The Latte Project:
The Milky Way on FIRE

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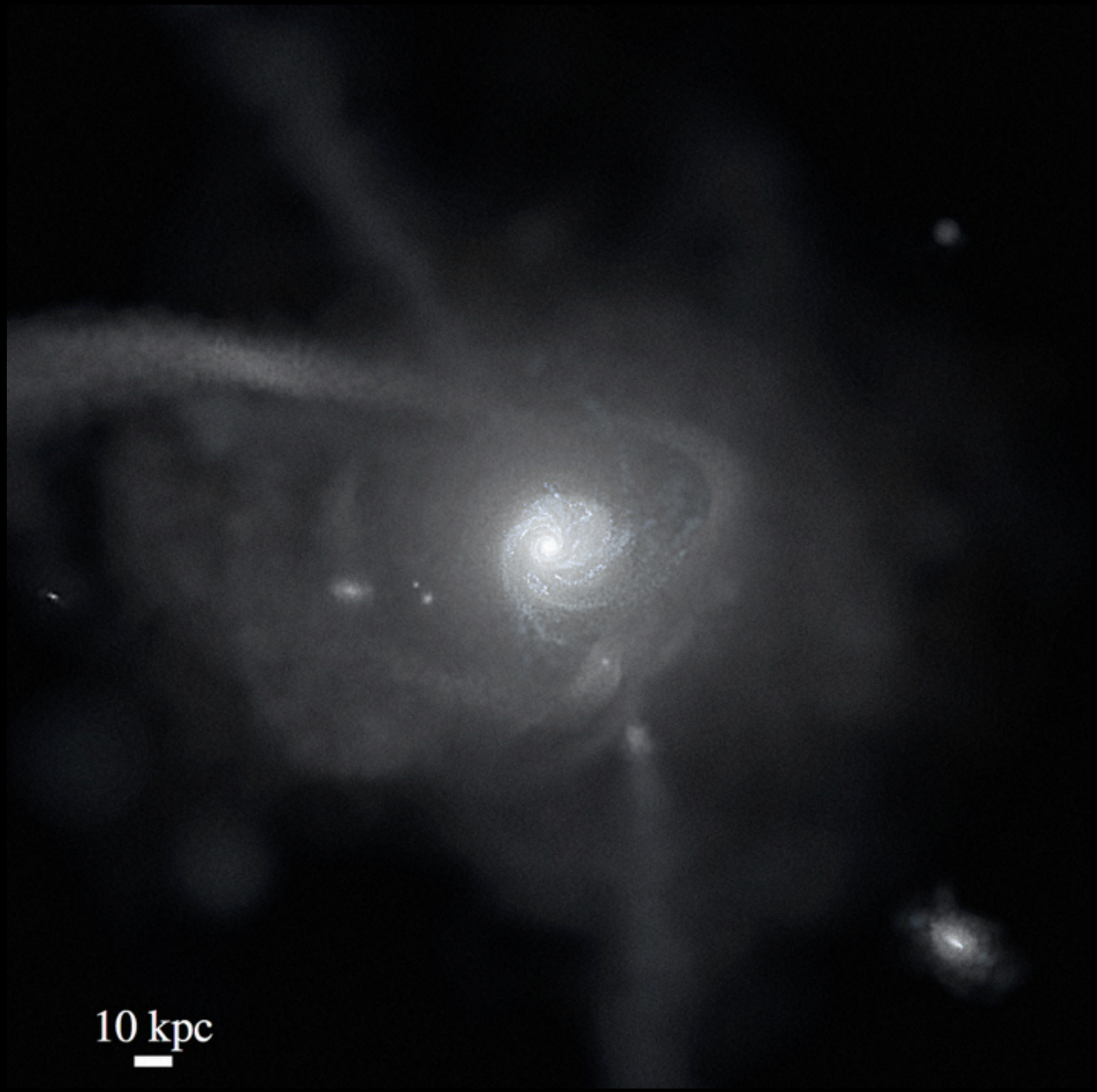
Caltech

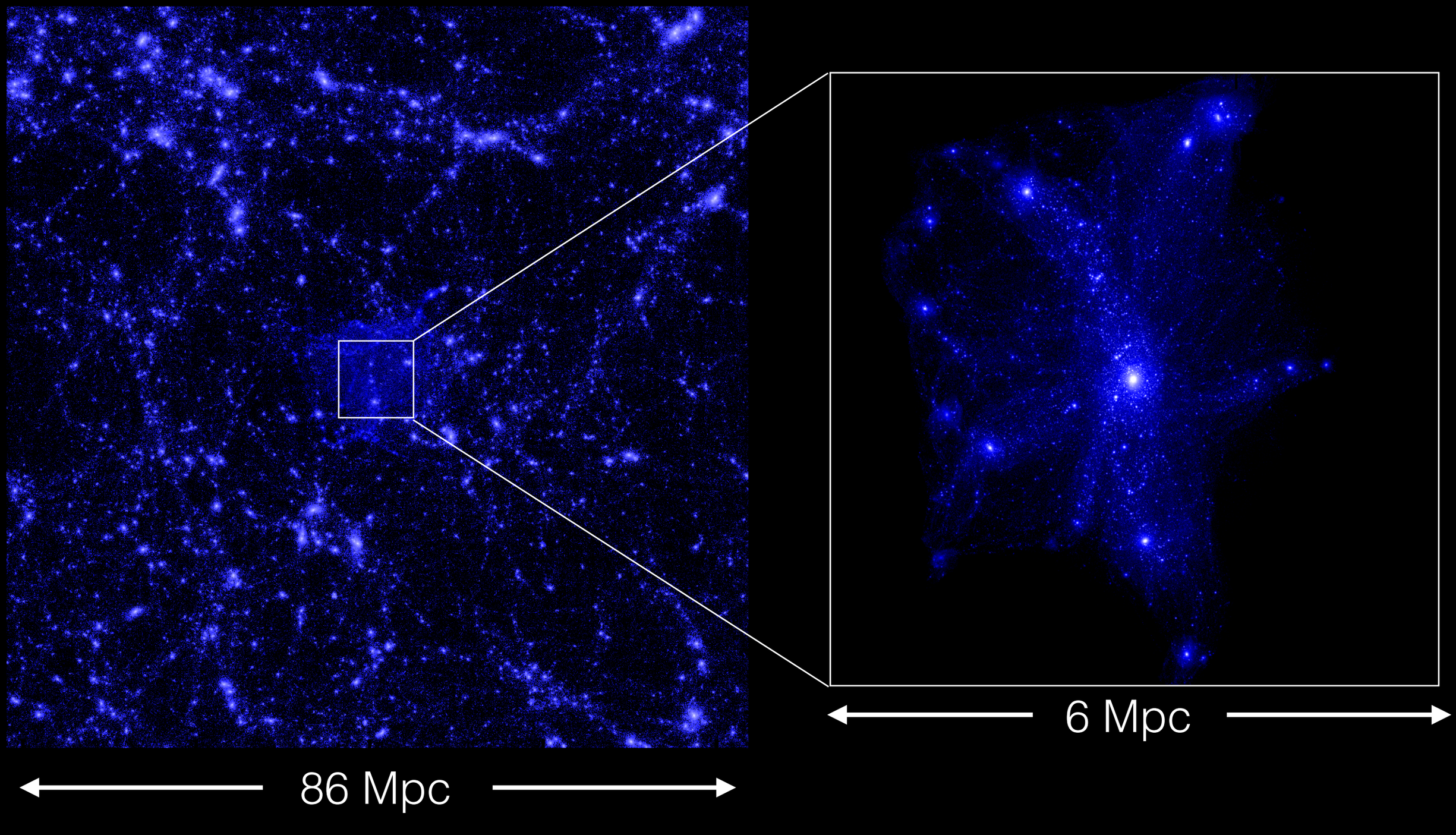
Carnegie Science

The Carnegie Observatories

UC Davis
University of California


10 kpc

cosmological zoom-in simulation to achieve high resolution



FIRE model for gas and star formation

Feedback In Realistic Environments

- High resolution to capture structure of multi-phase inter-stellar medium
  - $m_{gas/star}$ = 7070 M_{sun}
  - h_{gas} = 1 pc (min)
  - h_{star} = 4 pc
  - h_{dm} = 20 pc
- Gas cooling from atoms, molecules, and 9 metals down to 10 K
- Star formation only in self-gravitating molecular clouds with $n > 1000$ atom/cm^3

FIRE model for stellar feedback

Feedback In Realistic Environments

- Heating:
  - Supernovae: core-collapse (II) and Ia
  - Stellar Winds: massive O-stars & AGB stars
  - Photoionization (HII regions) + photoelectric heating
- Explicit Momentum Flux:
  - Radiation Pressure

$$\dot{P}_{\rm rad} \sim \frac{L}{c}\,(1+\tau_{\rm IR})$$

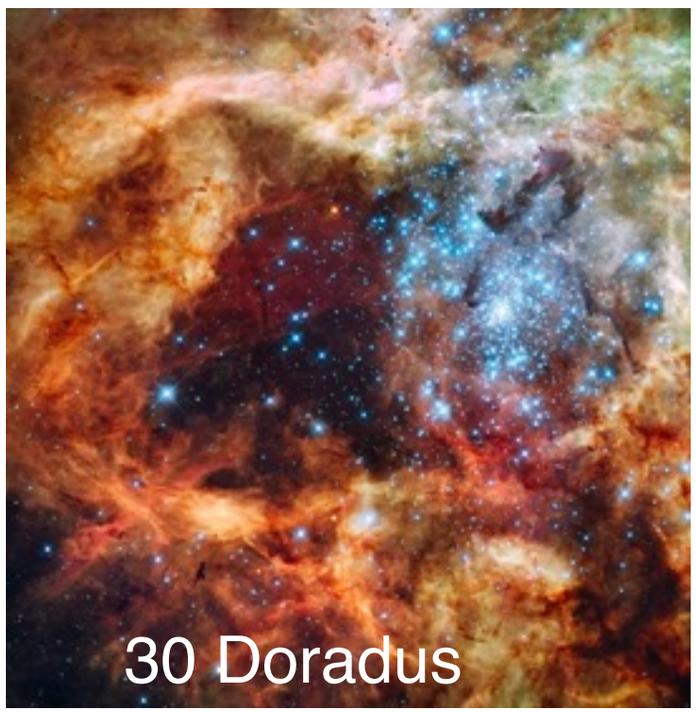
  - Supernovae

$$\dot{P}_{\rm SNe} \sim \dot{E}_{\rm SNe}\, v_{\rm ejecta}^{-1}$$

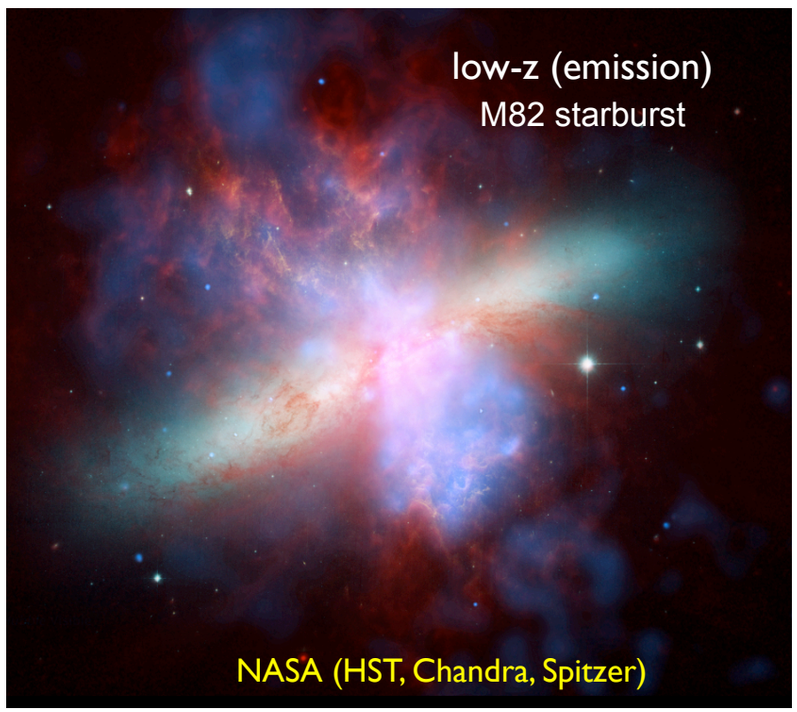
  - Stellar Winds

$$\dot{P}_{\rm W} \sim \dot{M}\, v_{\rm wind}$$

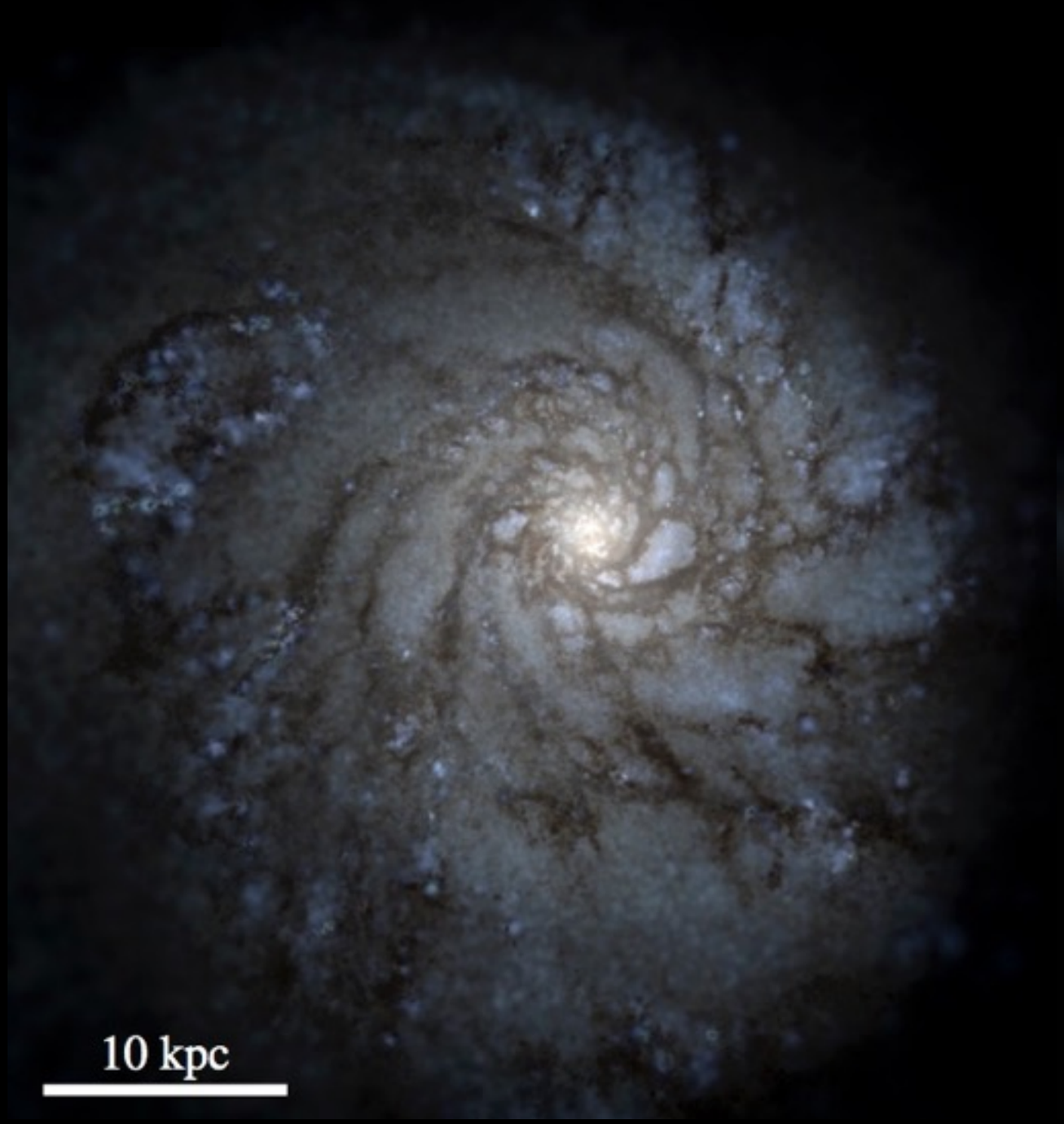
stellar scale



galaxy scale

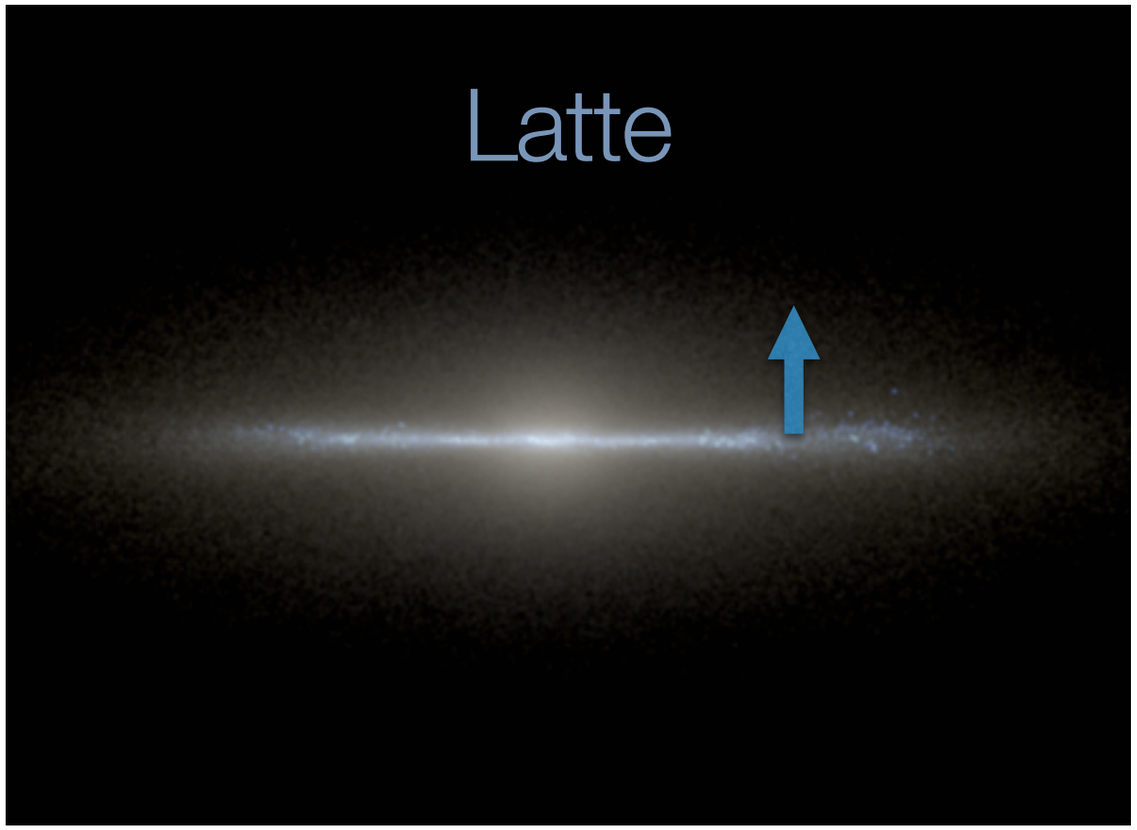


host galaxy at z = 0

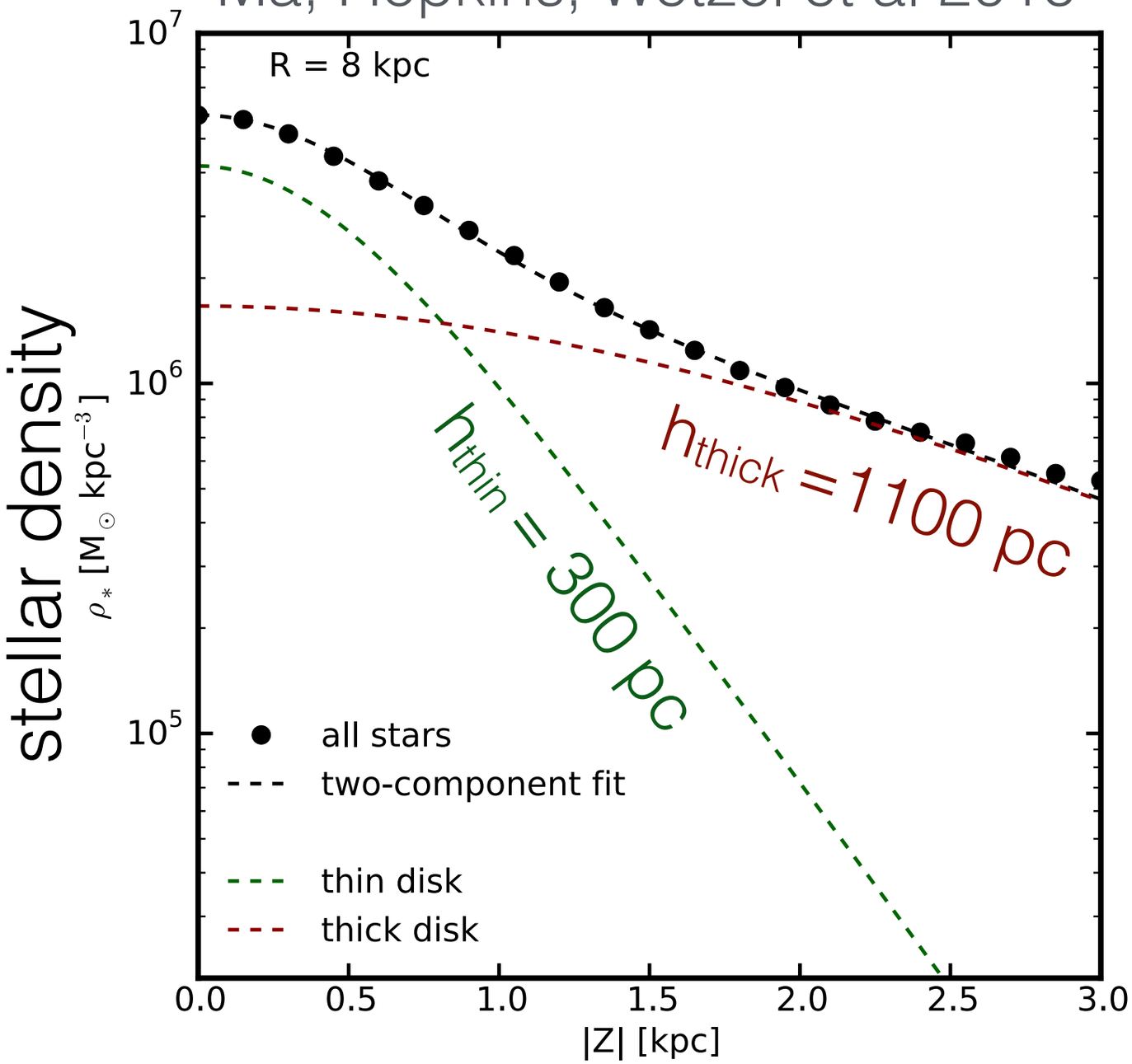


$M_{star} = 7x10^{10} M_{sun}$

successful formation of ‘thin’ and ‘thick’ stellar disk similar to Milky Way



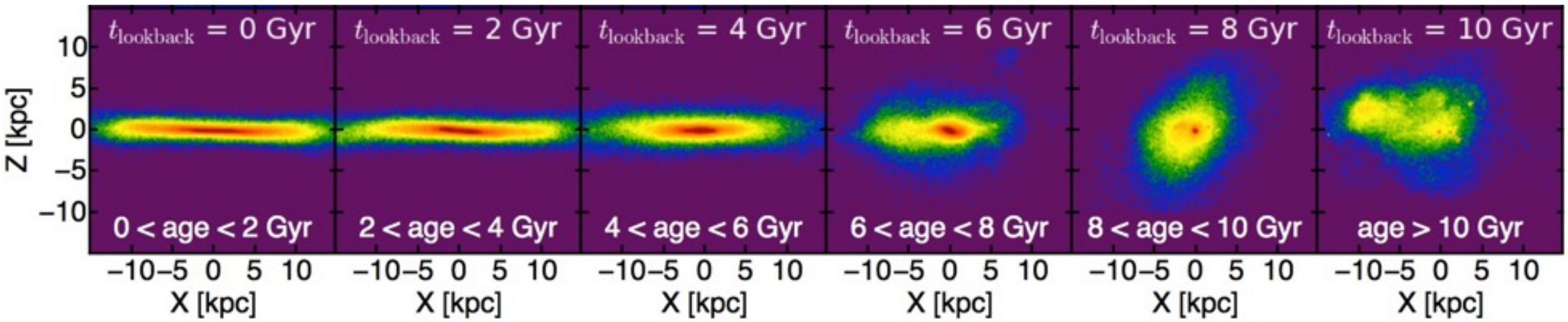
Ma, Hopkins, Wetzel et al 2016



vertical height

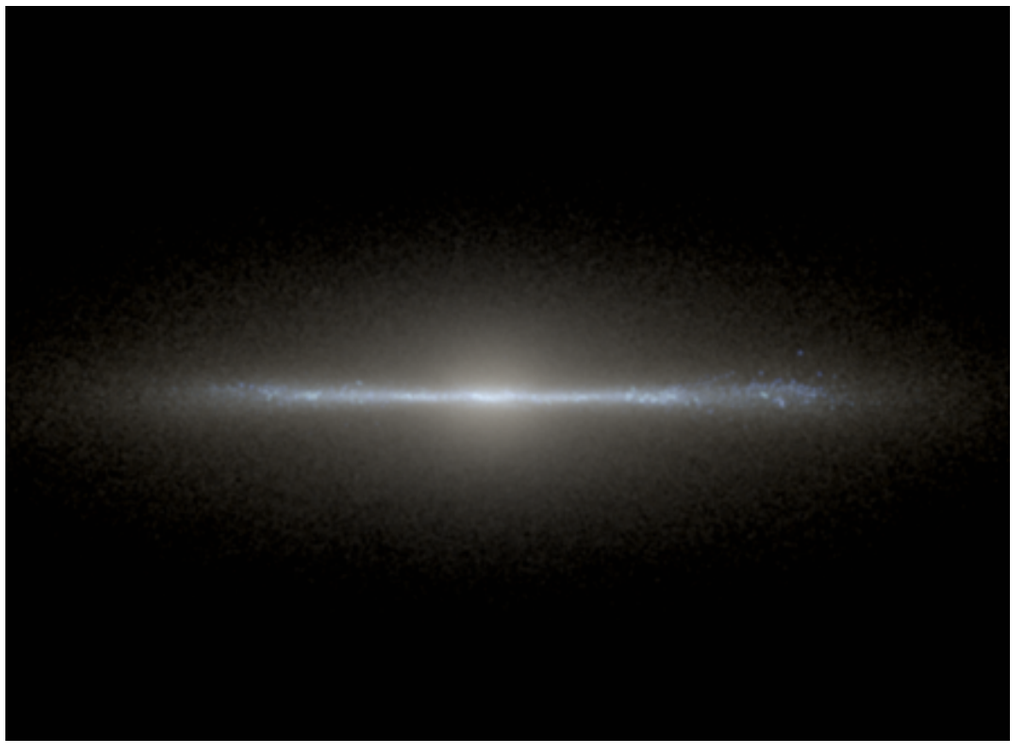
thick —> thin disk formation

stars at formation

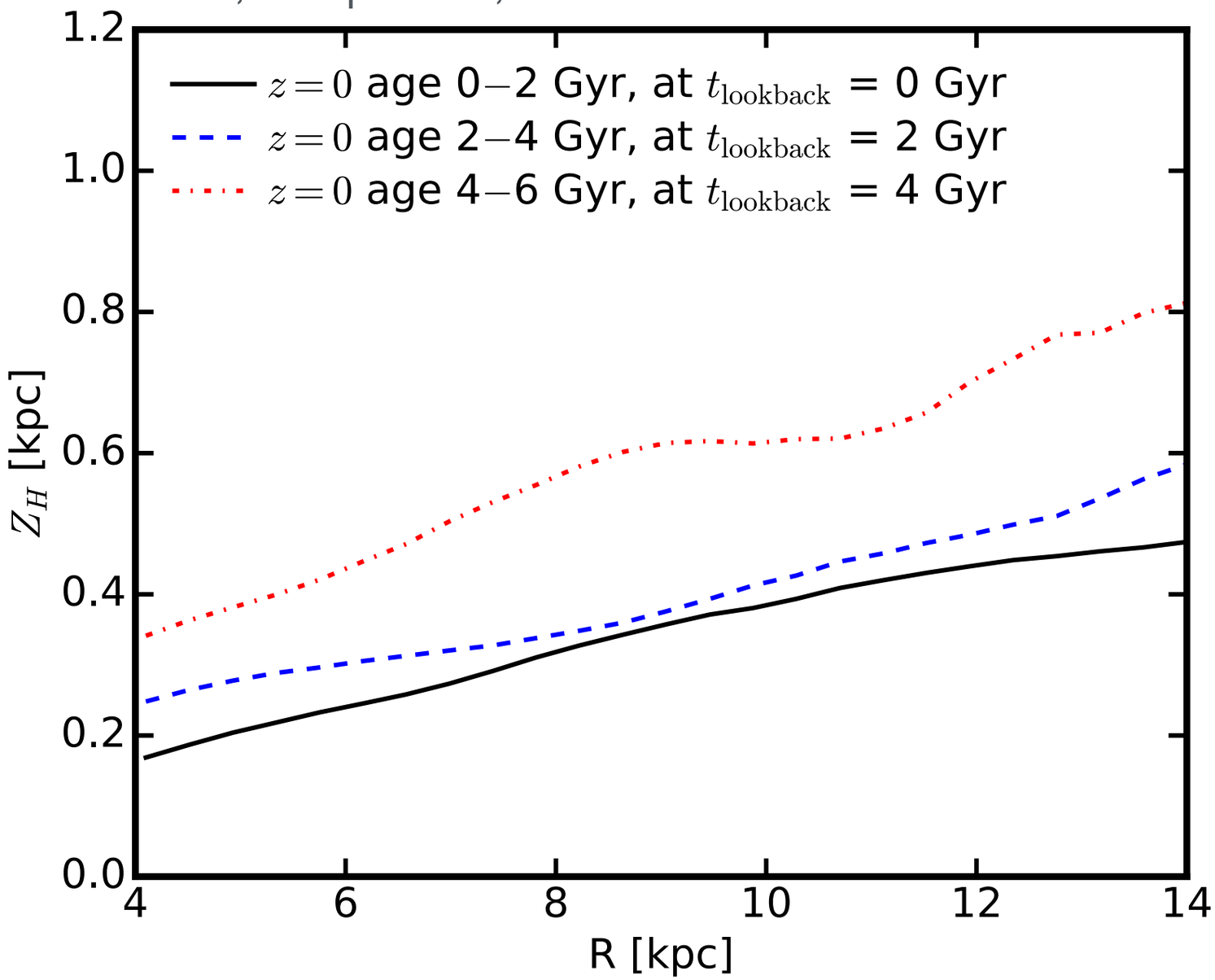


Ma, Hopkins, Wetzel et al 2016

stellar disk was flared at formation because gas disk is flared



Ma, Hopkins, Wetzel et al 2016



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population of satellite dwarf galaxies

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300 kpc

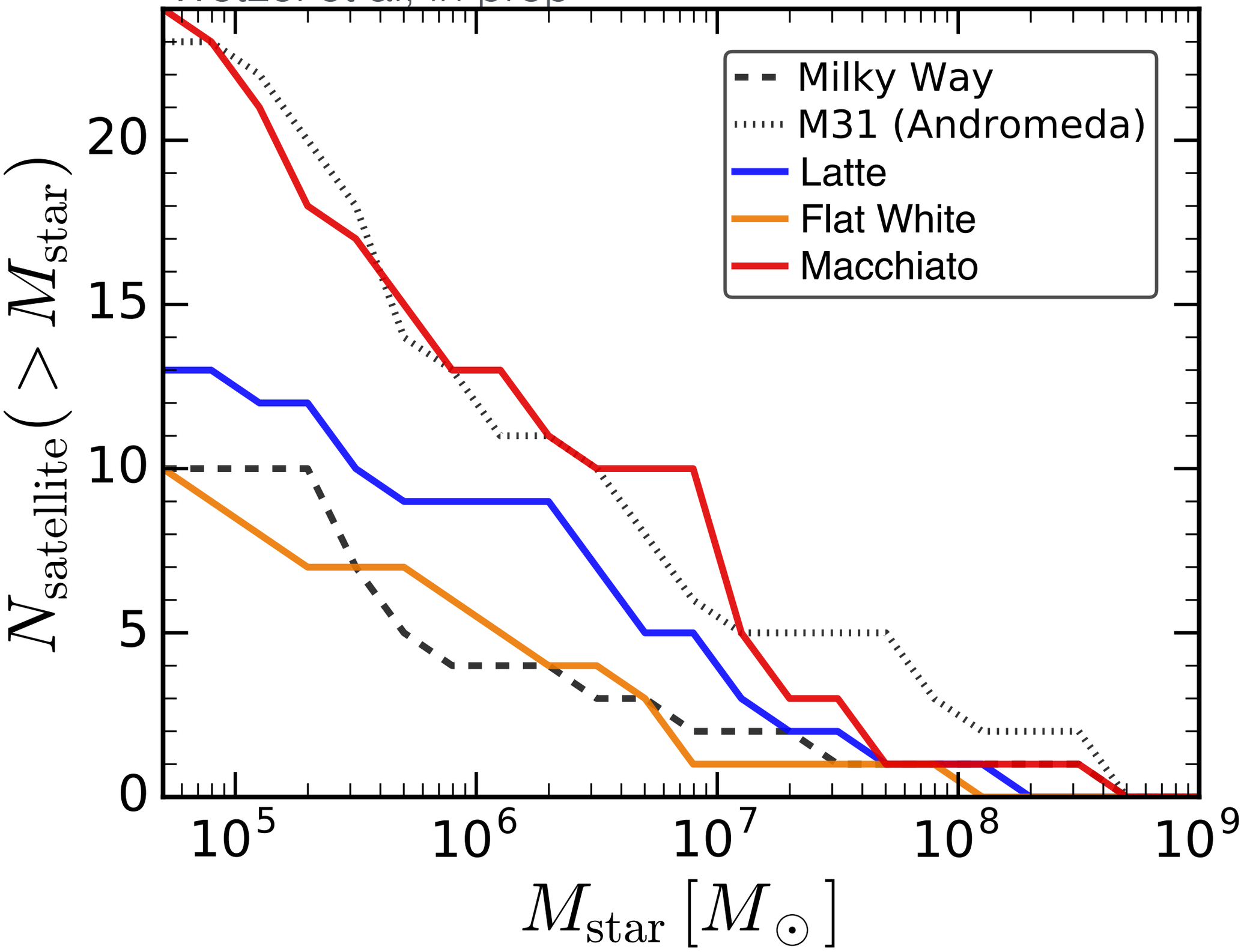
Latte
M_{200}=1.3e12

Flat White
M_{200}=1.8e12

Macchiato
M_{200}=1.6e12

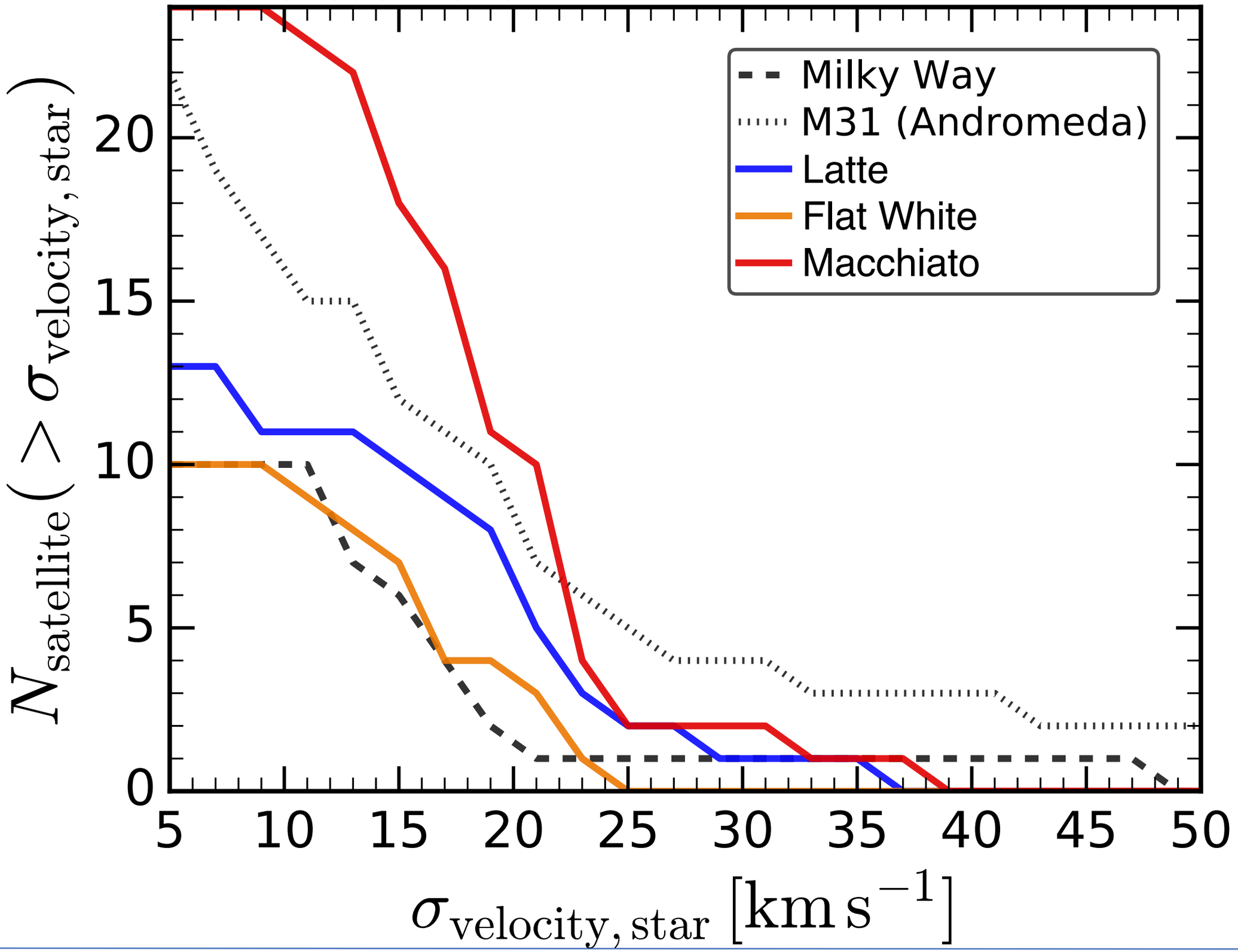
stellar masses of satellite galaxies

Wetzel et al, in prep

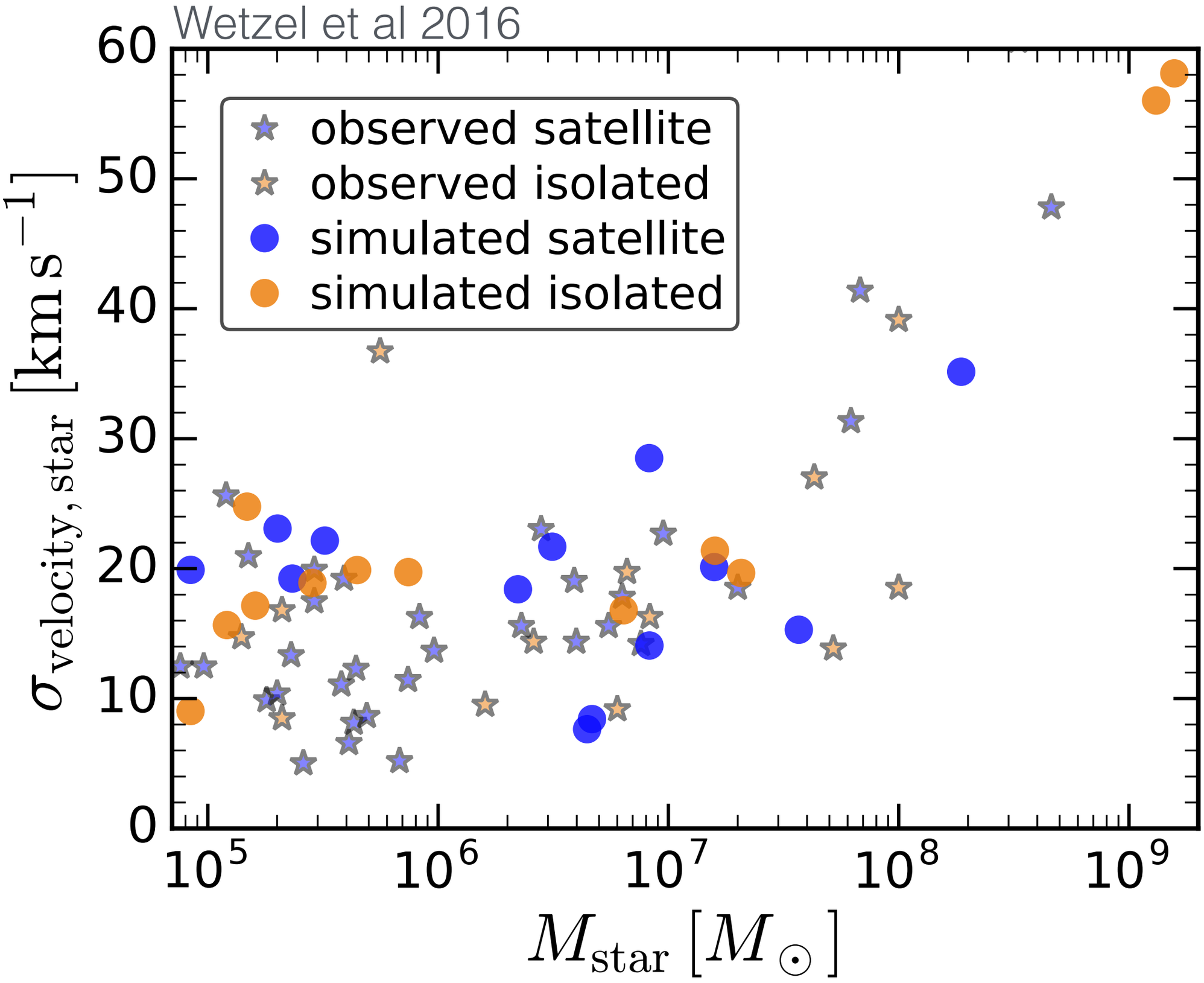


stellar velocity dispersions of satellites

Wetzel et al 2016

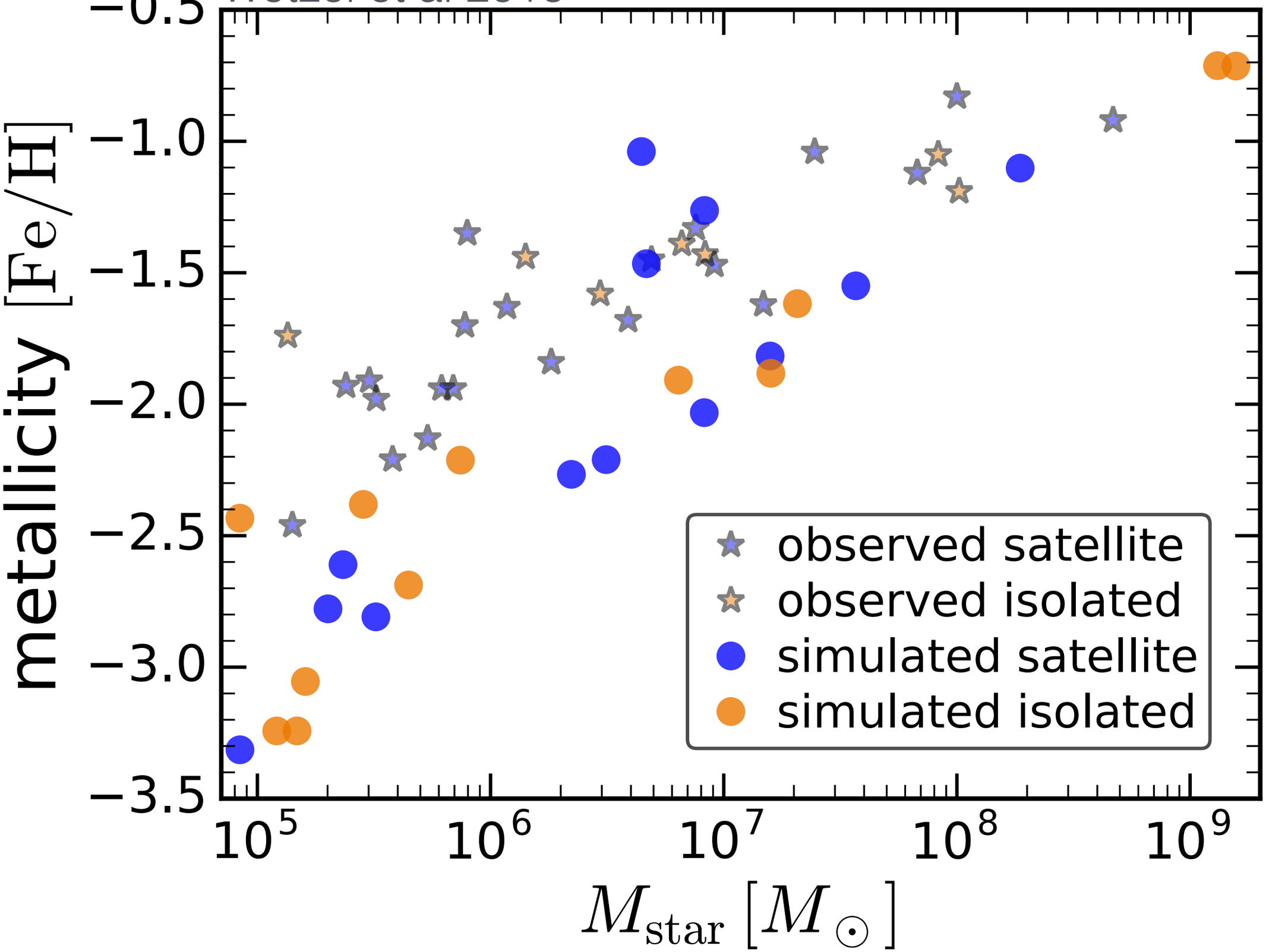


velocity dispersion - mass relation



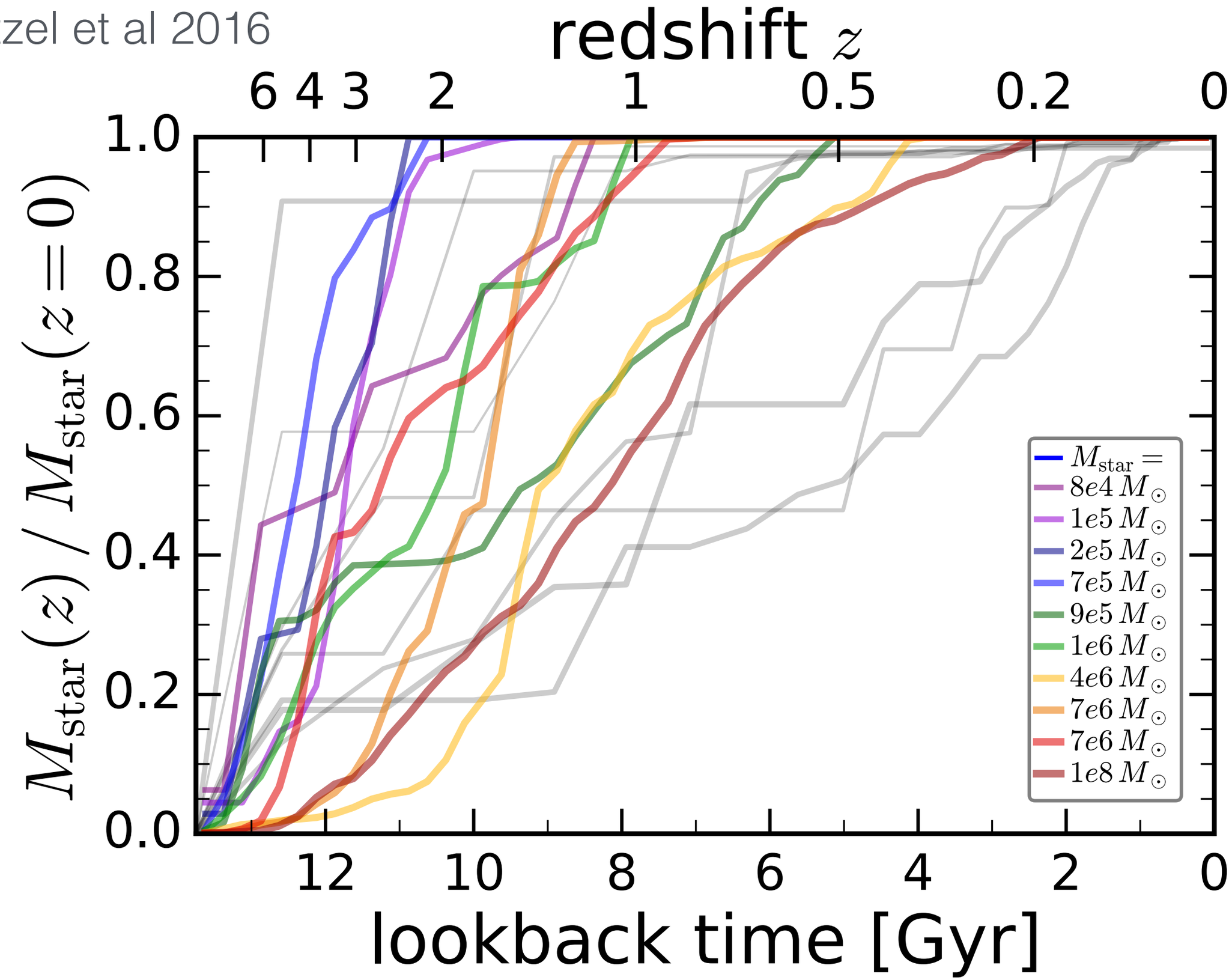
mass - metallicity relation

Wetzel et al 2016



star-formation histories of satellite galaxies

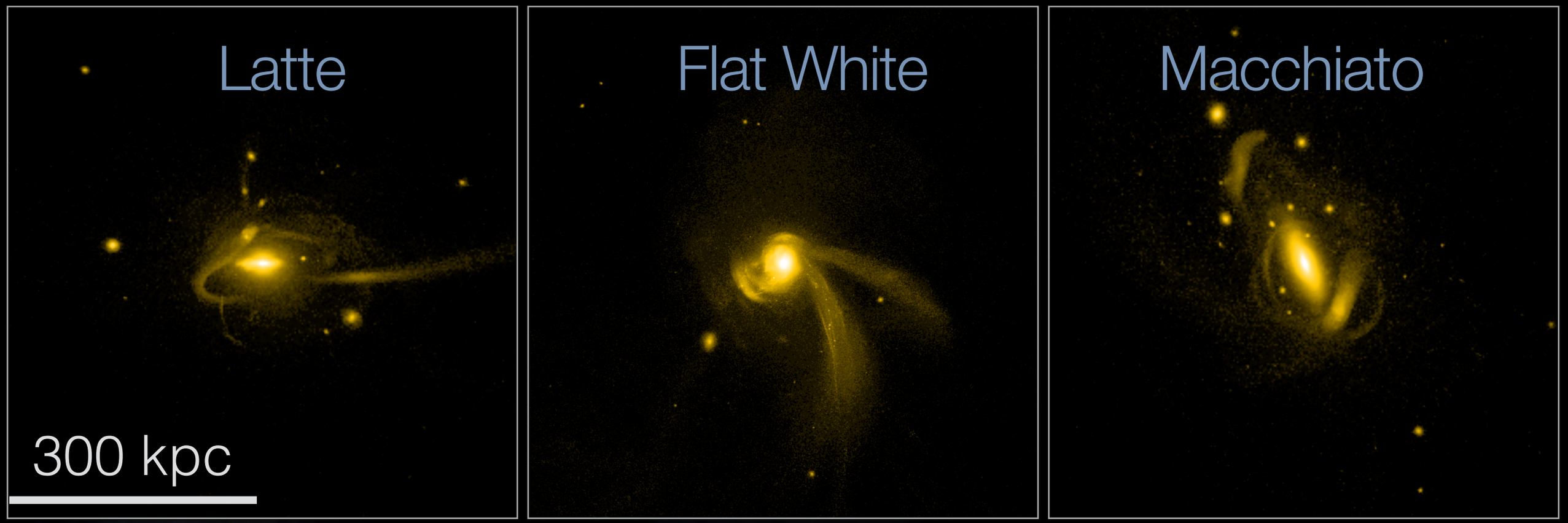
Wetzel et al 2016

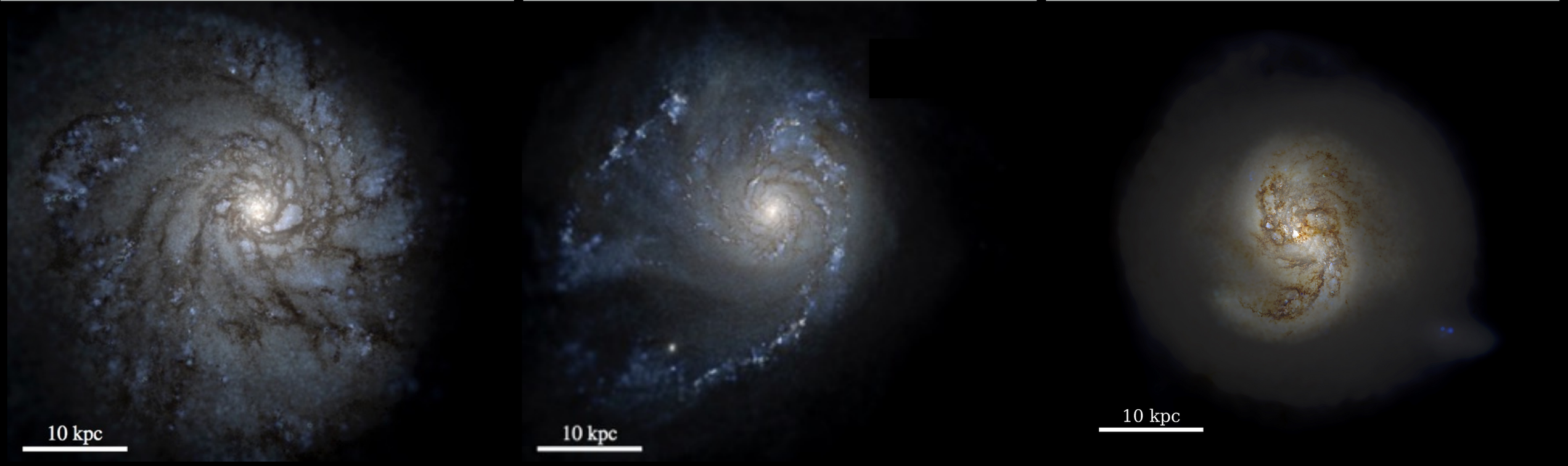


What causes the lack of (massive) satellite dwarf galaxies?

1. Stellar feedback drives significant gas outflows/inflows that dynamically heat dark matter, reducing the inner density (cores)

2. Stellar disk of Milky Way-mass host galaxy destroys satellites (via tidal shocking, etc)





with Robyn Sanderson (Caltech) and Sanjib Sharma (Sydney):
using Galaxia (Sharma et al 2011) to generate synthetic stellar catalogs
to mock of your favorite survey (Gaia, Gaia-ESO, APOGEE, GALAH, etc)

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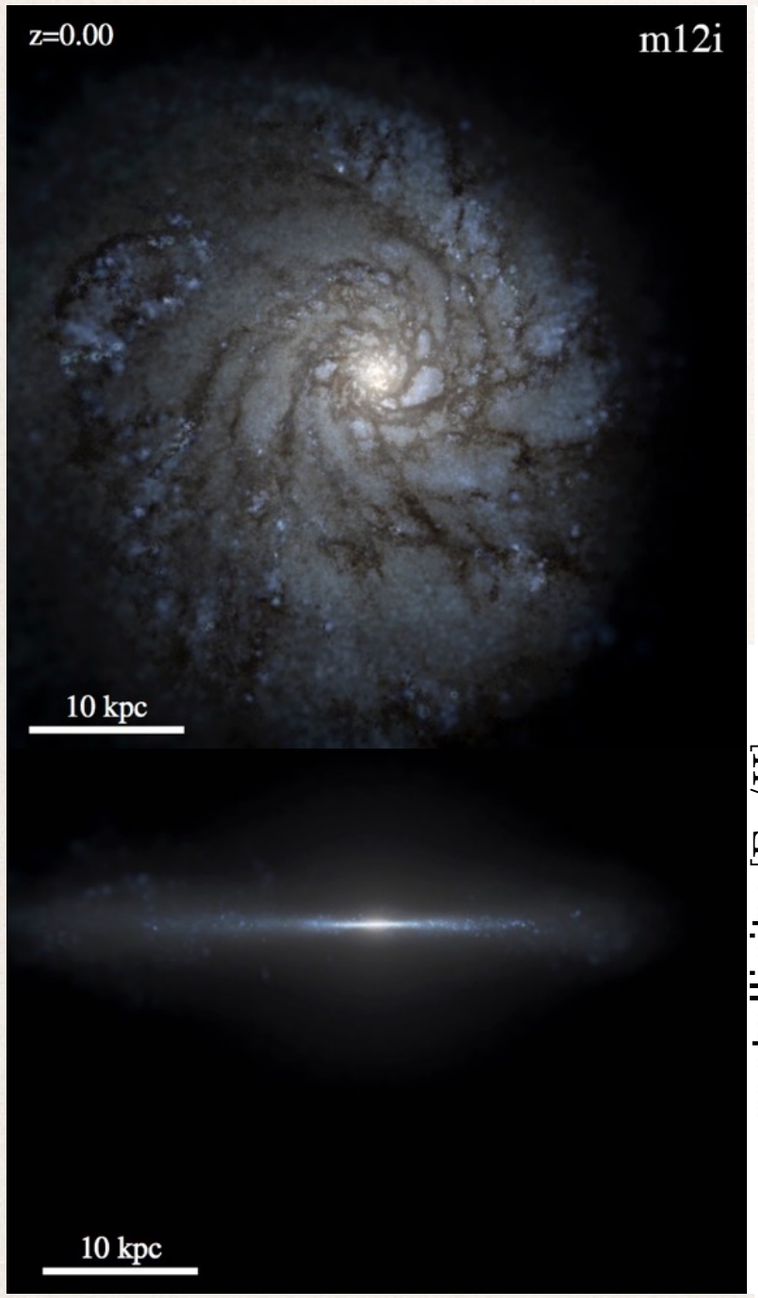

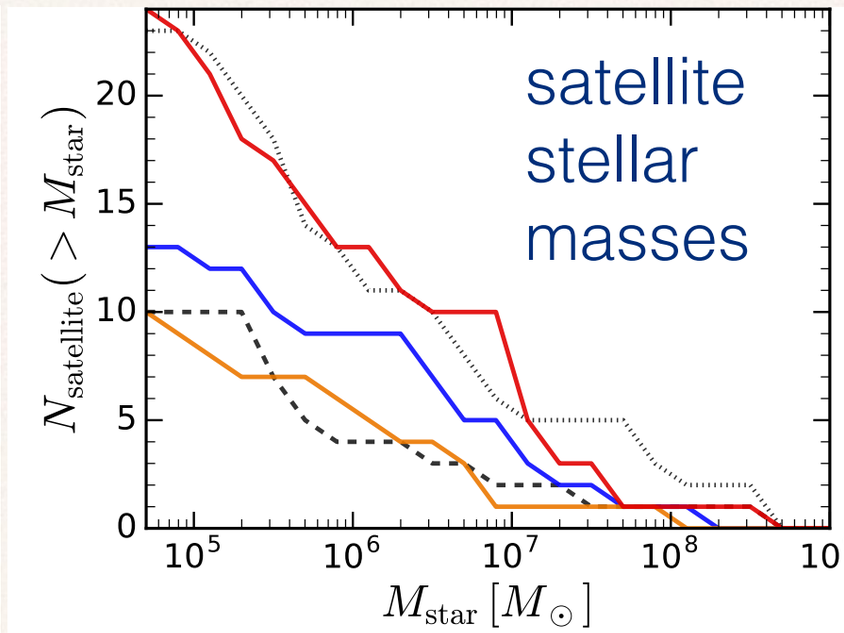

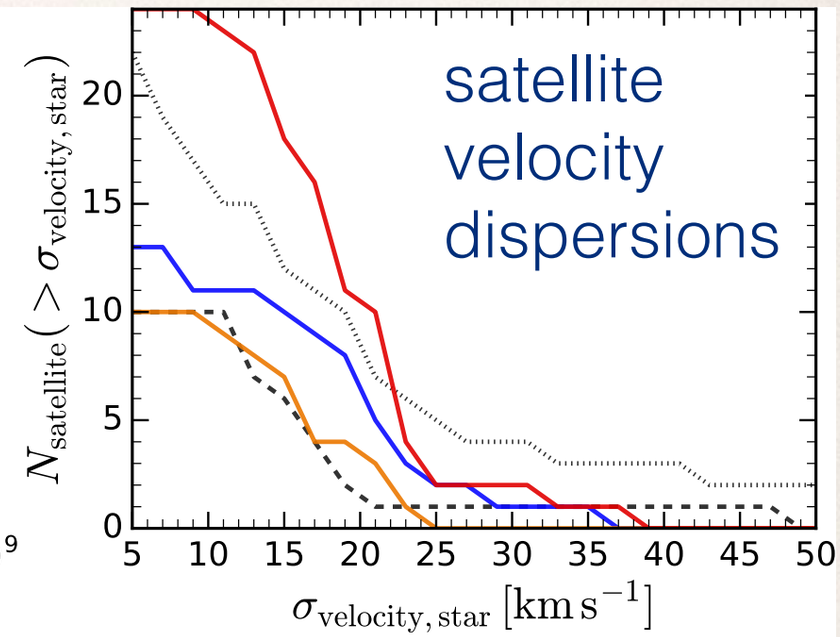

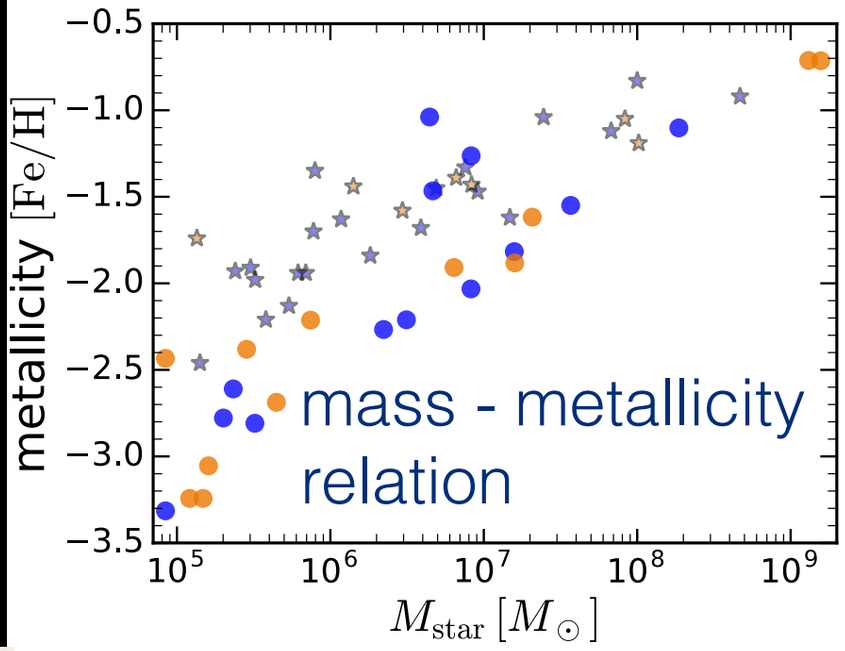

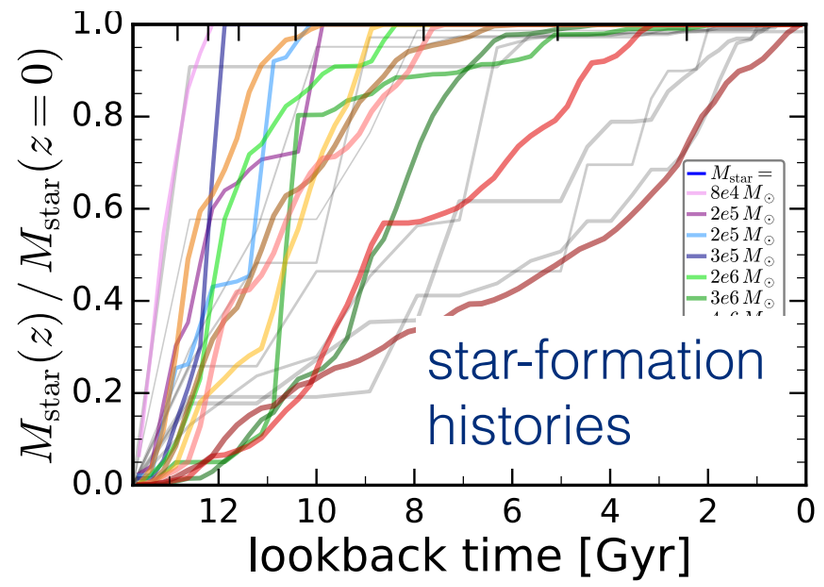

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