



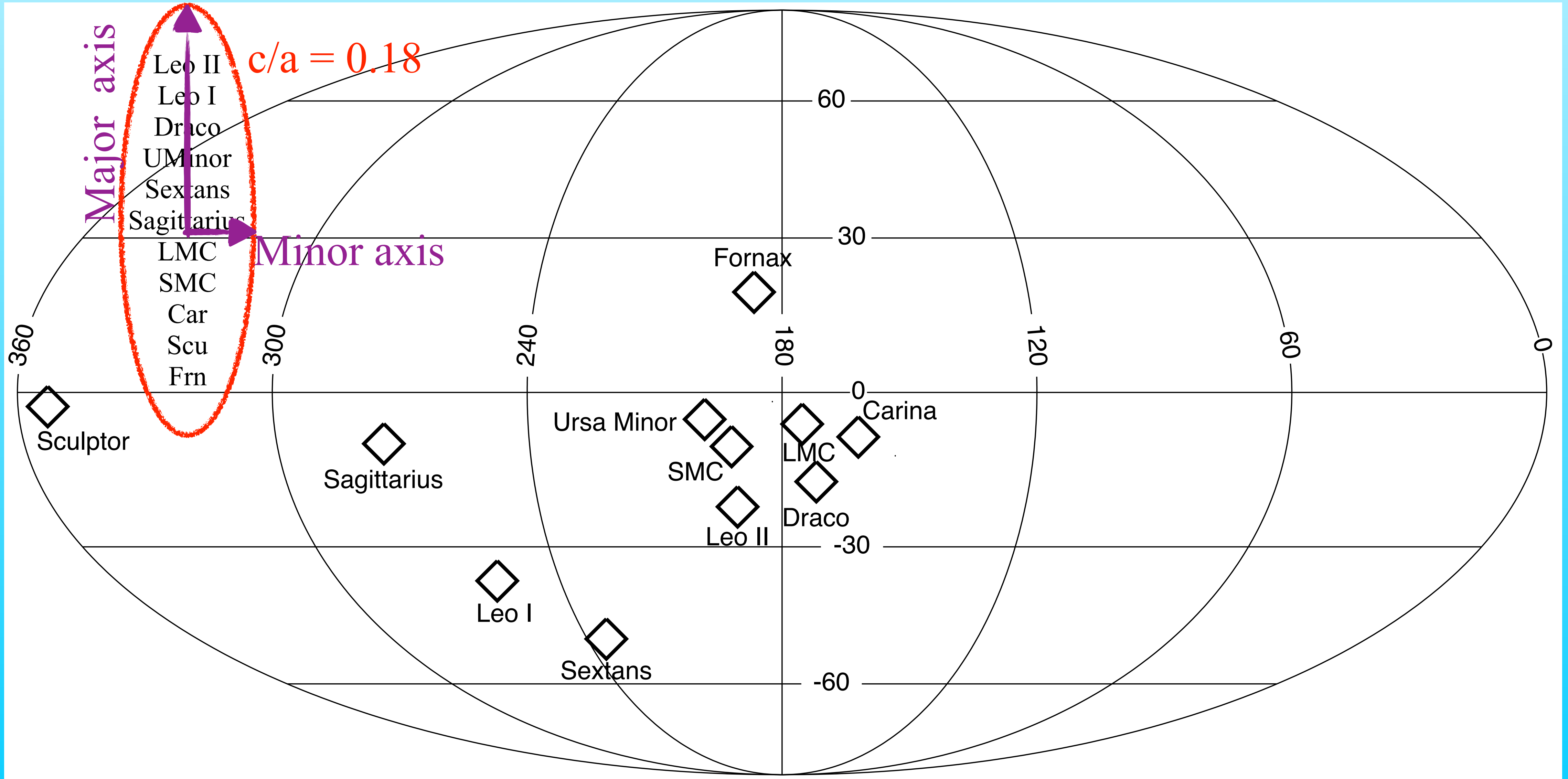
Evolution of planes of satellites

Shi Shao (邵实)

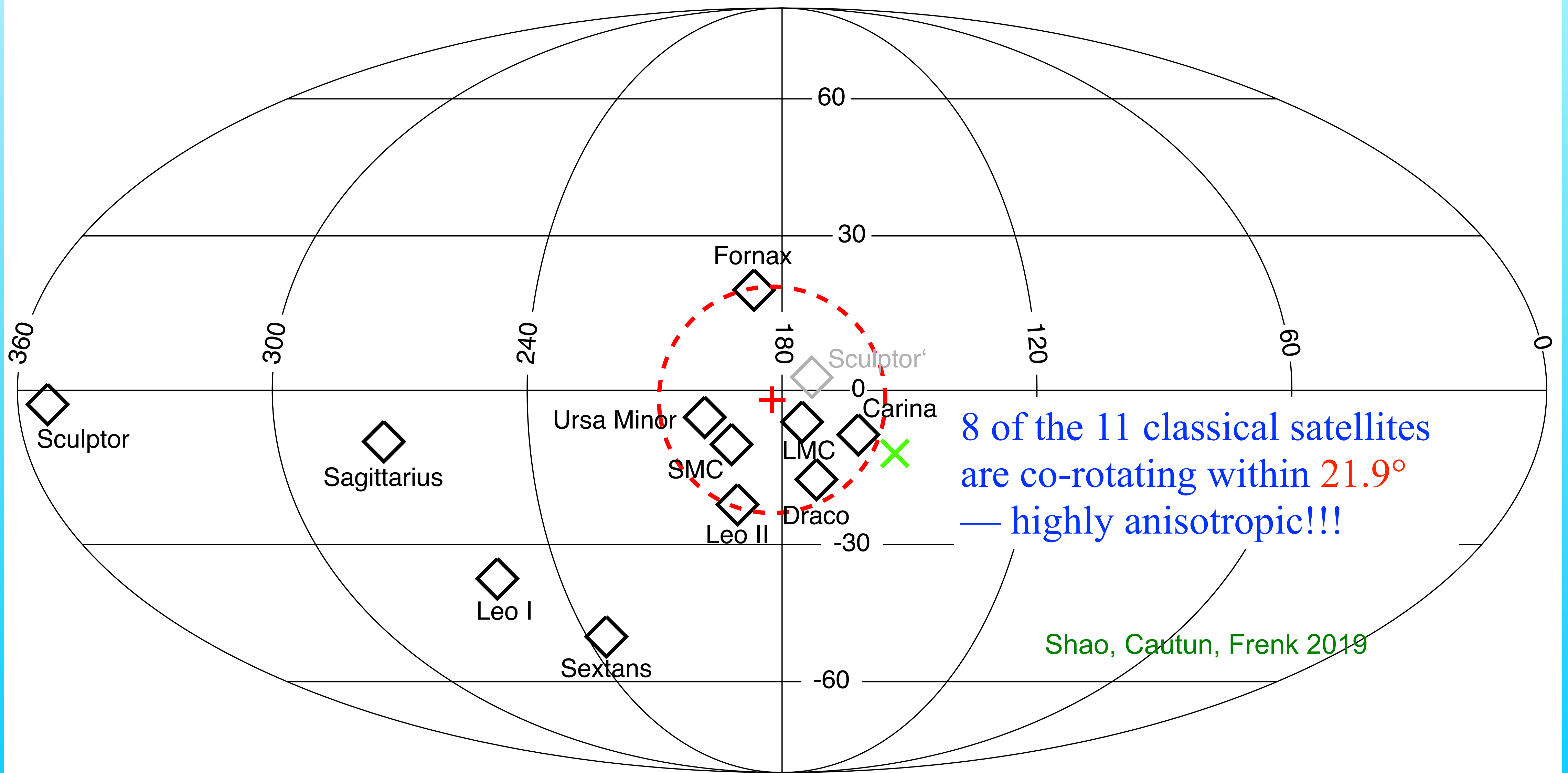
*Institute for Computational Cosmology,
Durham University*

with Marius Cautun, Alis Deason, Adrian Jenkins, Carlos Frenk

MW satellite positions and orbital poles



MW satellite positions and orbital poles

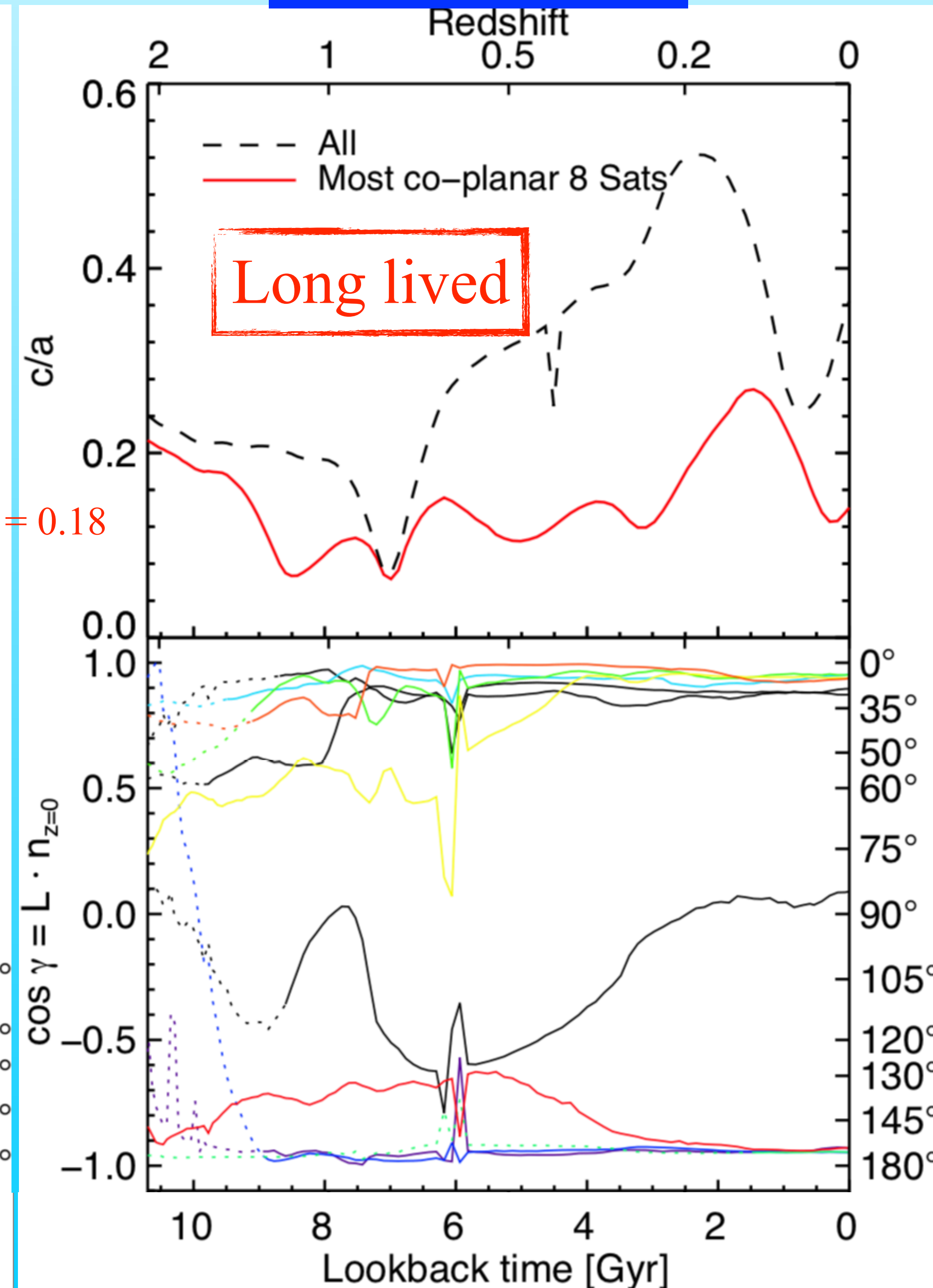
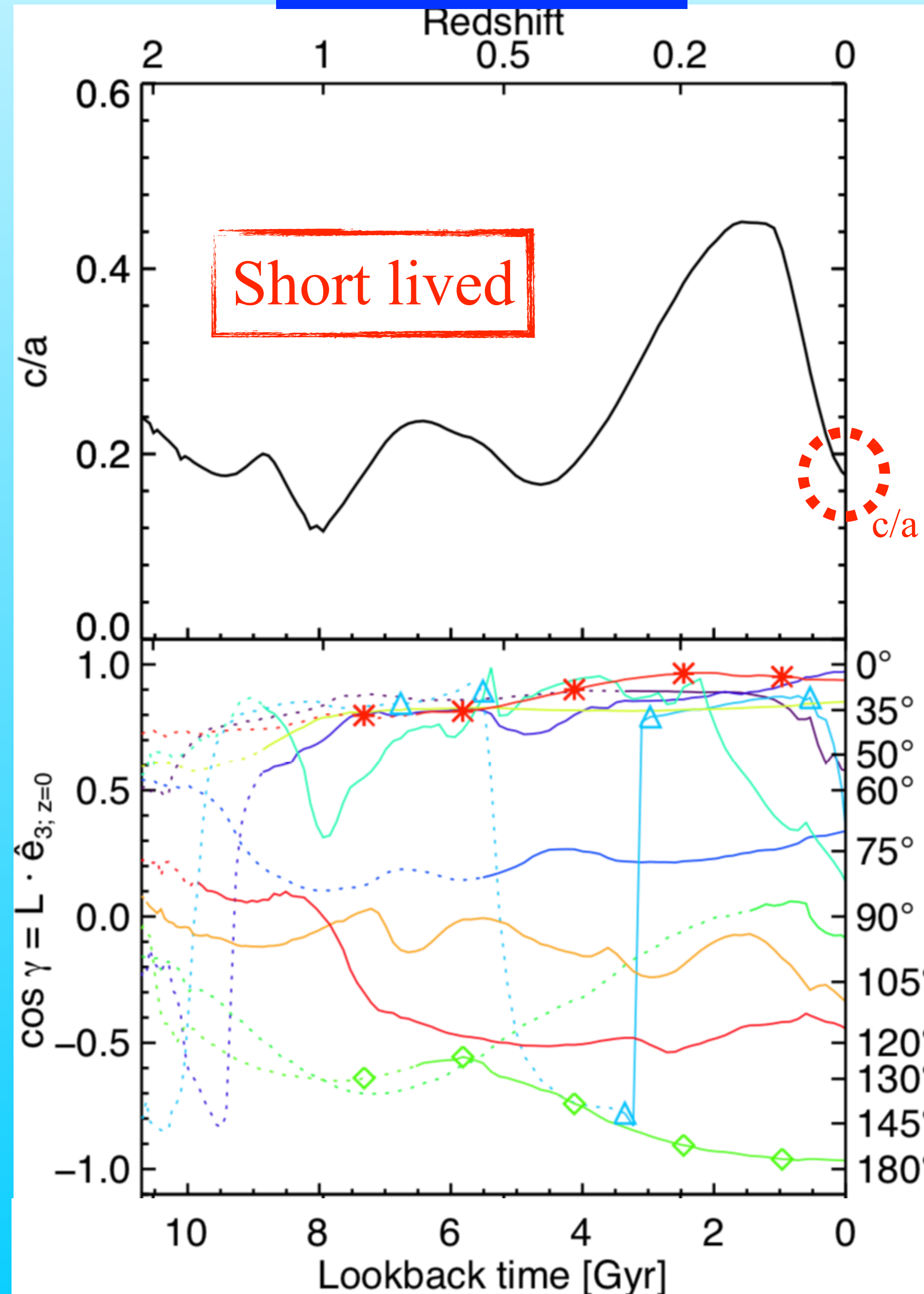


• MW-like-thin

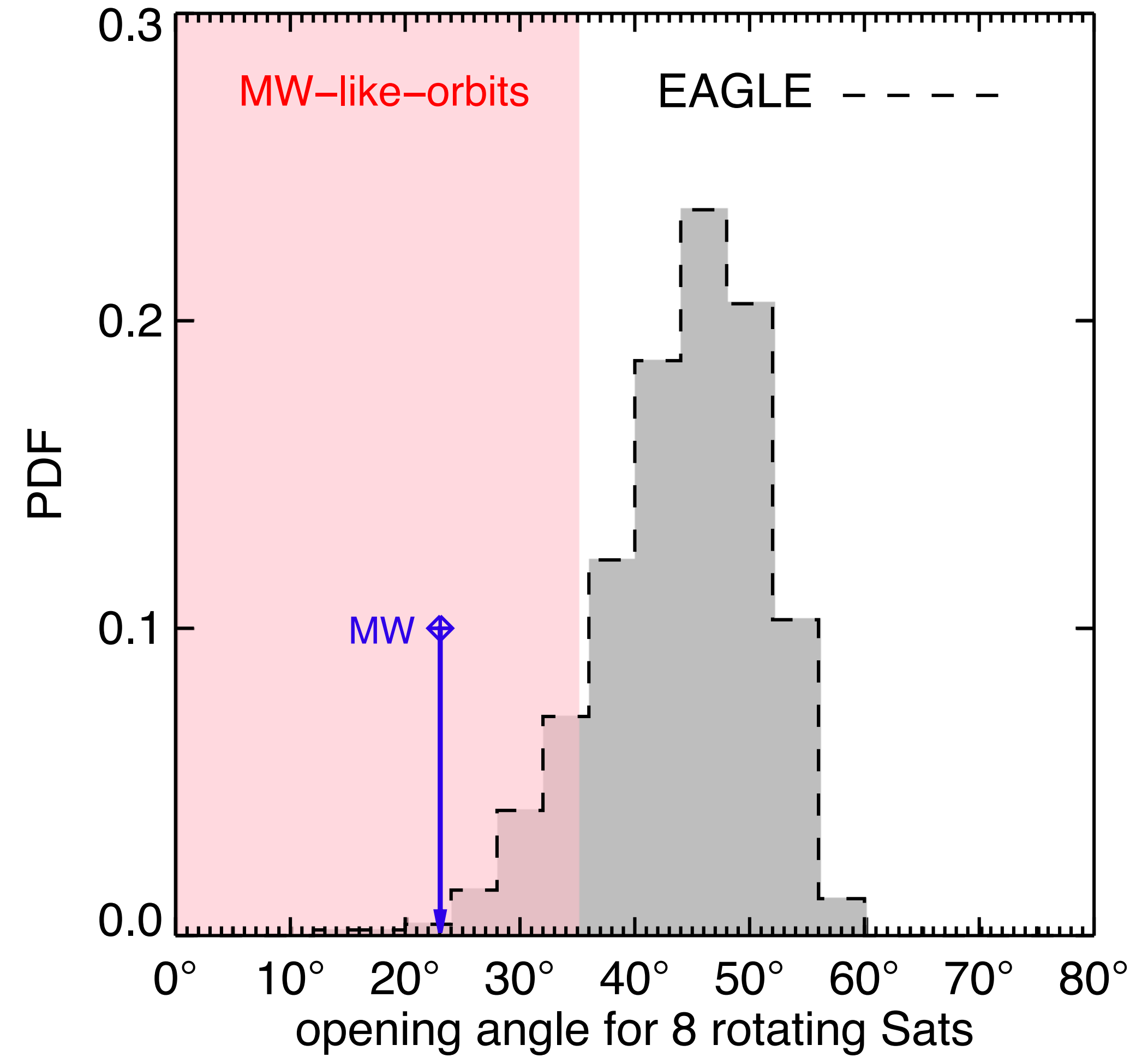
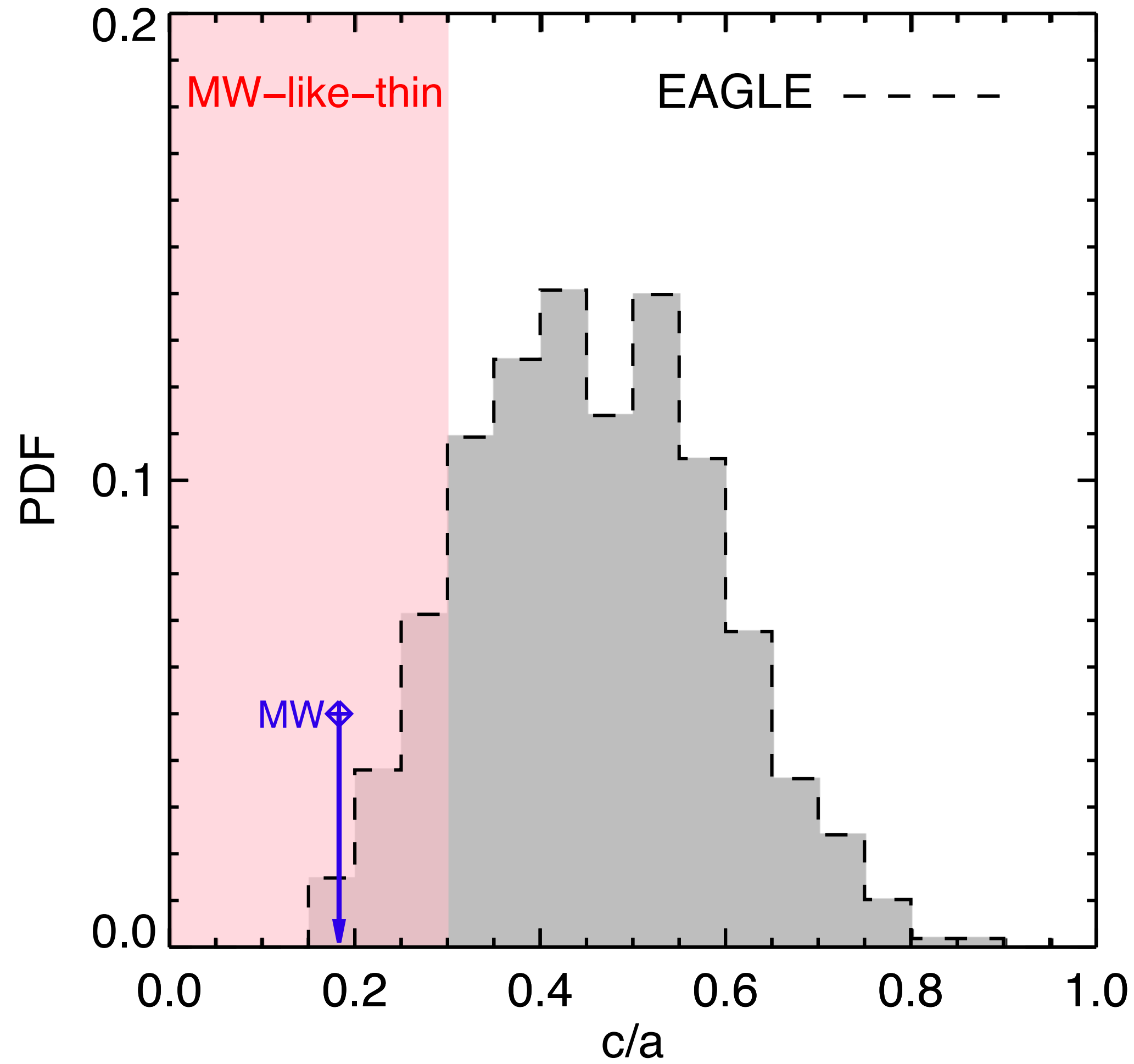
• MW-like-orbits

Comparison to simulations

- We use the EAGLE hydrodynamical simulation.
- We use MW-mass haloes to construct **mock** satellite catalogues.



Comparison to simulations



For each, only $\sim 1\%$ satellite systems in the simulation are as rare as our MW.

Find 'the One' in Eagle matrix!

~1,000,000 EAGLE galaxies in 100 Mpc³

~2000 MW-mass with $M_{200} \in [0.5, 2] \times 10^{12} M_{\odot}$

+ Sats orbitally thin

+ Sats perpendicular to their central

+ LMC (with SMC)

-
-
-

And then you find ...



I'm not the one.

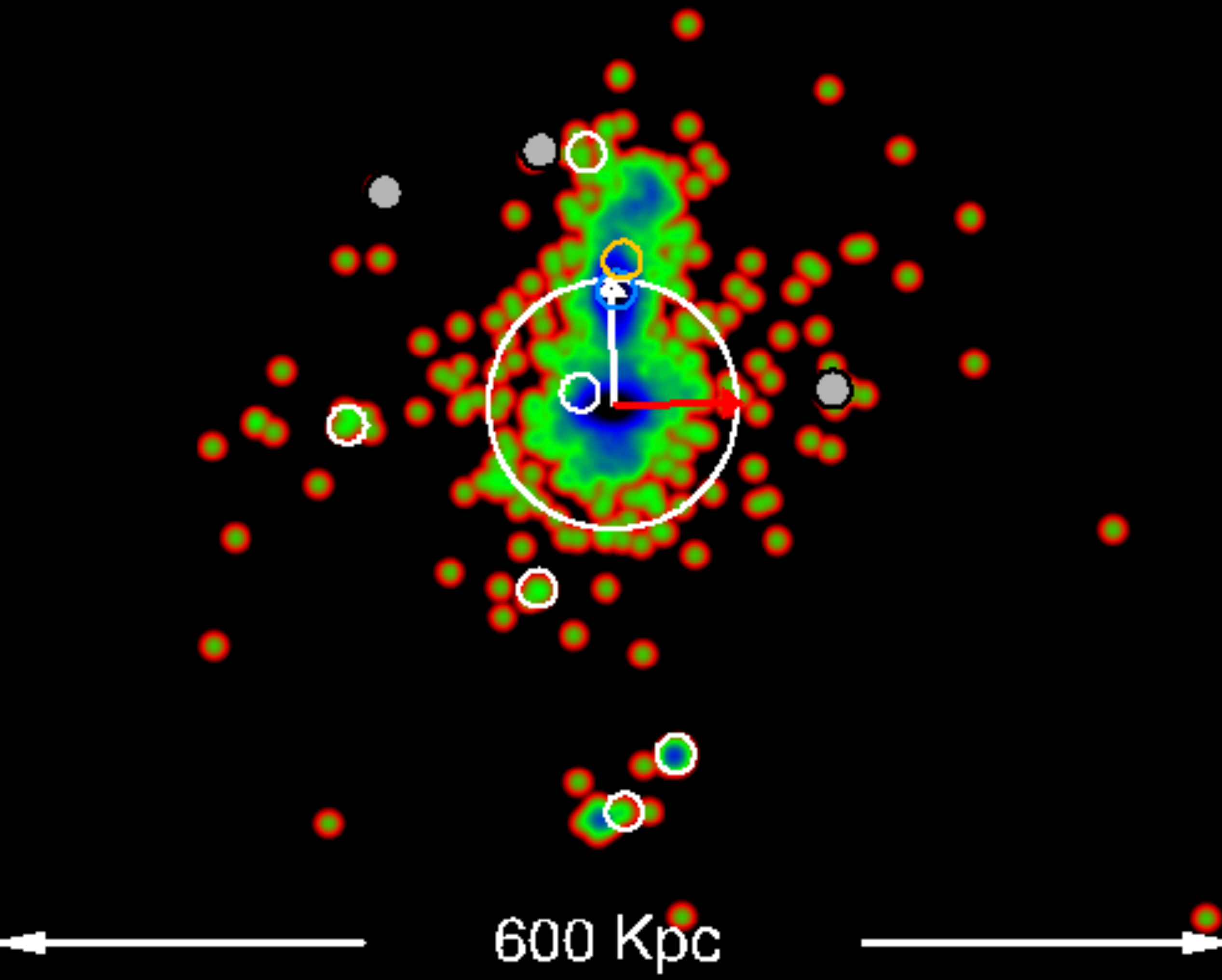
069

$z = 0.00$

$t = 0.00$ Gyr

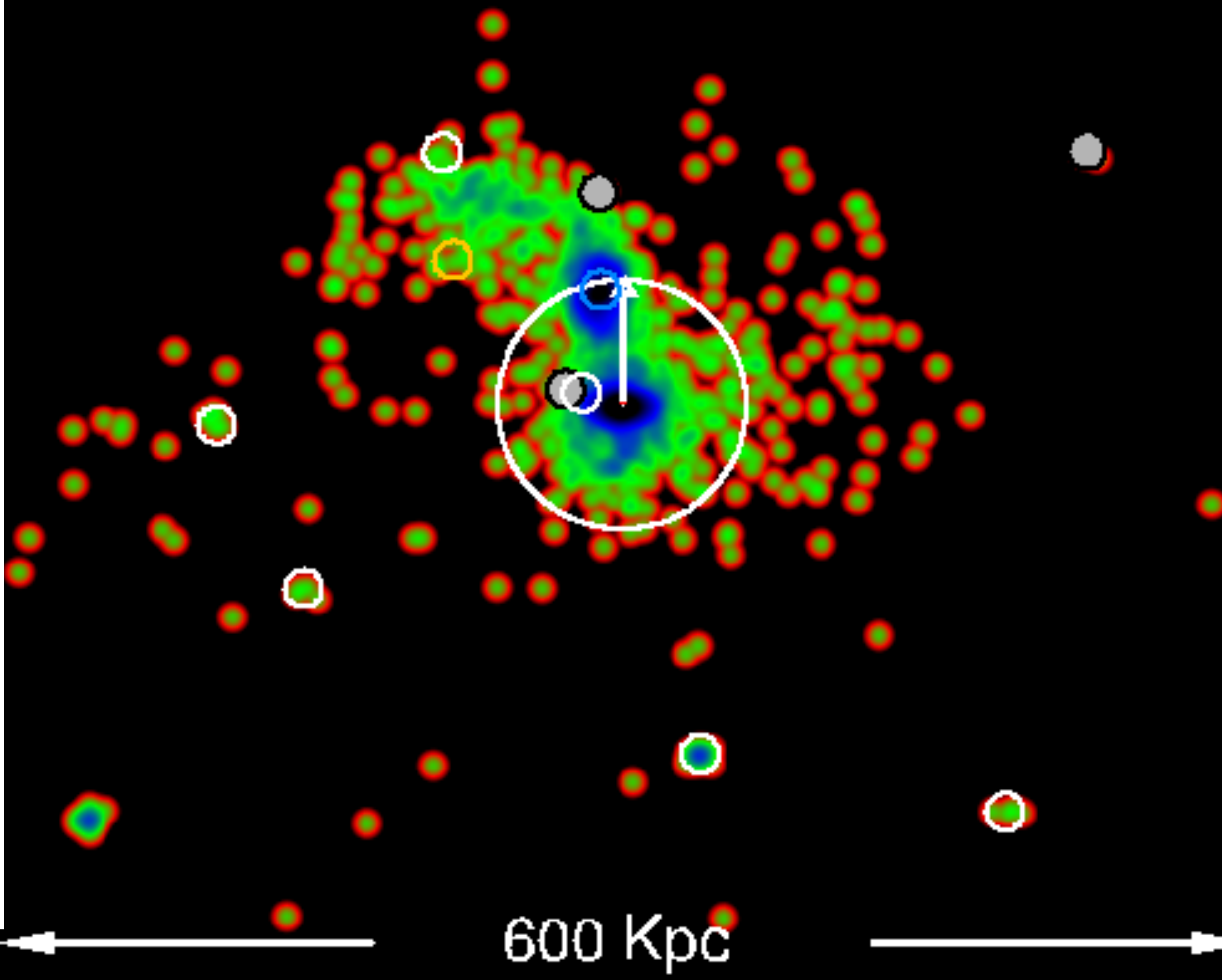
- Disc edge-on
- Sat plane edge-on

XZ



YZ

- Disc edge-on
- Sat plane face-on



069

$z = 0.00$

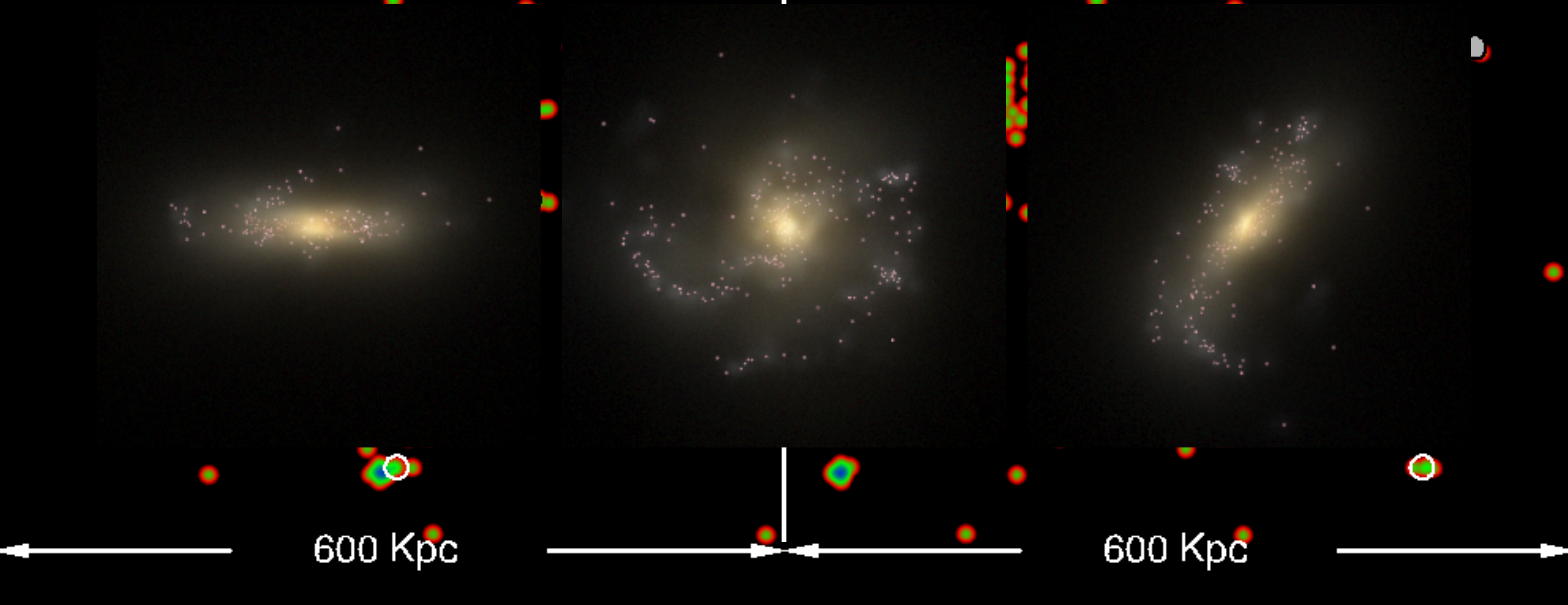
$t = 0.00$ Gyr

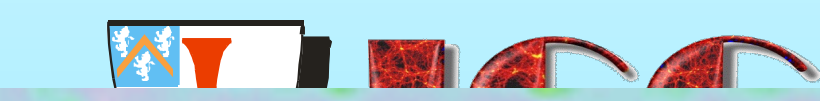
- Disc edge-on
- Sat plane edge-on

XZ

YZ

- Disc edge-on
- Sat plane face-on

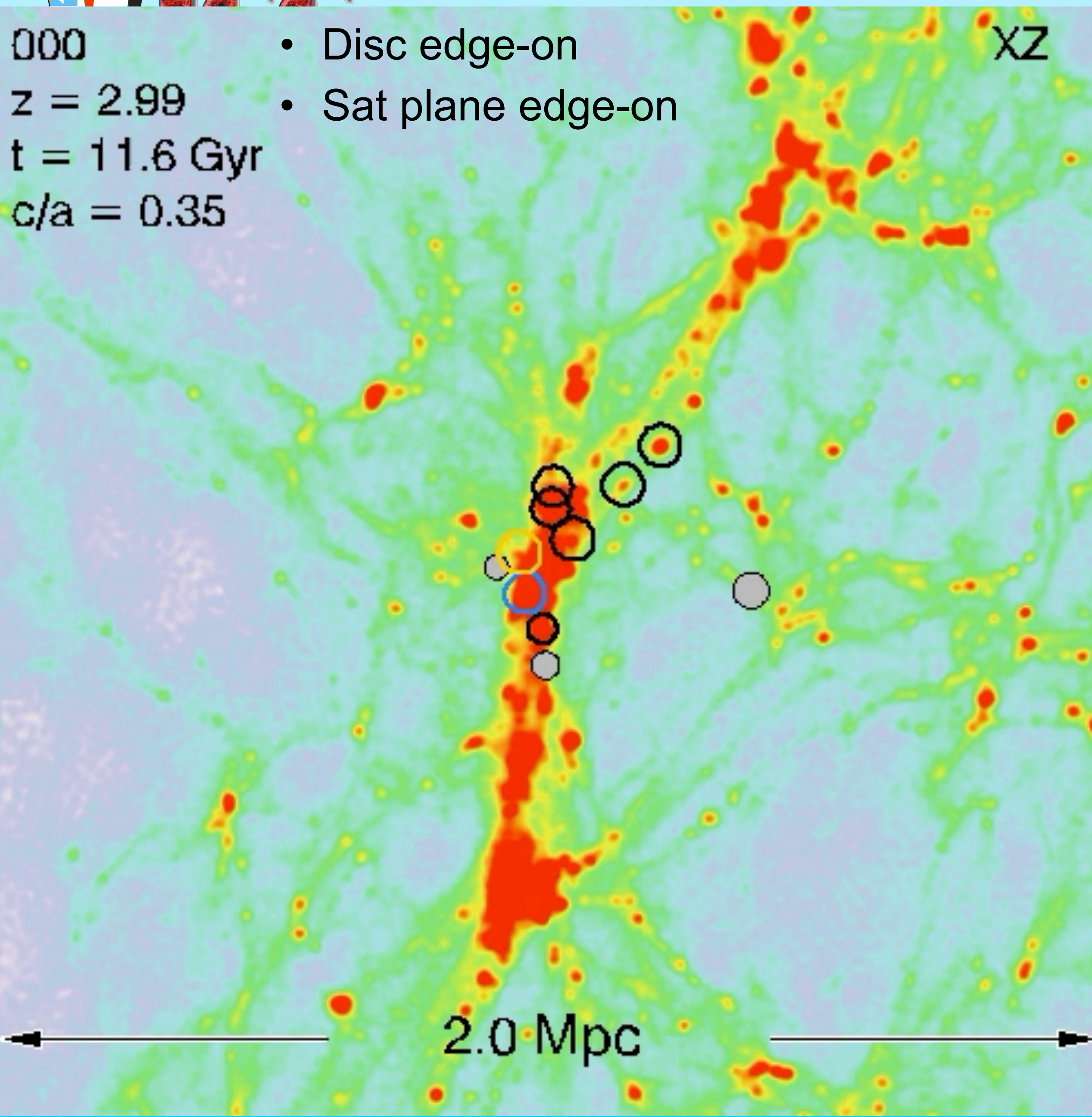




000
 $z = 2.99$
 $t = 11.6 \text{ Gyr}$
 $c/a = 0.35$

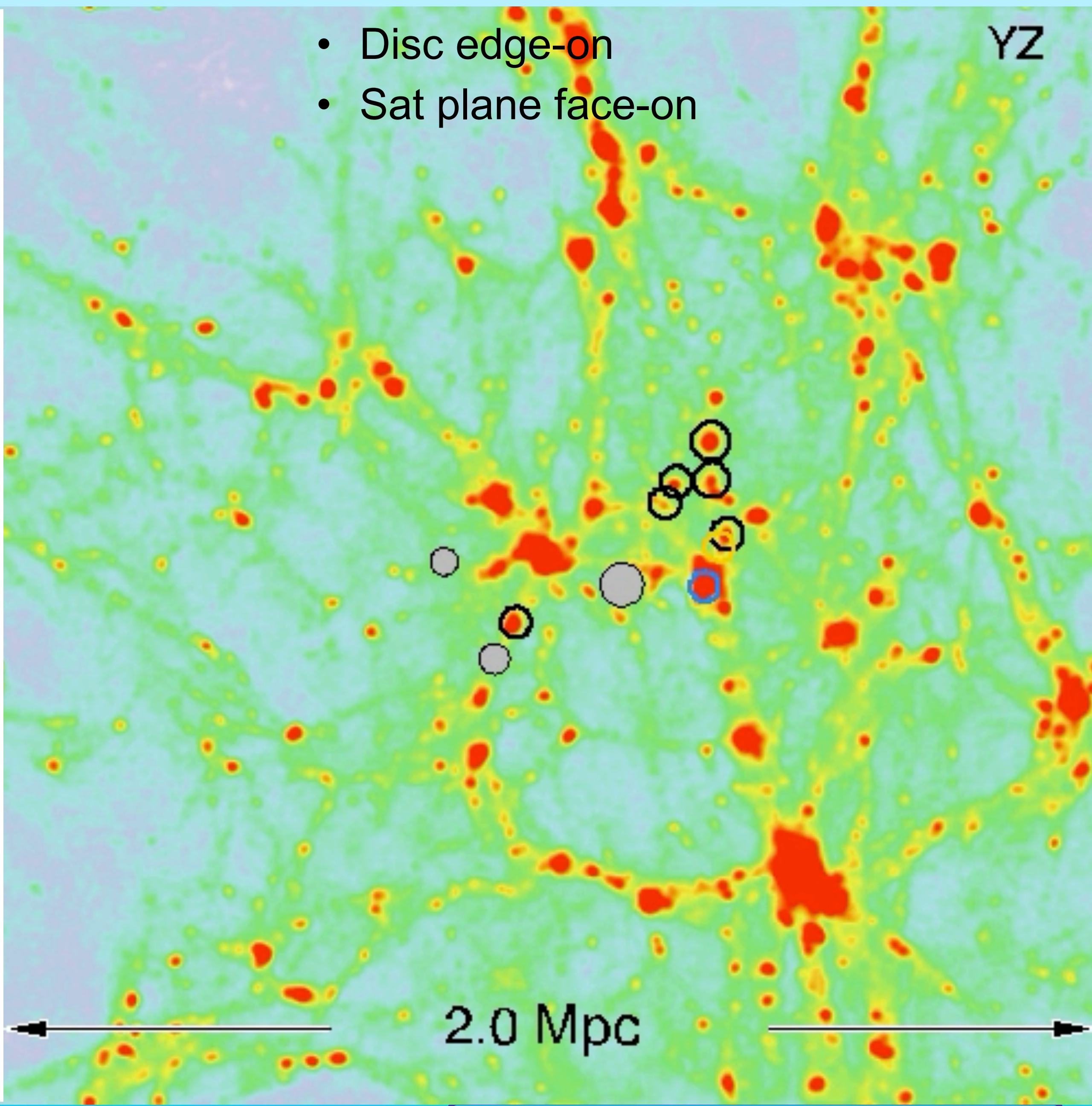
- Disc edge-on
- Sat plane edge-on

XZ



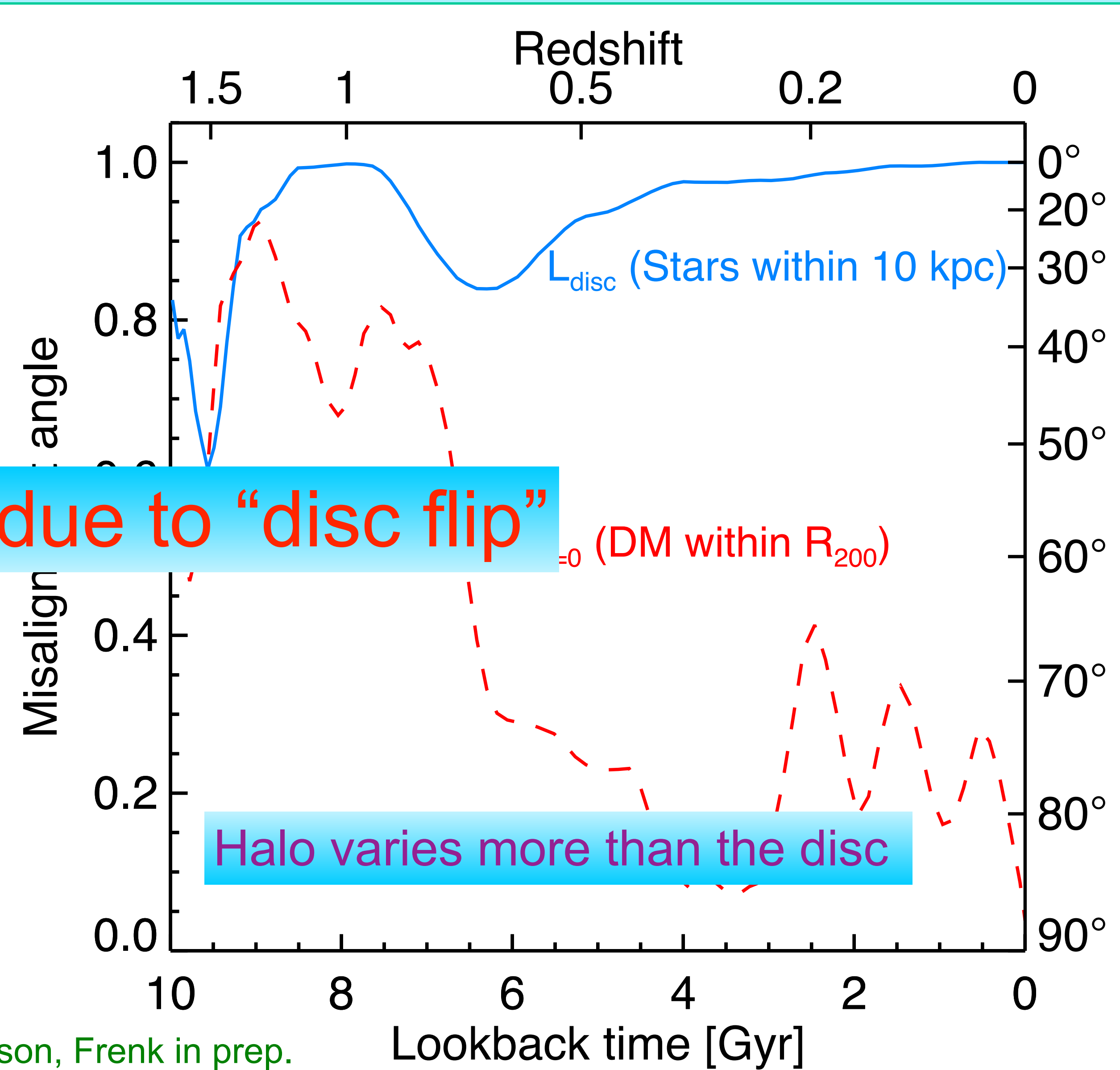
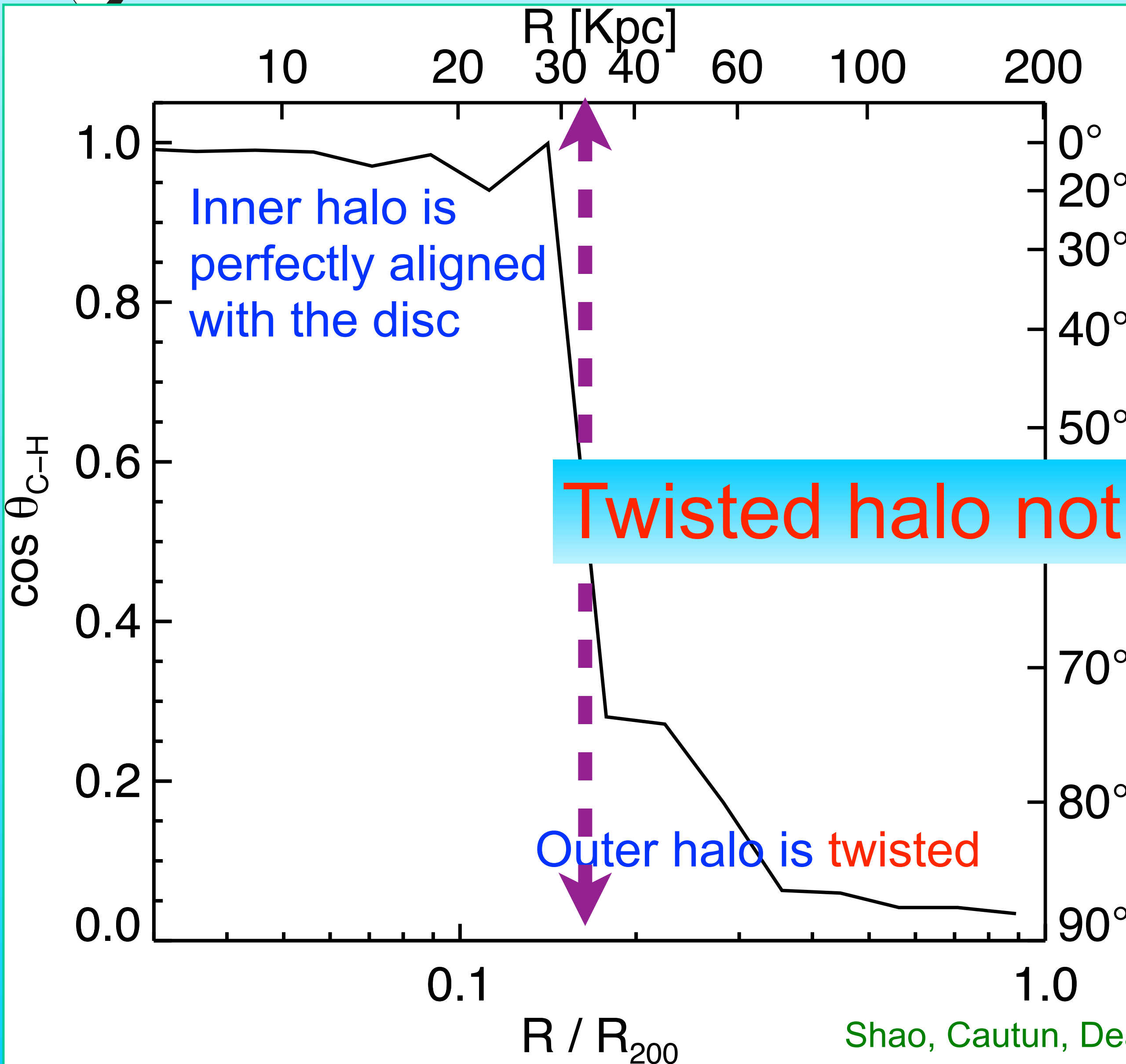
- Disc edge-on
- Sat plane face-on

YZ



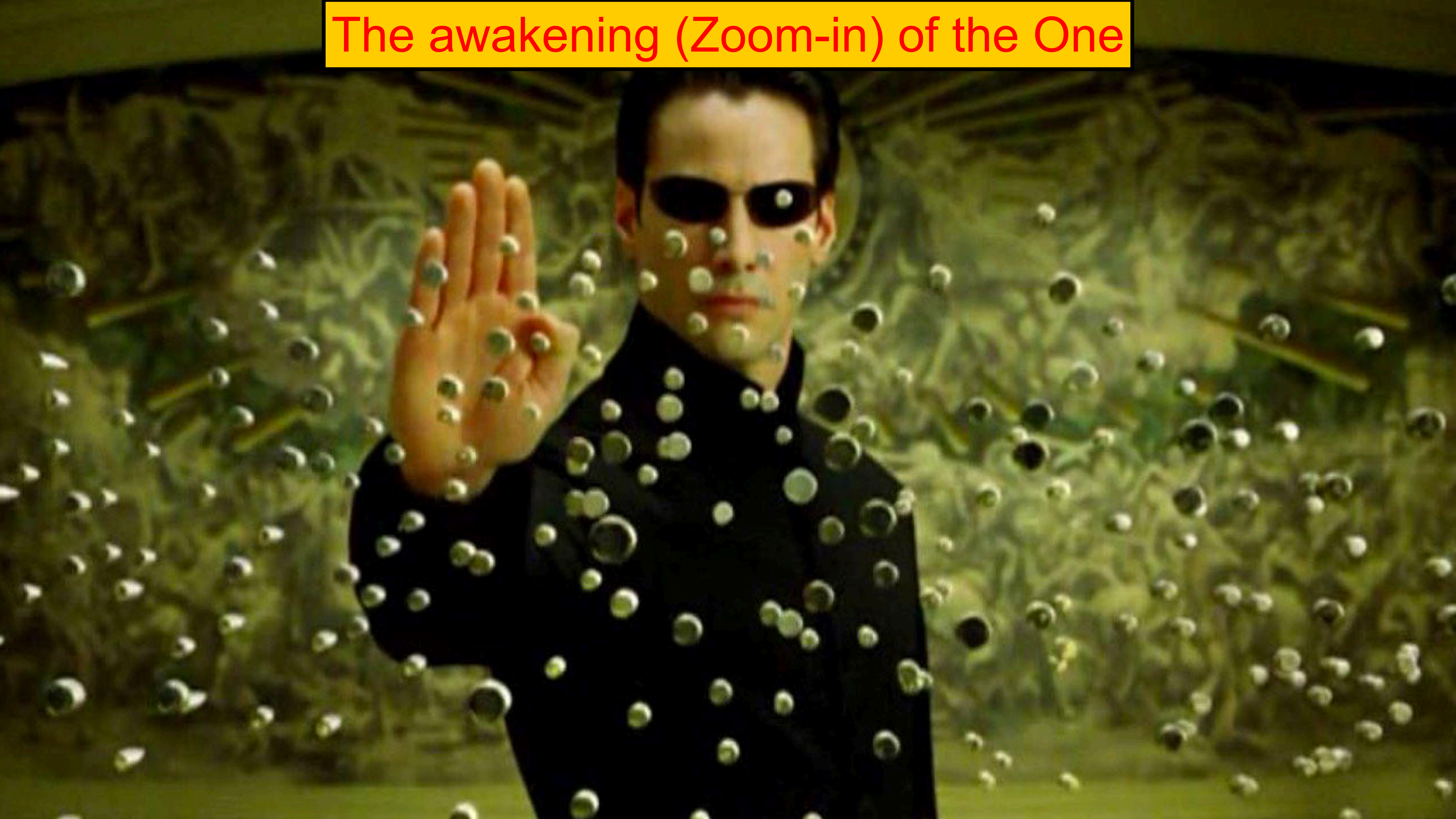
2.0 Mpc

A twisted MW halo?



Shao, Cautun, Deason, Frenk in prep.

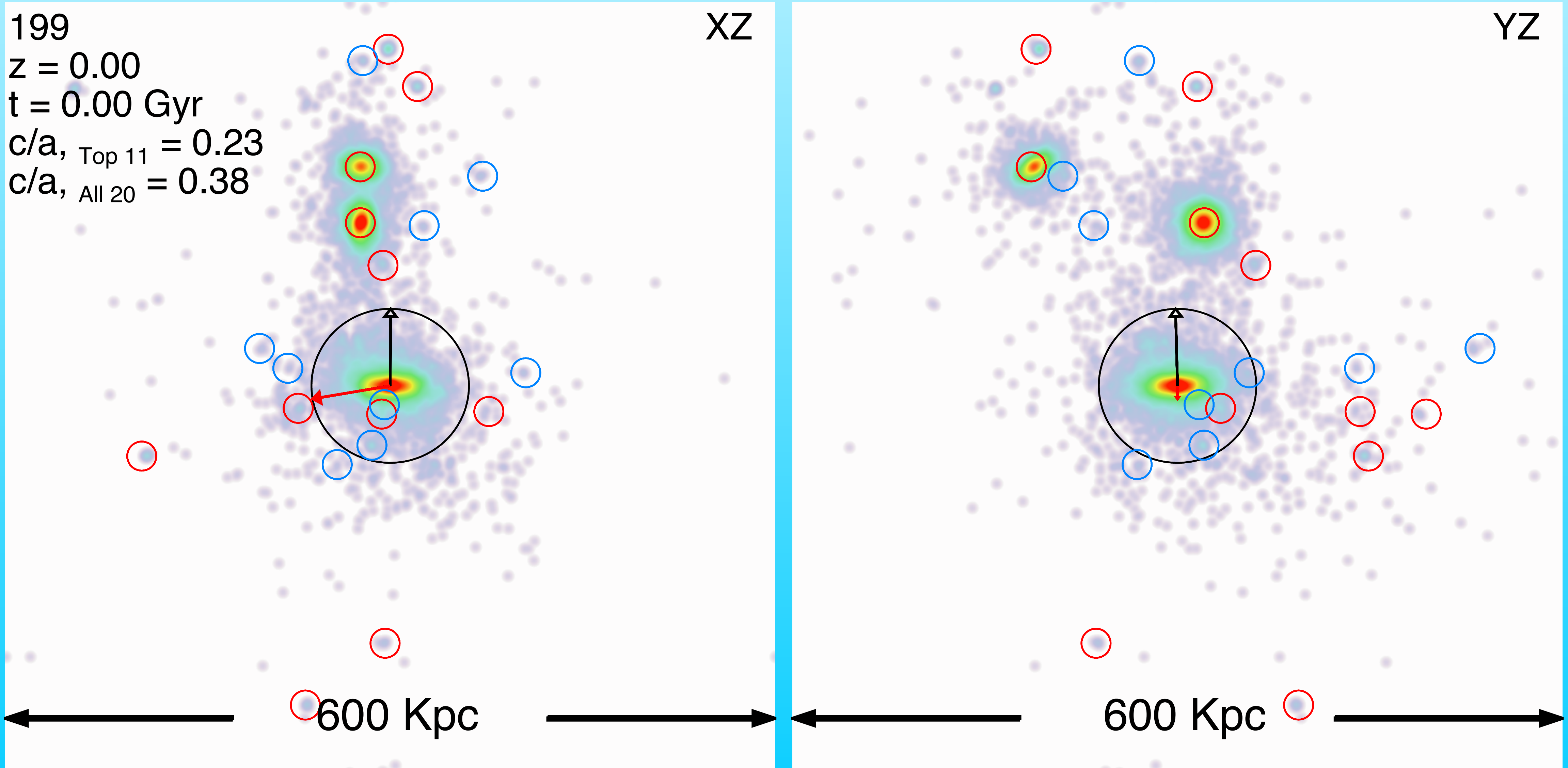
The awakening (Zoom-in) of the One



199
 $z = 0.00$
 $t = 0.00$ Gyr
 $c/a, \text{Top } 11 = 0.23$
 $c/a, \text{All } 20 = 0.38$

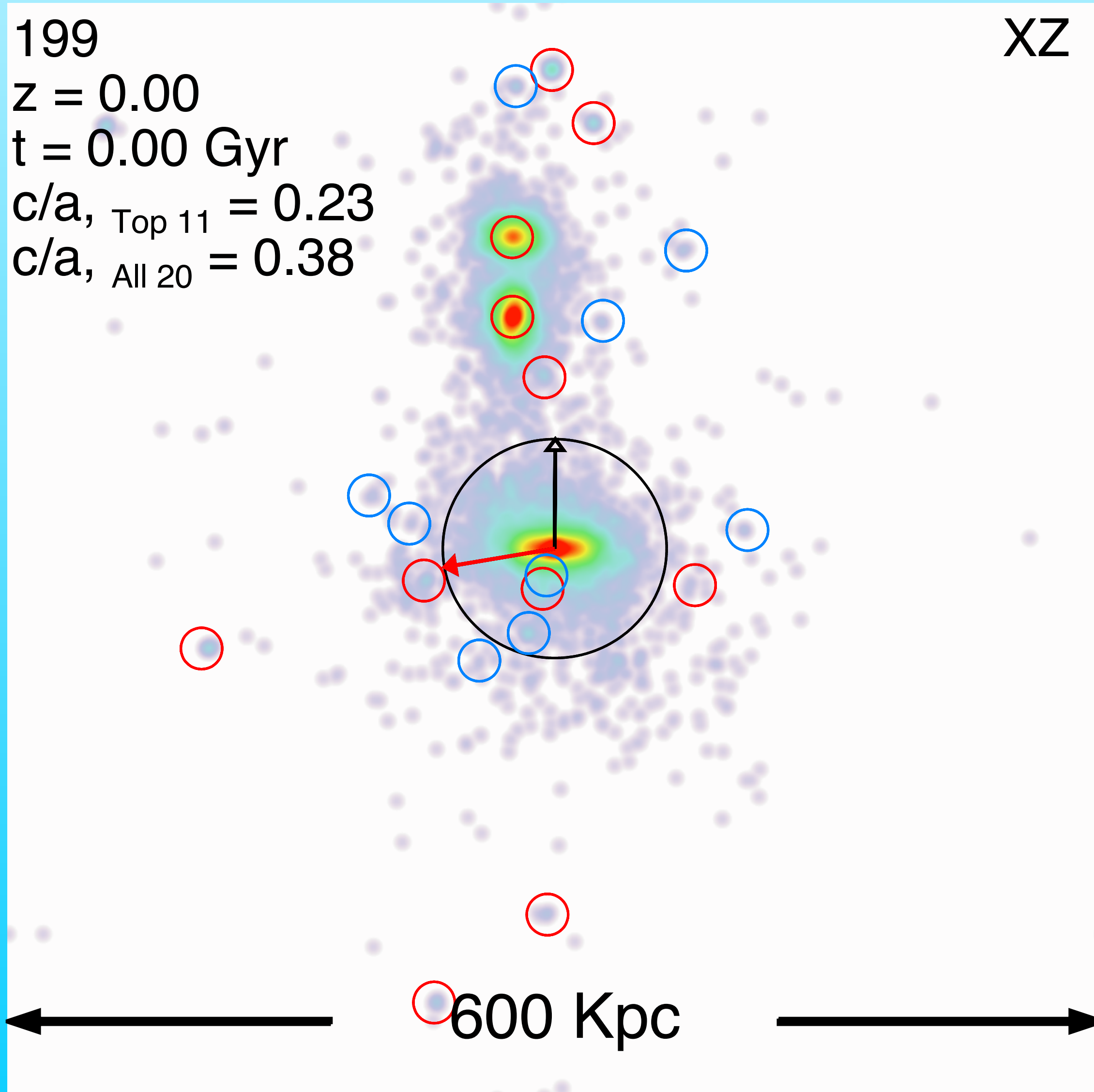
XZ

YZ

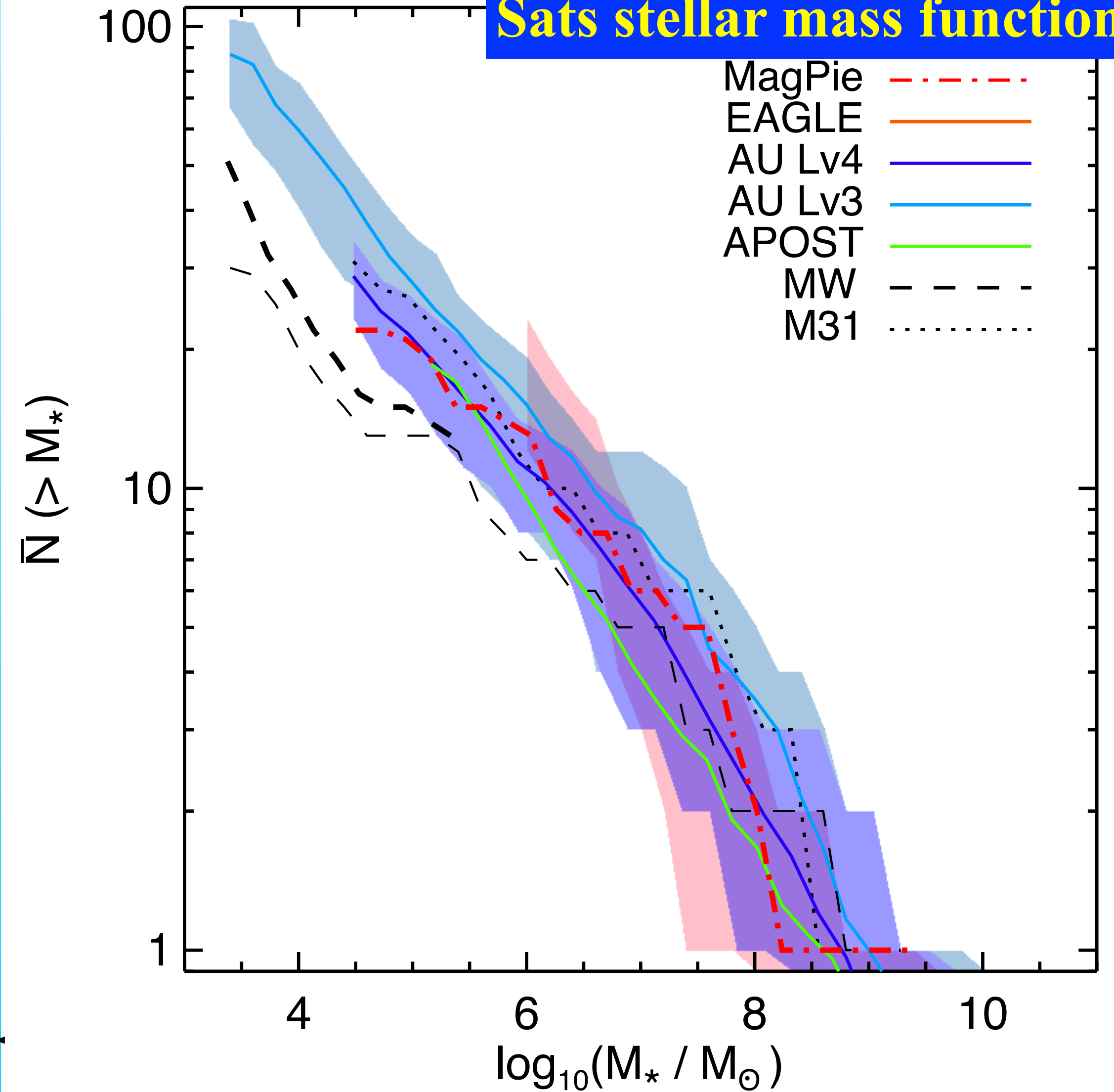


199
 $z = 0.00$
 $t = 0.00$ Gyr
 $c/a, \text{Top } 11 = 0.23$
 $c/a, \text{All } 20 = 0.38$

XZ



Sats stellar mass function

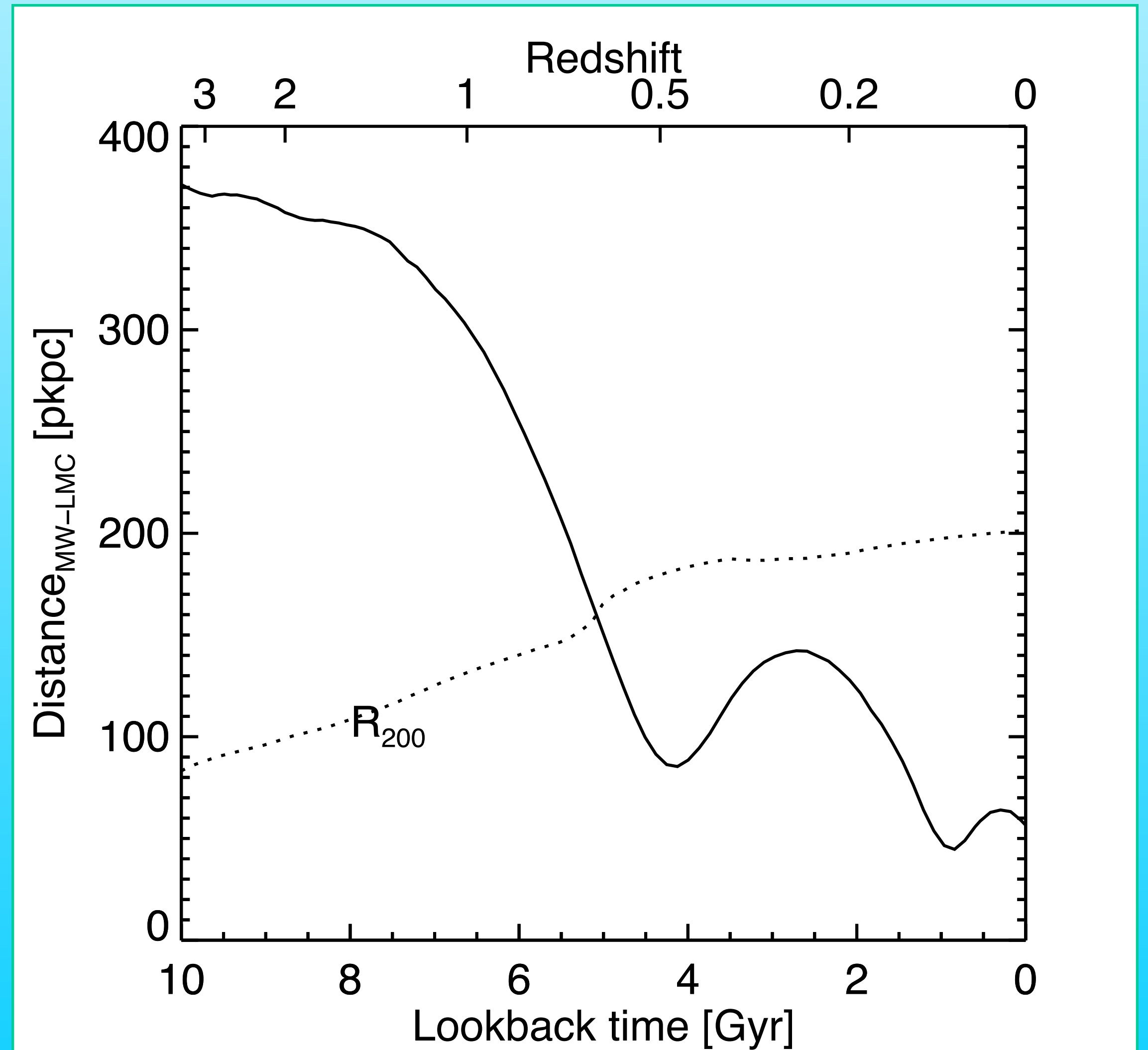
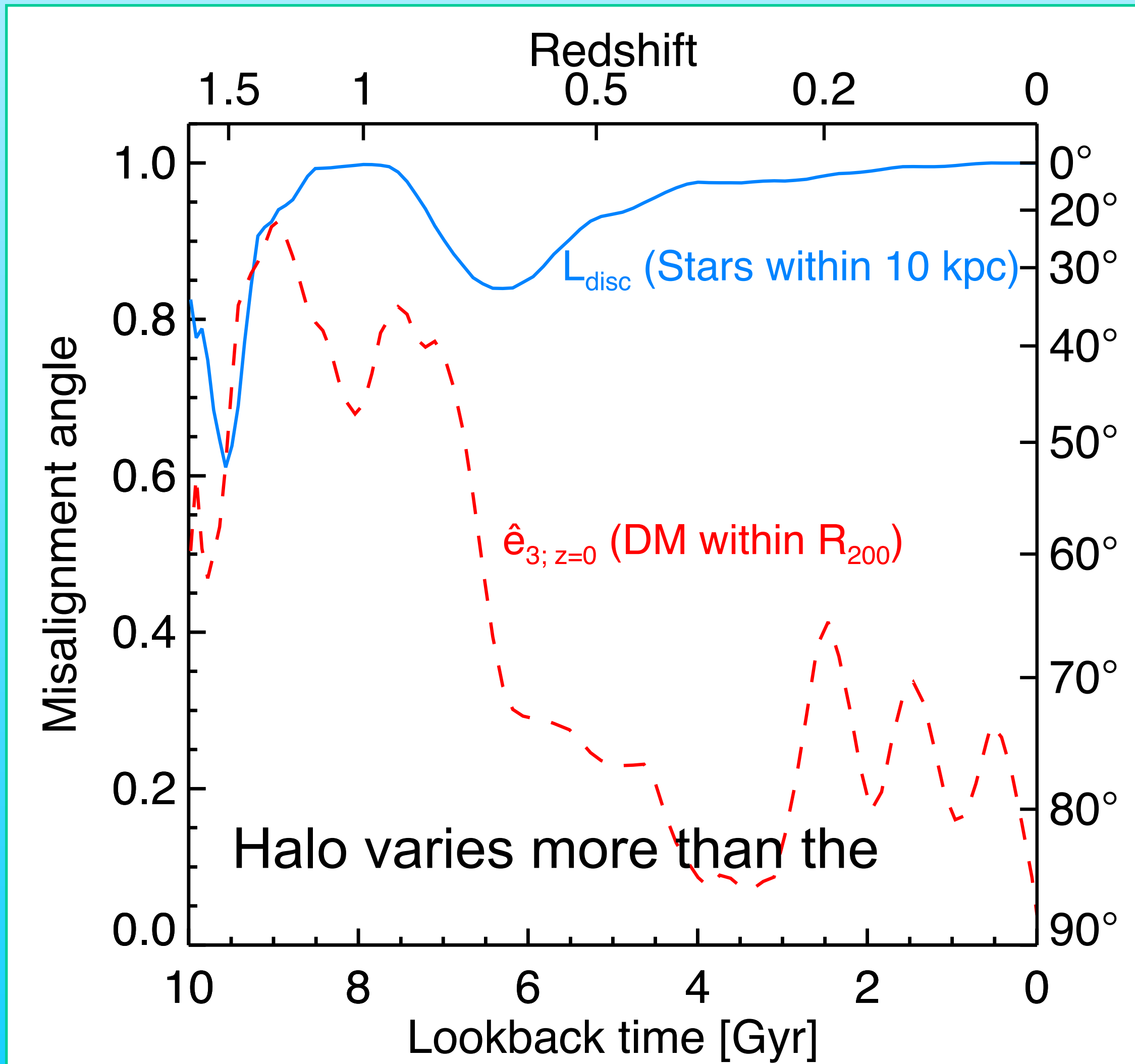


Conclusions

- 8 out of the 11 MW classical satellites have roughly co-planar orbits.
- This is atypical in LCDM, with only $\sim 1\%$ of EAGLE systems showing a similarly high degree of **co-rotation**.
- The satellite rotation plane is very well aligned with the shape of the DM halo \longrightarrow can infer the **orientation** of MW dark halo.
- In the MW, the satellite rotation plane is **perpendicular** to the MW disc \longrightarrow MW dark halo is **twisted**.
- The twist is due to changes in the orientation of the MW dark halo due to **cosmic web accretion**.
- Stay tuned for more MagPie results!



Orbital evolution of LMC-mass sat.



- Halo shape is **not** determined by massive sat.