Responsible for the galaxy disk wide star formation ~2 Gyrs ago (Williams et al. 2015) in which 1/5 th of its stars were formed (Williams et al. 2017).

- Responsible for disk thickening (disk scale length ~ 1 kpc, Dalcanton et al. 2015) and the large age - velocity dispersion in the RGB stars (V_{disp} ~ 90 km/s; see also Hammer et al. 2018)

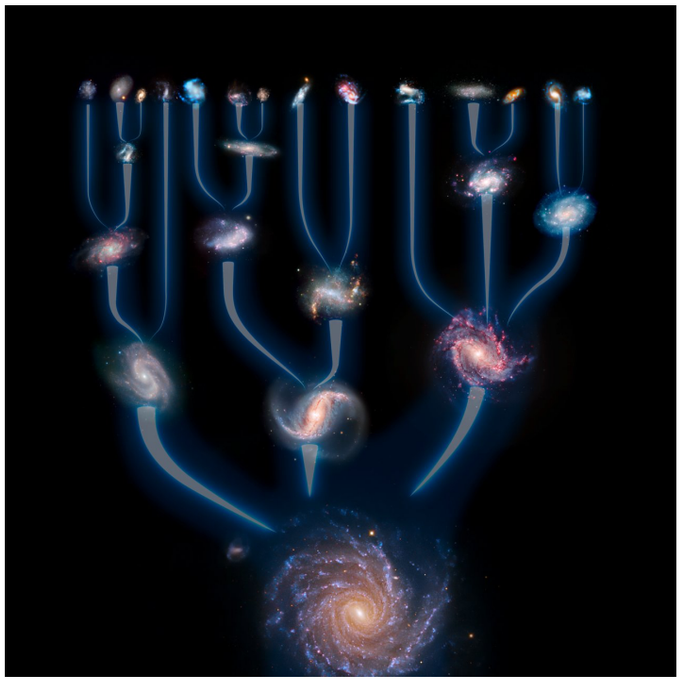
- M31's bulge is substantially older (Olsen et al. 2006) than the merger.

What do mergers do to galaxies?

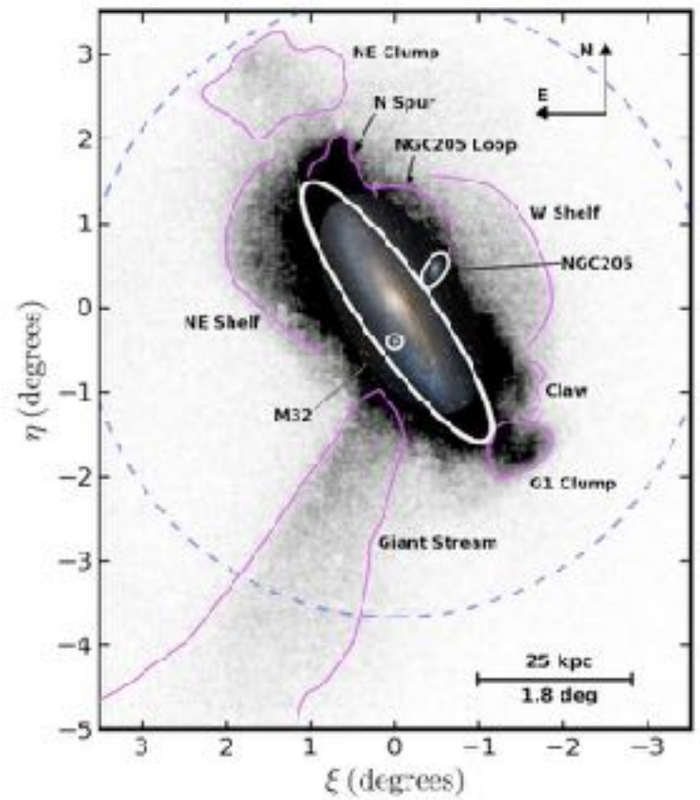
Visually through examples of identified M32p analogues

M81 + M82 **M51a + M51b** **M31+M32**

3 Key Takeaways



Massive merger of M31 ~2 Gyrs ago:
Third largest member of the Local Group



Remnants of the merger:
M32,
much of the inner stellar halo
& the Giant Stellar stream

Effect of the merger:
Global burst
of star formation &
Disk thickening

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