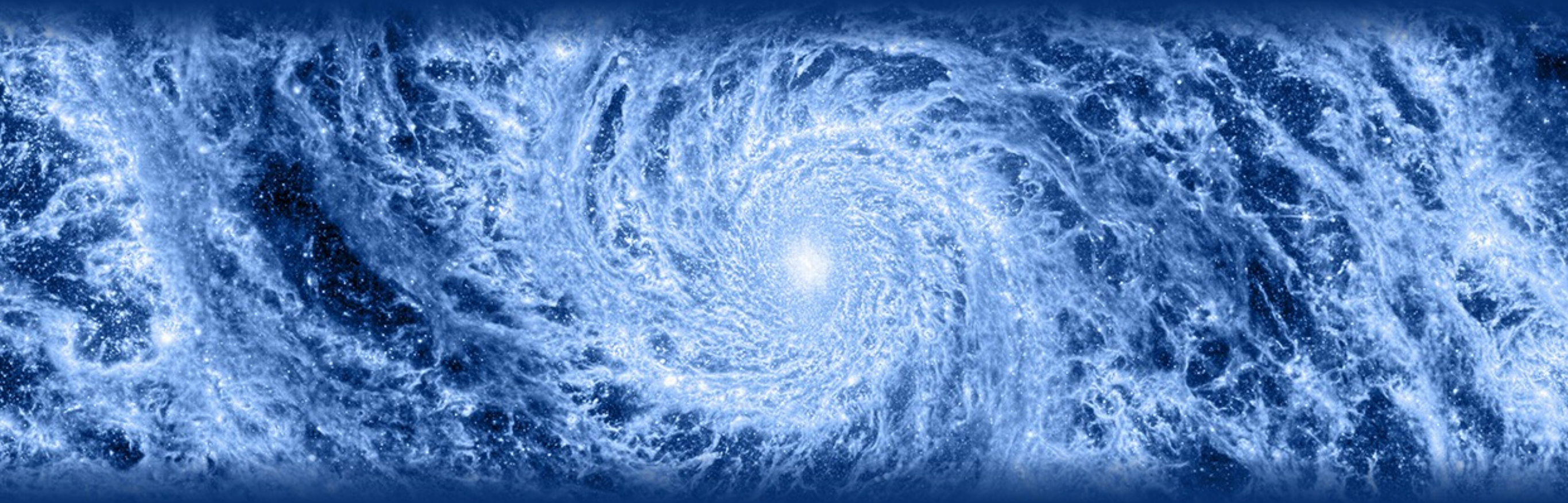


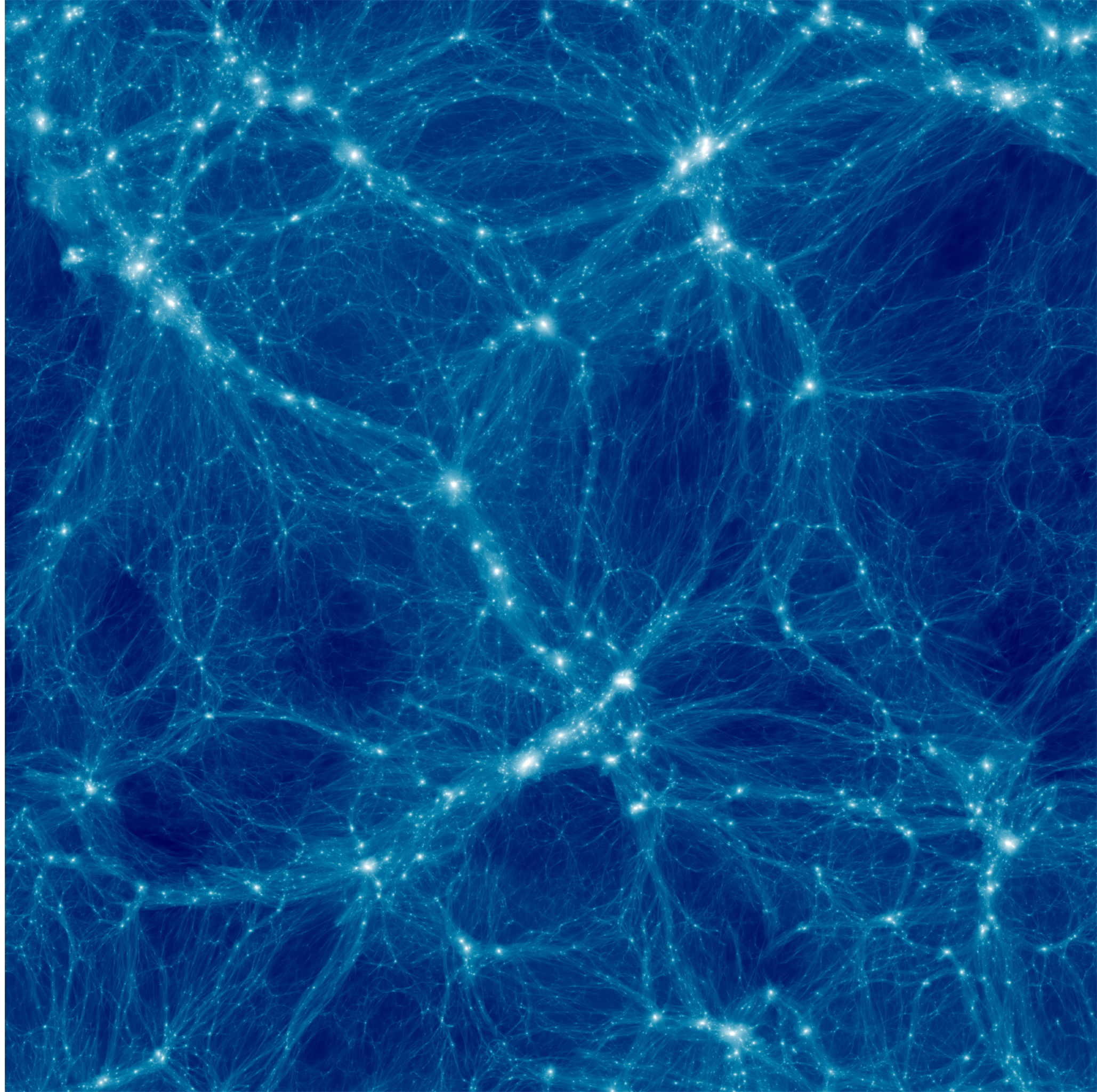
Galaxies

Prof. Benedikt Diemer



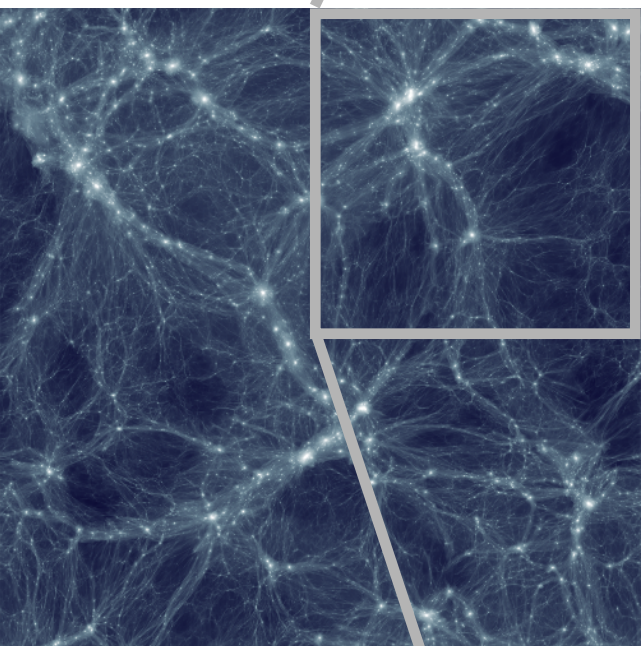
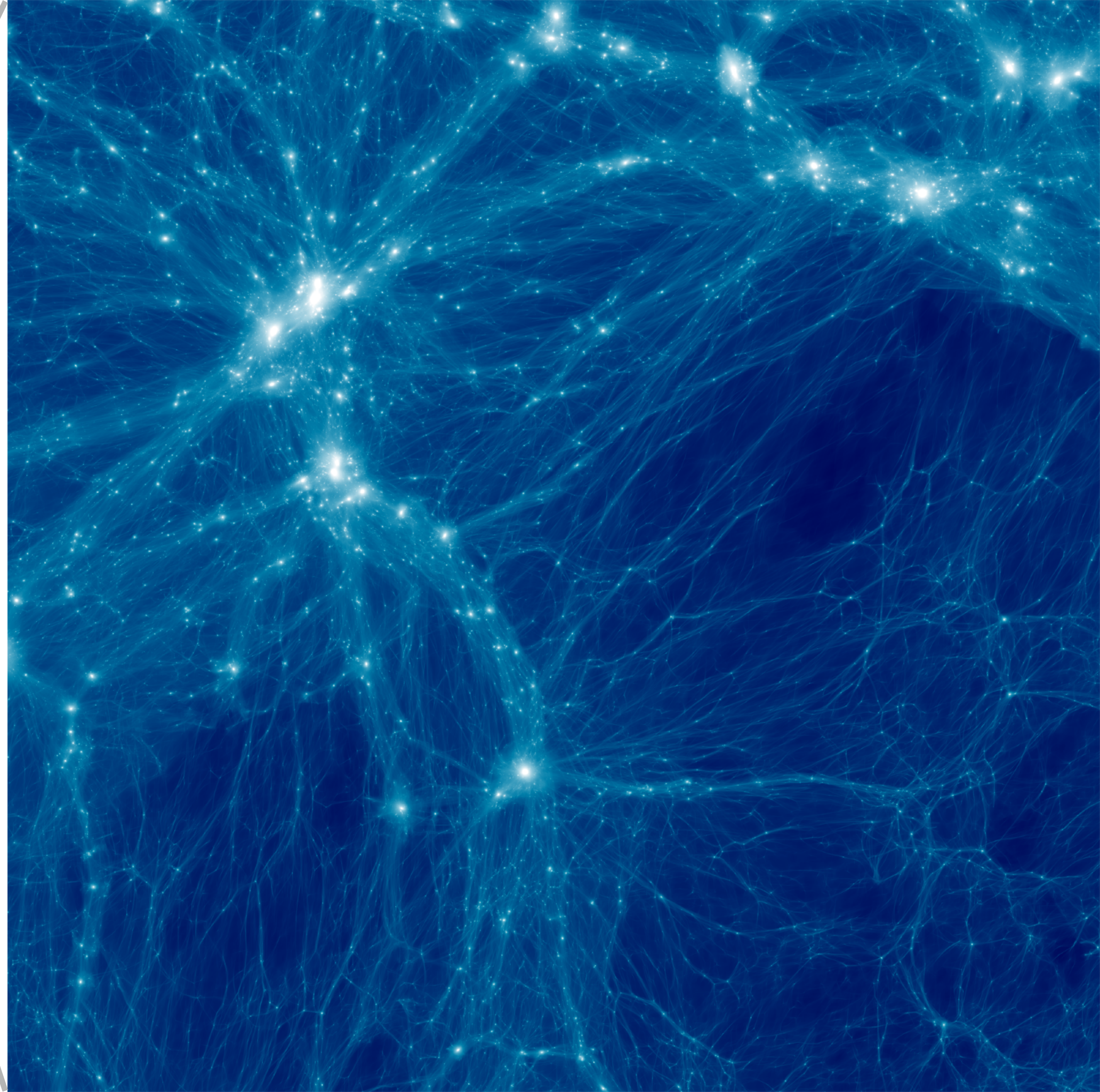
Chapter 5 • The galaxy-halo connection

Dark matter simulation



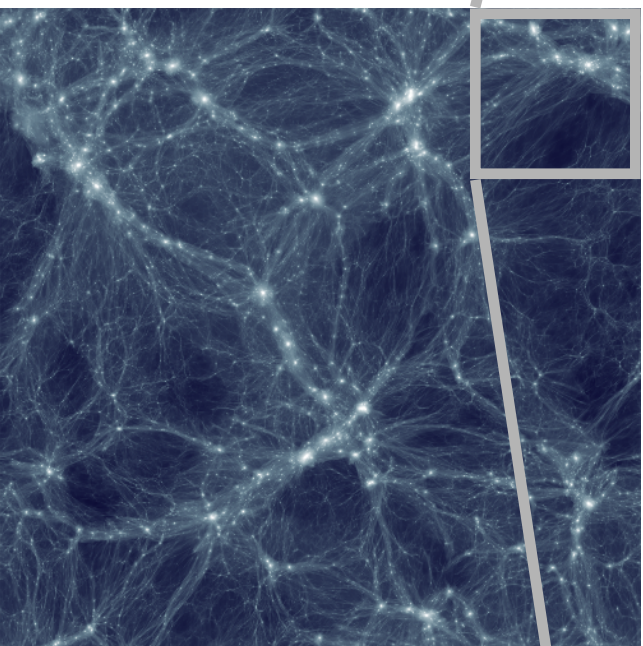
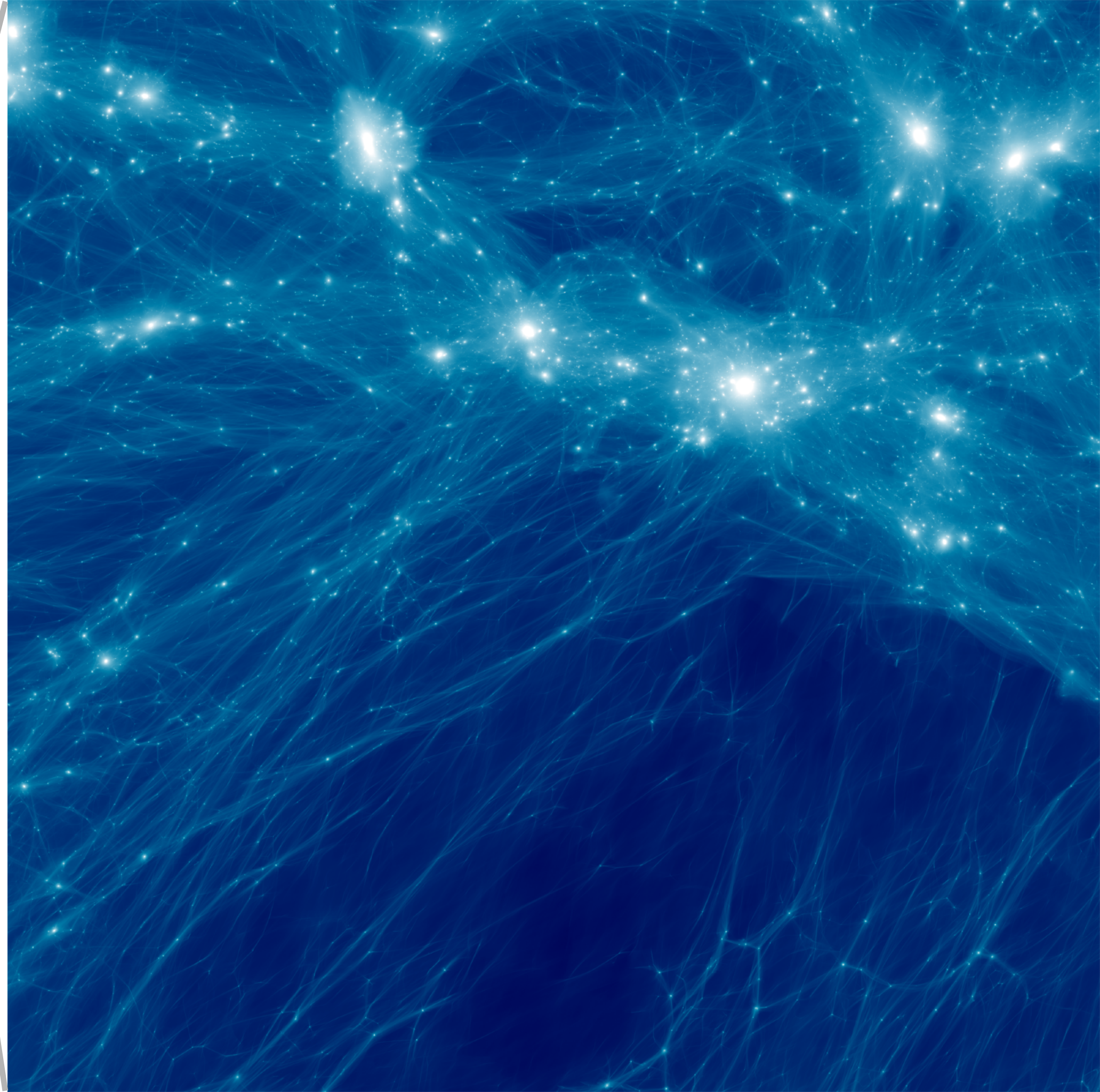
Visualization code:
Phil Mansfield

Dark matter simulation



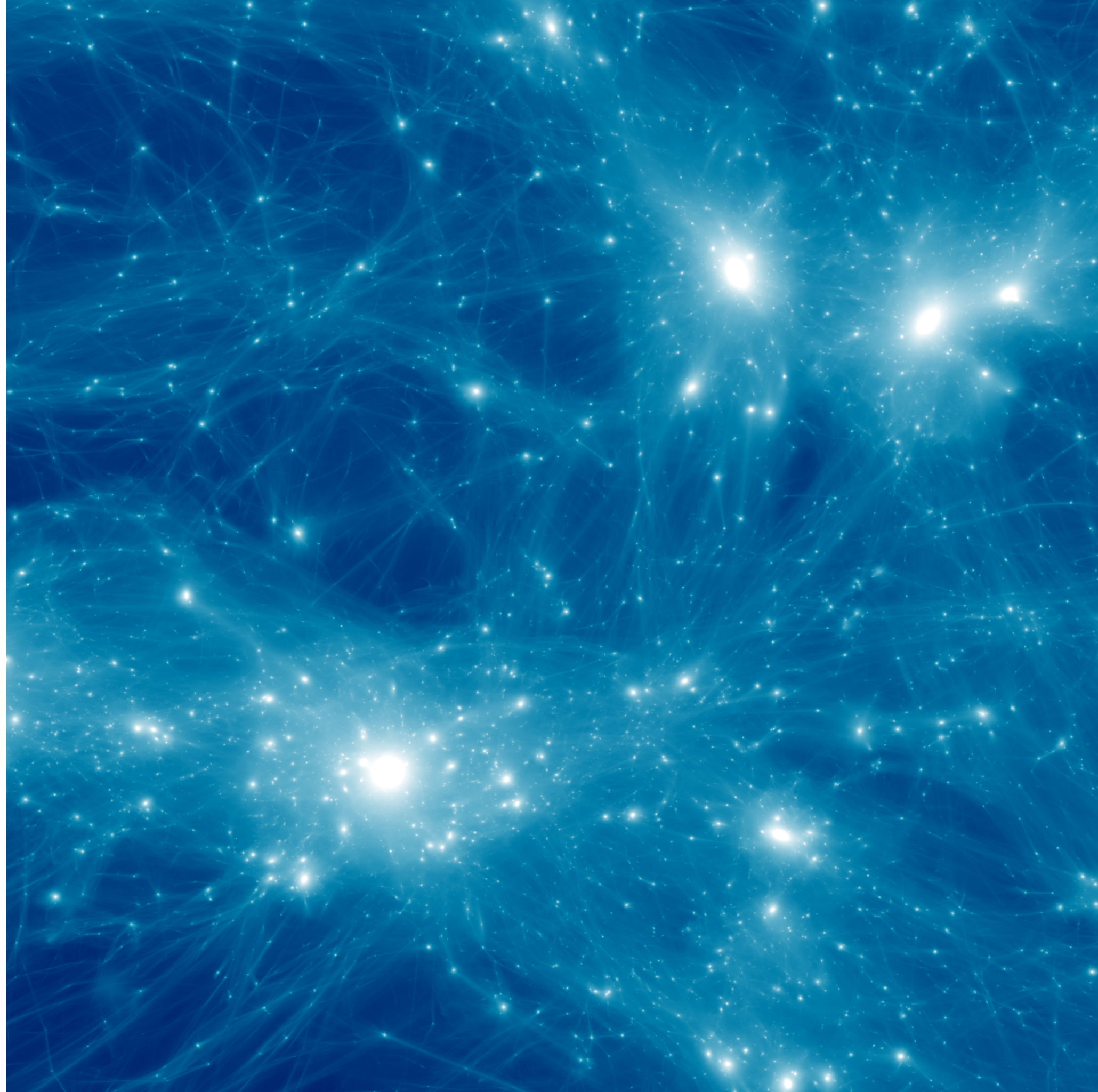
Visualization code:
Phil Mansfield

Dark matter simulation



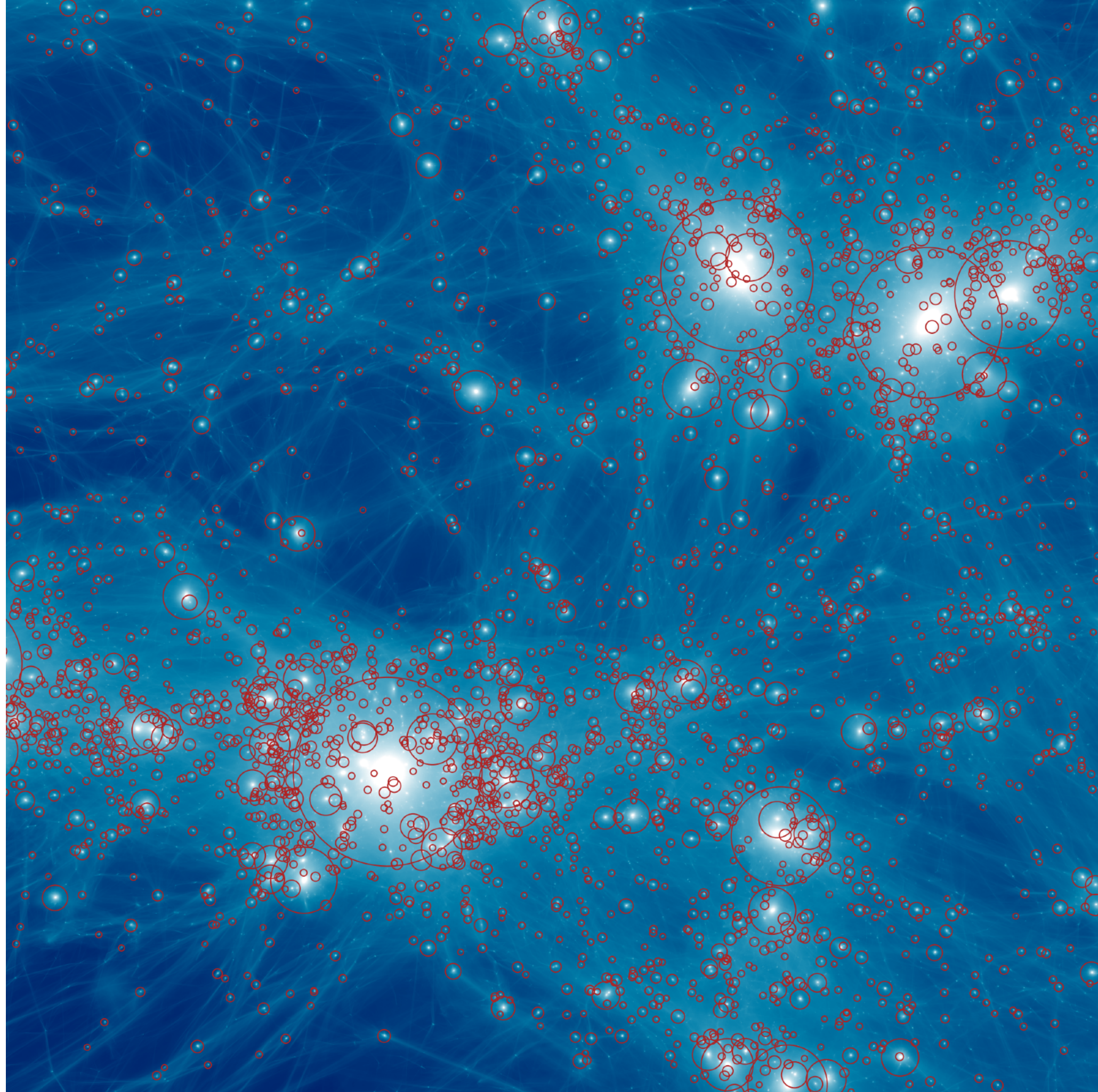
Visualization code:
Phil Mansfield

Dark matter simulation



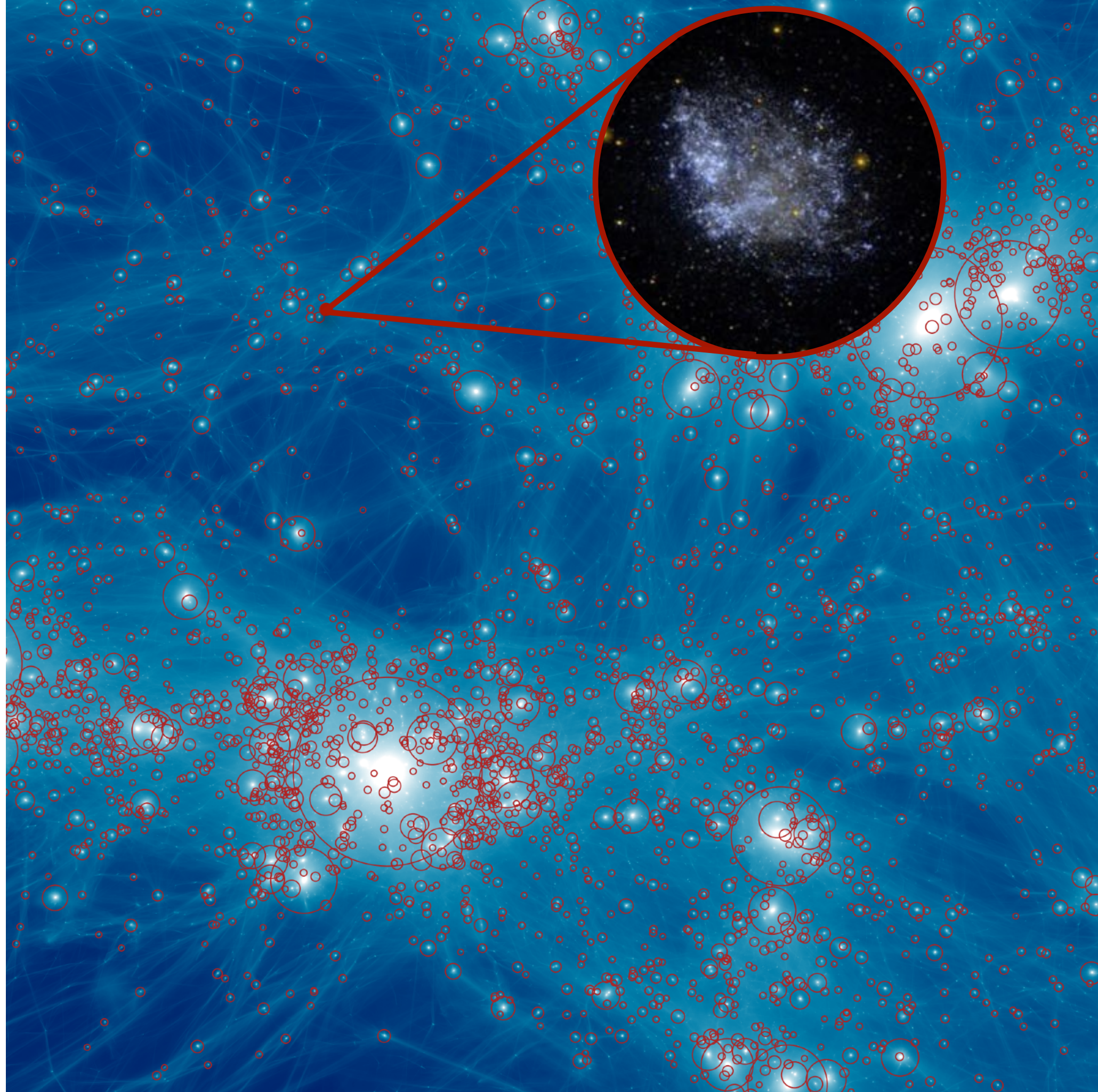
Visualization code:
Phil Mansfield

Dark matter simulation



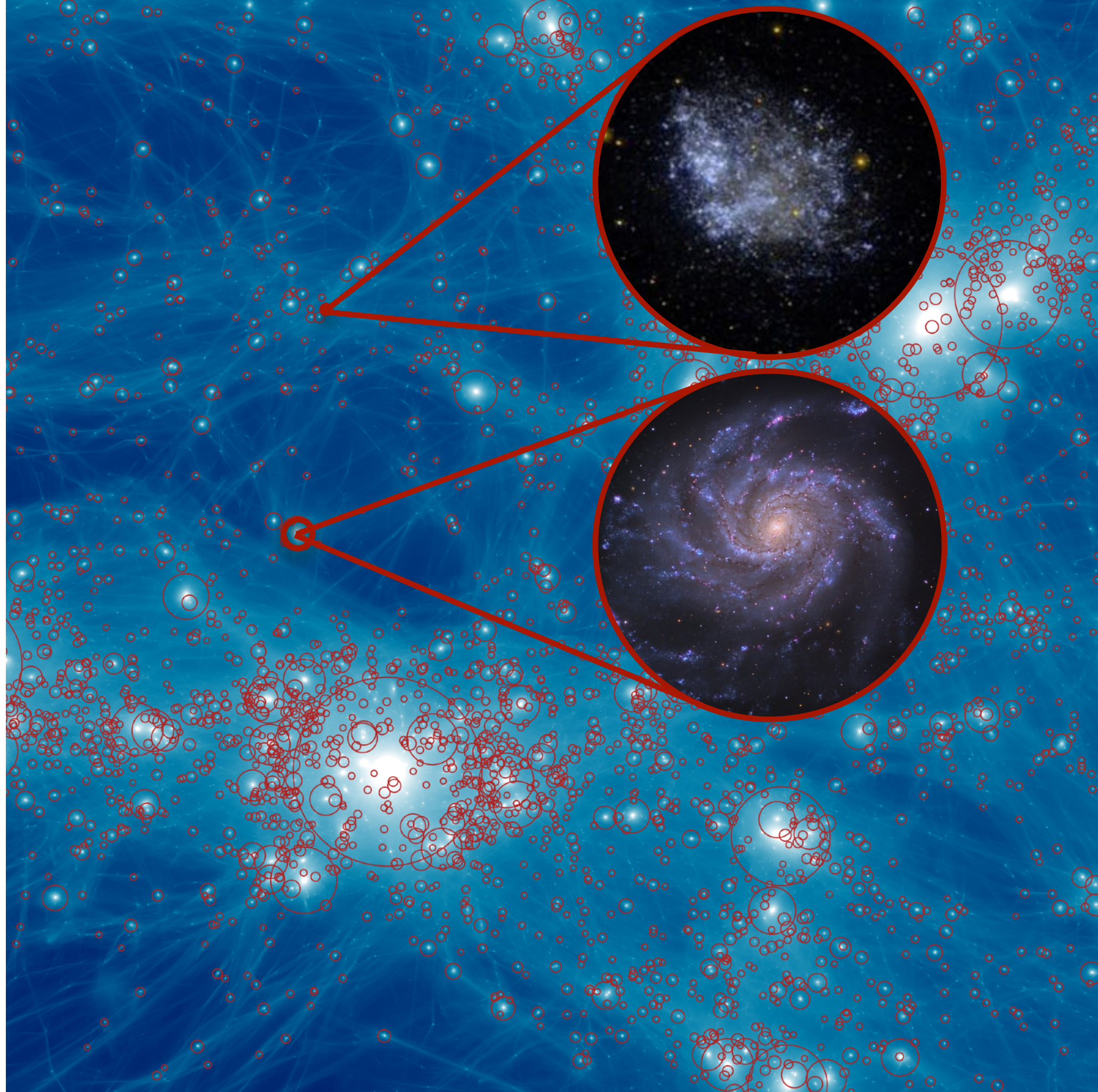
Visualization code:
Phil Mansfield

Dark matter simulation



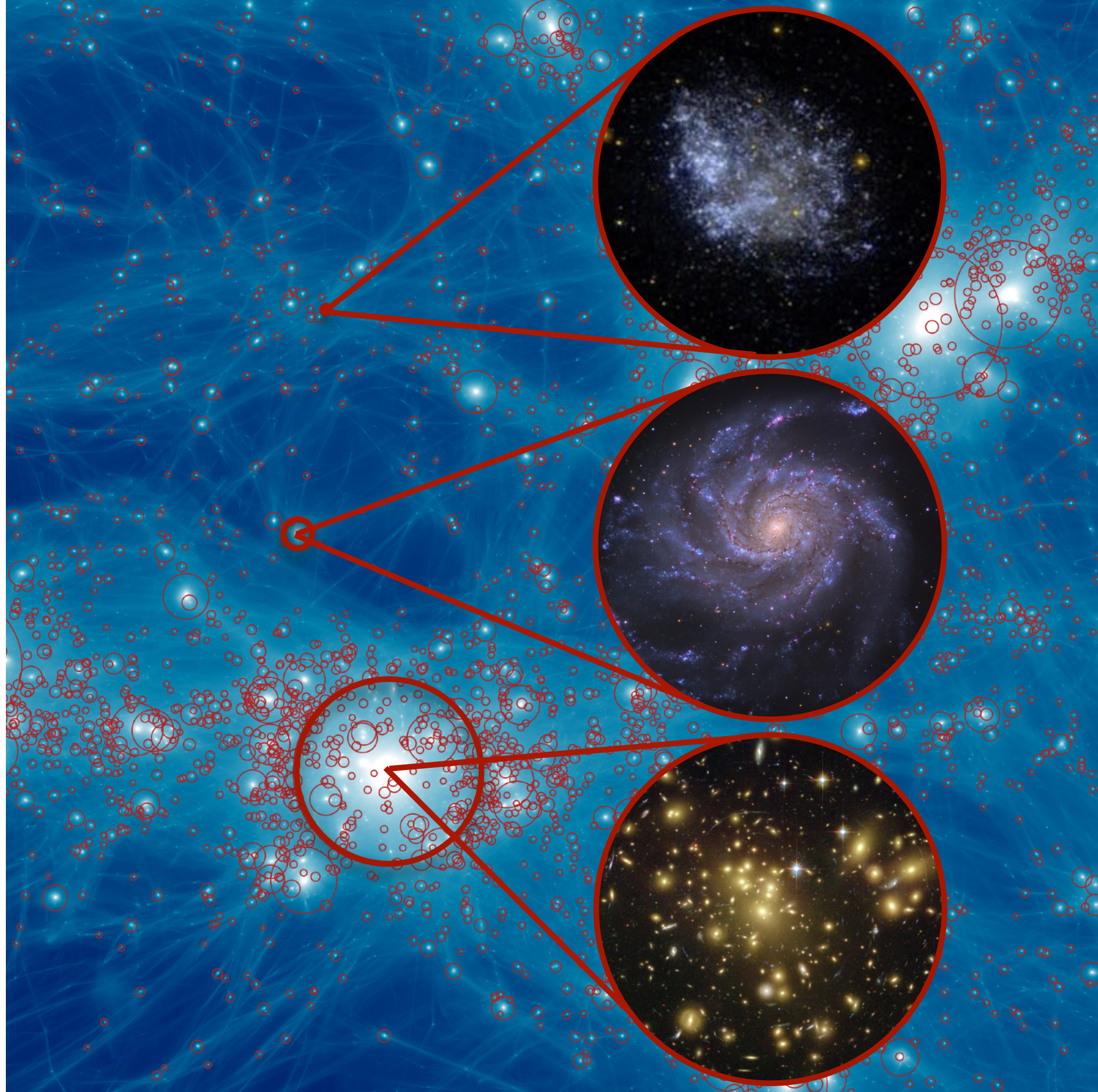
Visualization code:
Phil Mansfield

Dark matter simulation



Visualization code:
Phil Mansfield

Dark matter simulation

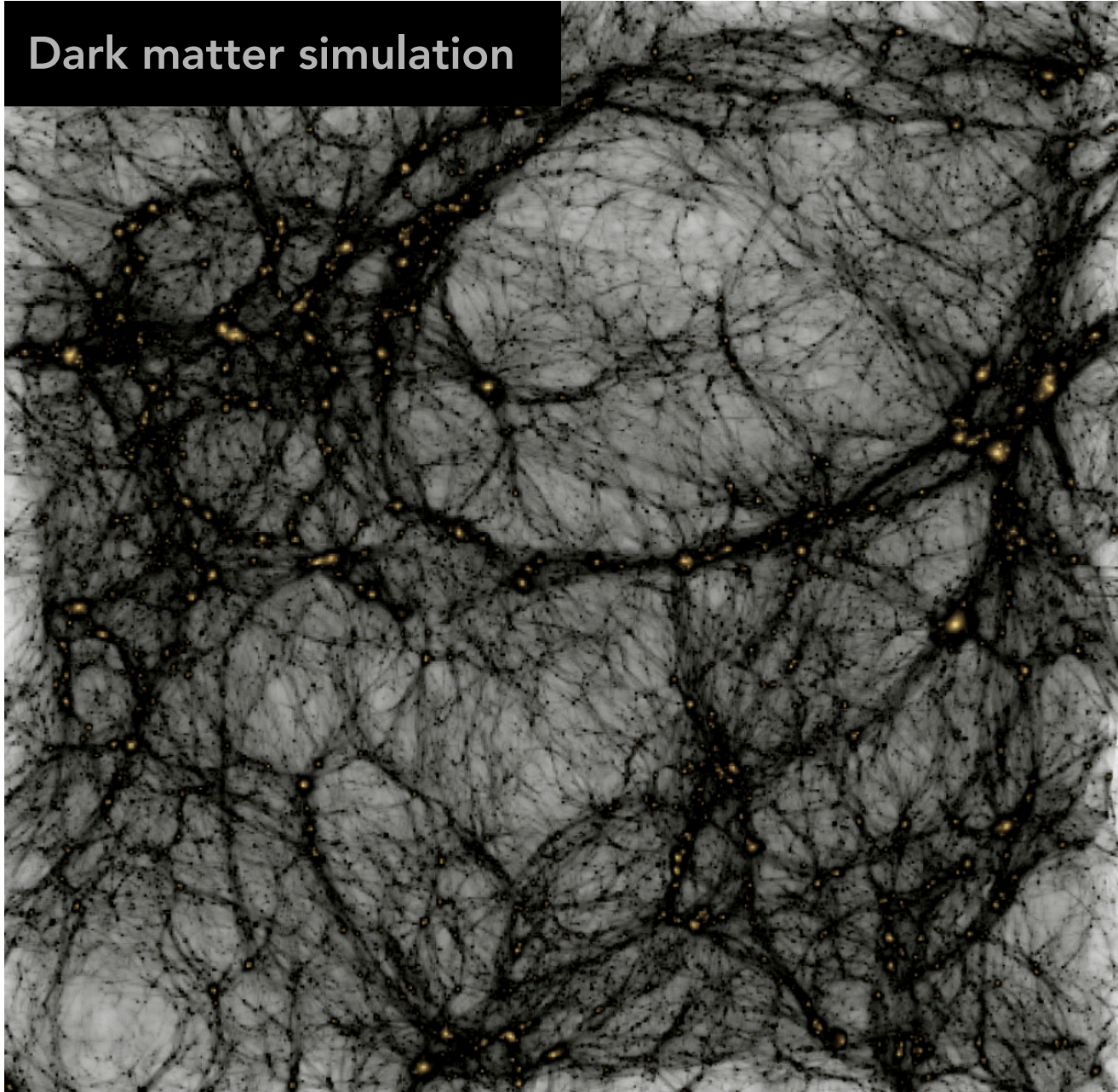


Visualization code:
Phil Mansfield

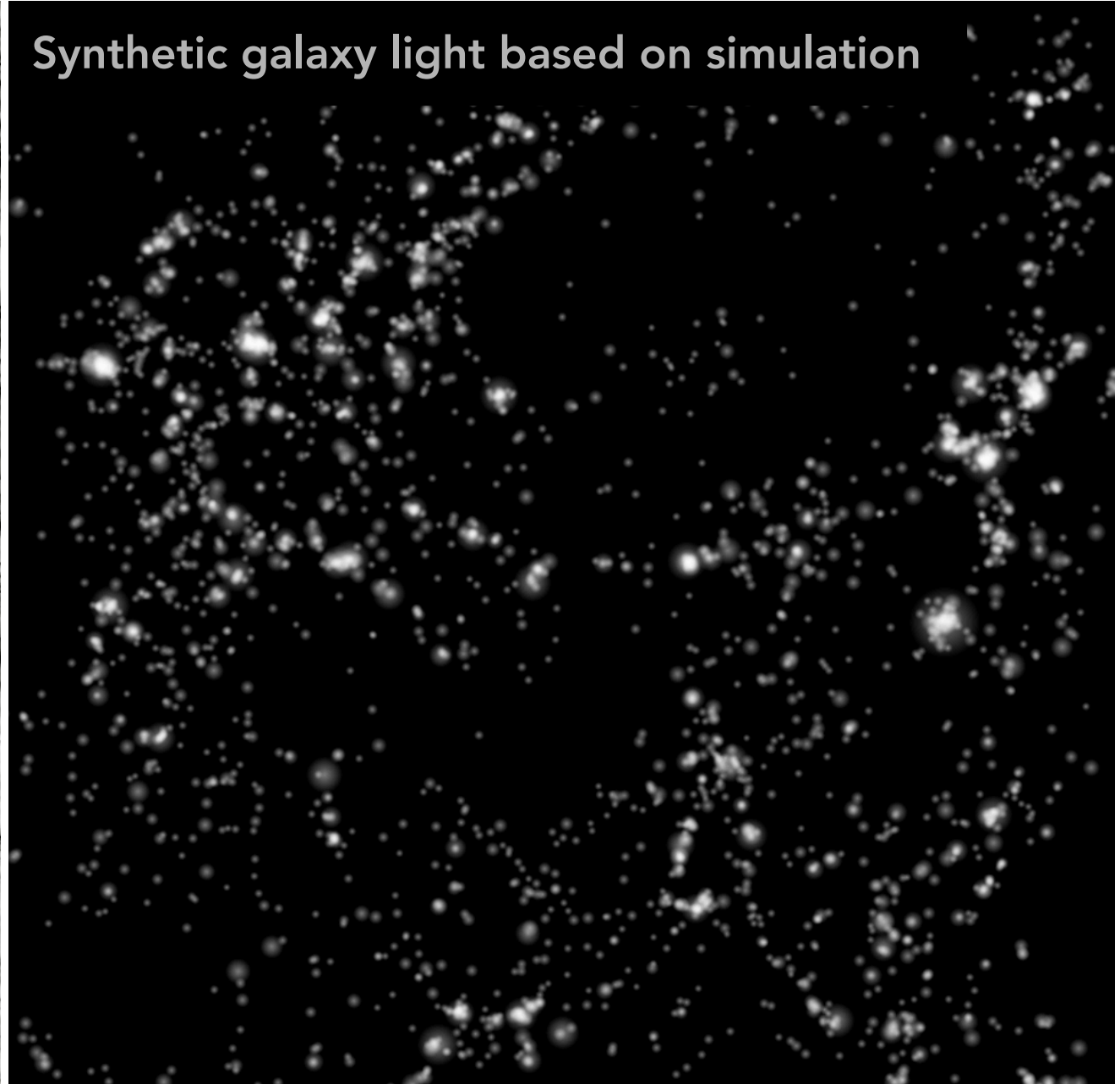
§5.1 • A simple model: abundance matching

Galaxy-halo connection

Dark matter simulation



Synthetic galaxy light based on simulation



- Simple recipe: **measure galaxy luminosities**, count how many galaxies are how luminous
- **Find halos** in simulation of cosmic web
- Assign **largest luminosity to biggest halo**, second-largest luminosity to second-biggest and so on
- Very simplistic! There are more complicated methods as well

Abundance matching

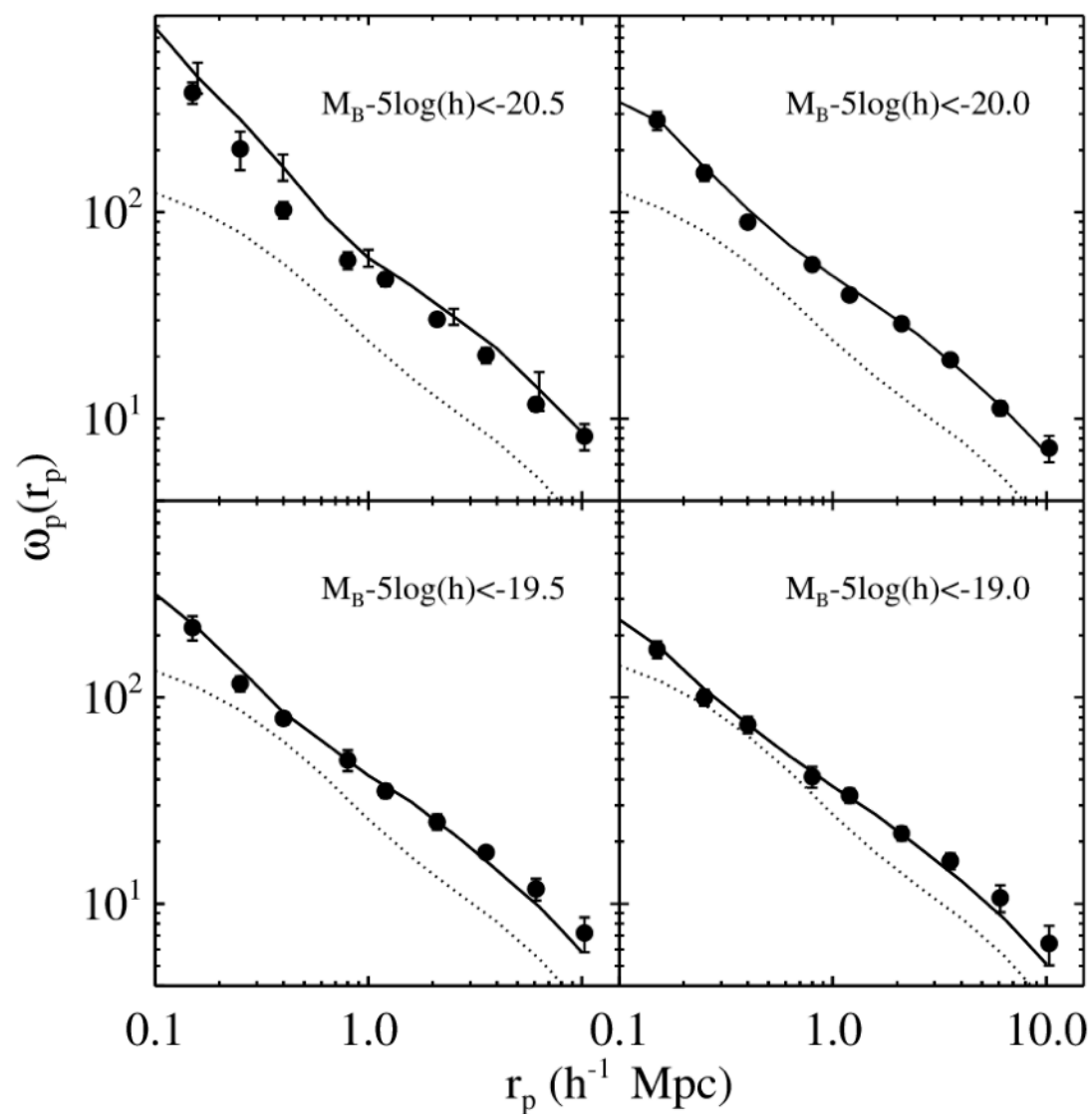
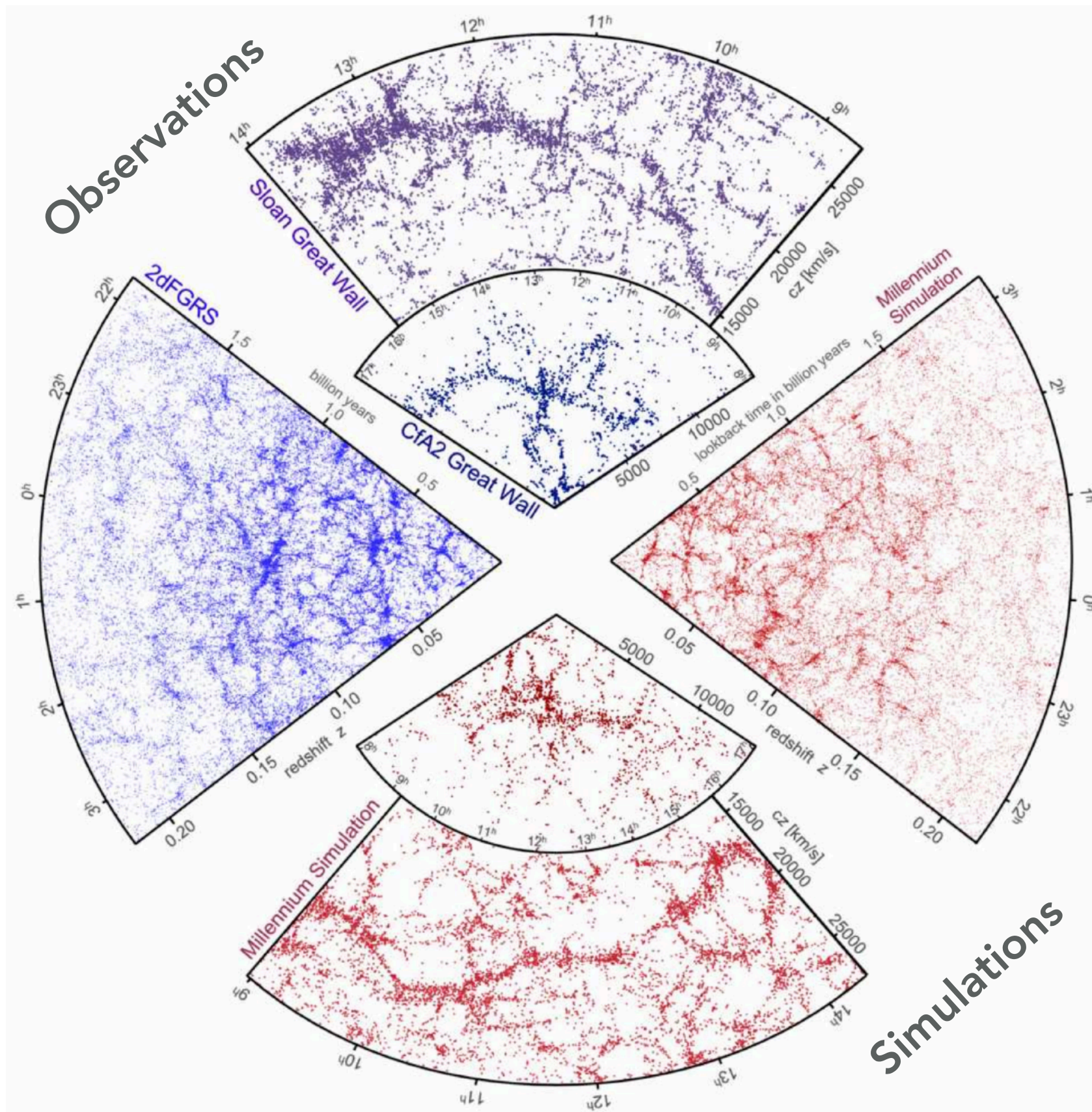


FIG. 6.—Projected two-point correlation function at $z \sim 1$ for DEEP2 galaxies (circles) and halos (solid lines), at four different luminosity thresholds. We include jackknife errors, computed using the eight octants of the simulation cube, on the model prediction for the brightest sample to demonstrate that they agree within 1σ . The excellent agreement on all scales for these four samples suggests that luminosity-dependent clustering is a result of two effects: a simple relation between galaxy luminosities and dark matter halos, and the spatial clustering of the halos. For comparison, we include the correlation function of dark matter particles (dotted lines).

better match to the data. Overall the agreement is excellent on all scales for all four samples.⁸

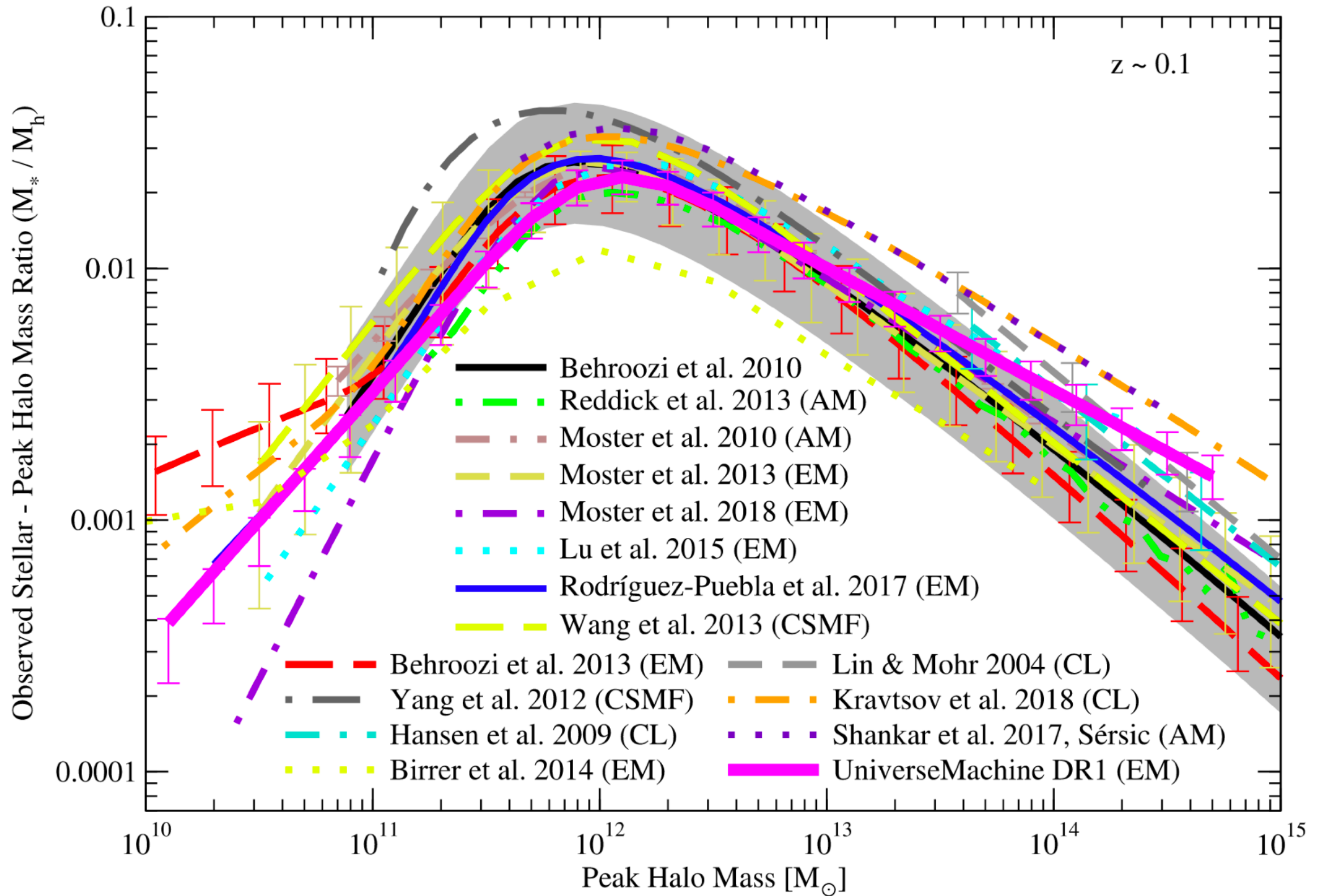
⁸ Booyah!

Observations vs. simulations



§5.2 • The stellar mass-halo mass relation

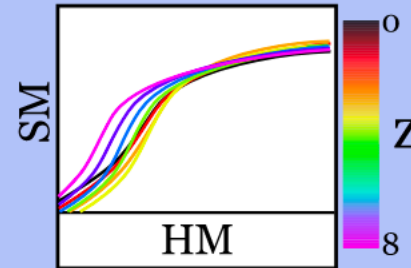
Stellar mass-halo mass relation



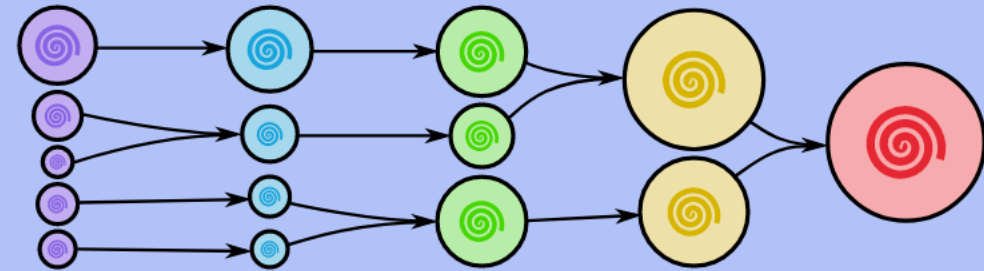
"Advanced abundance matching"

Markov Chain Monte Carlo

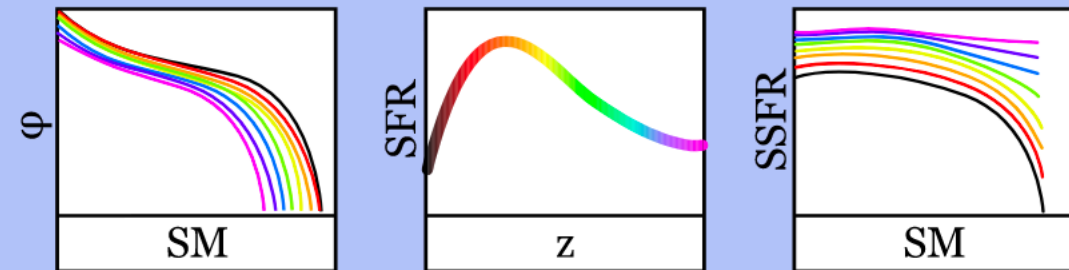
1. Choose a stellar mass - halo mass (SMHM) relation from parameter space.



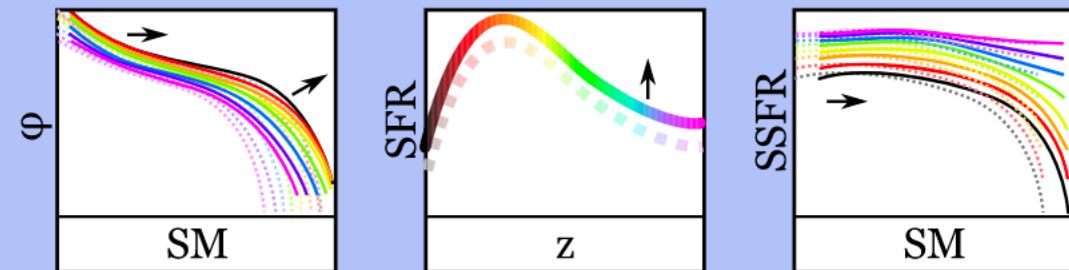
2. Find galaxy growth histories by applying the SMHM relation to dark matter merger trees.



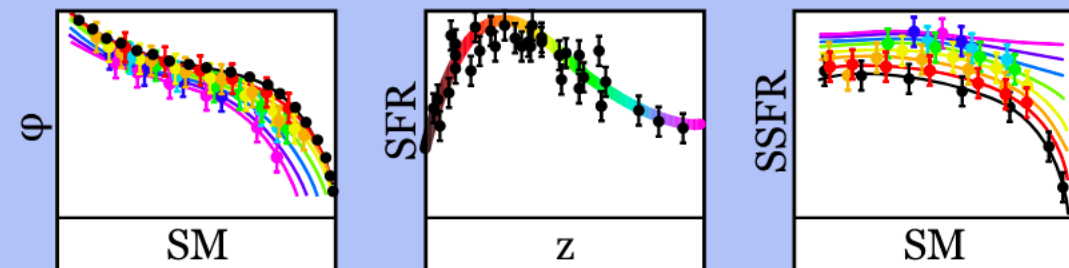
3. Derive the inferred stellar mass functions and star formation rates.



4. Apply effects to simulate observational errors and biases.

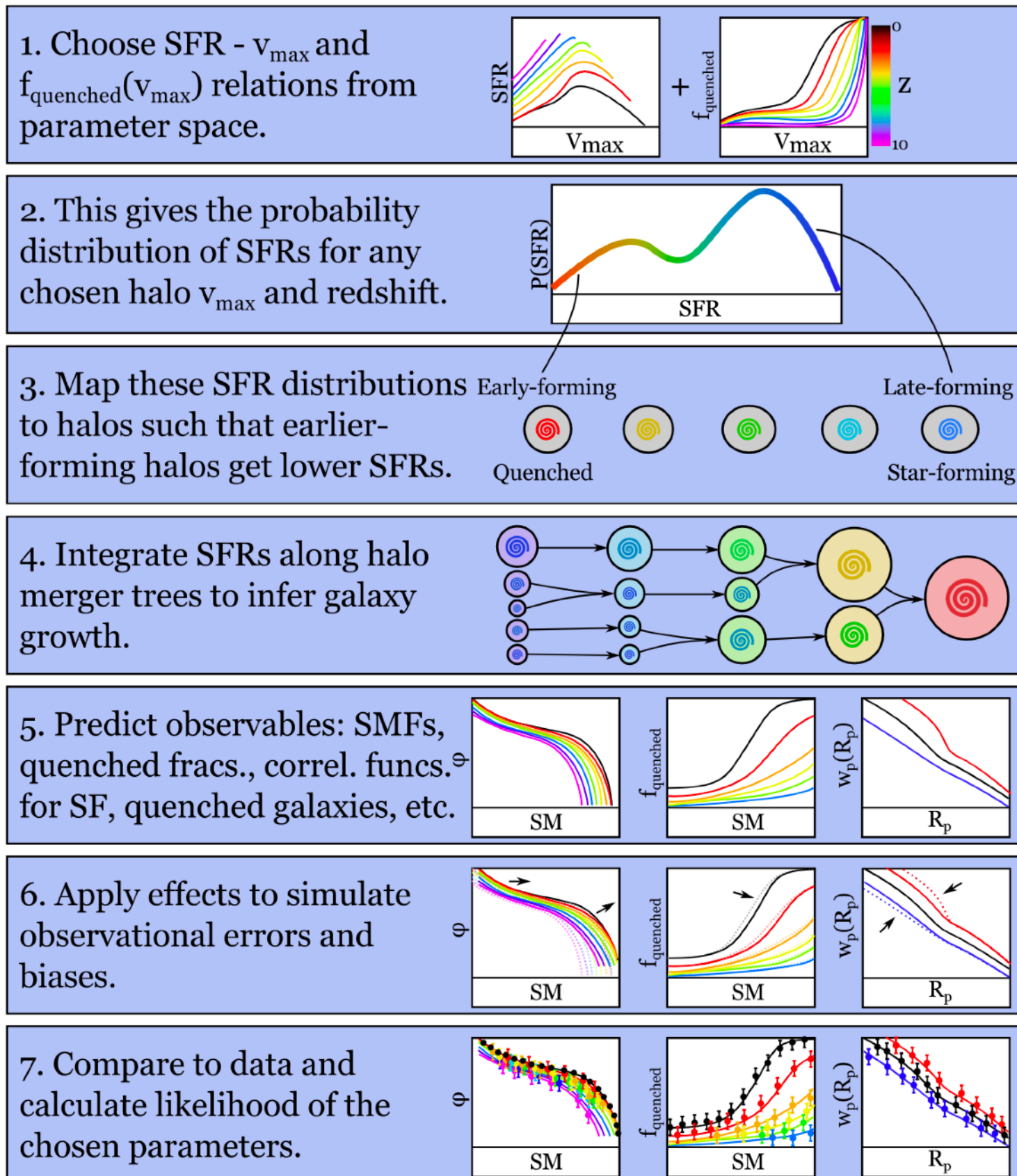


5. Compare to data and calculate likelihood of the chosen SMHM relation.

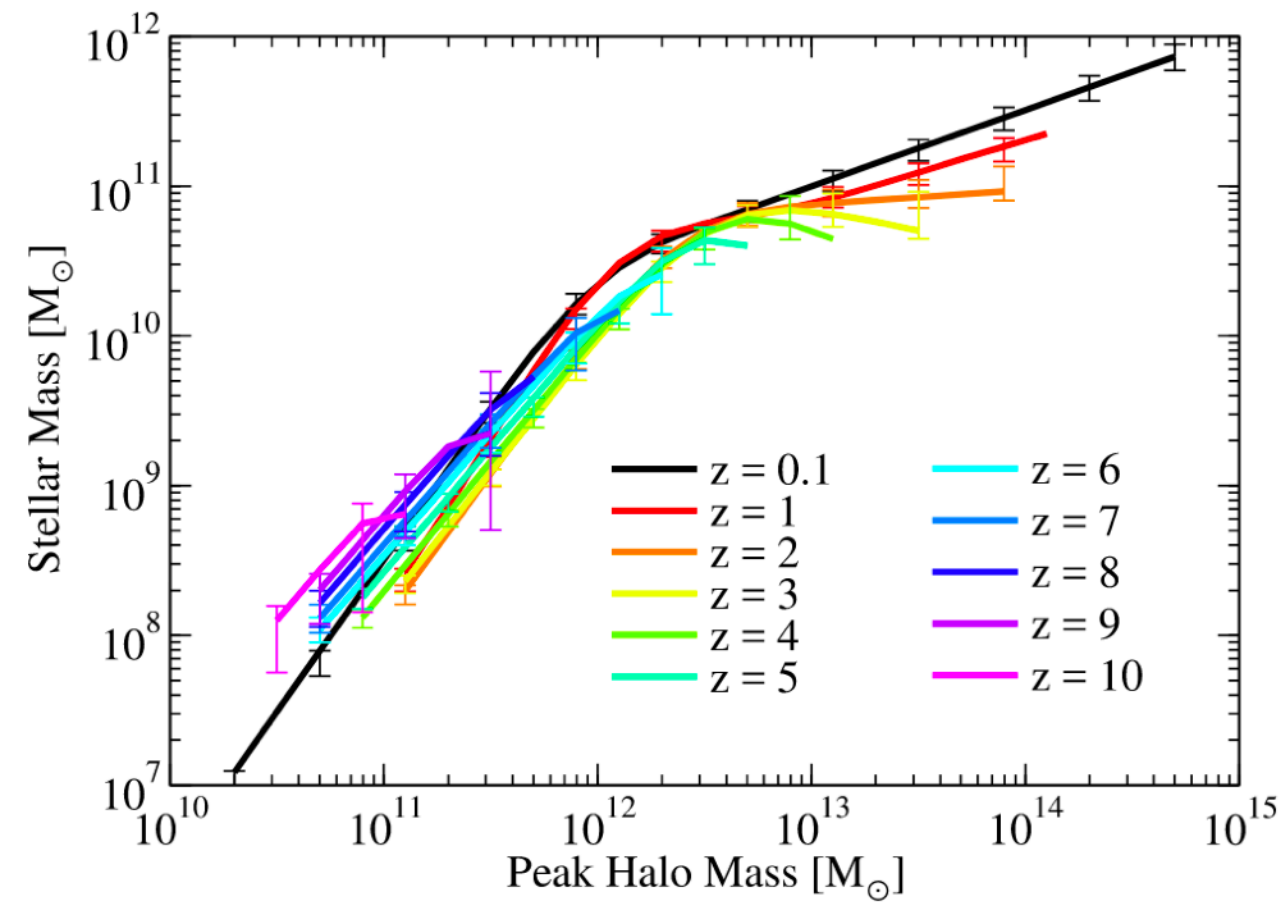
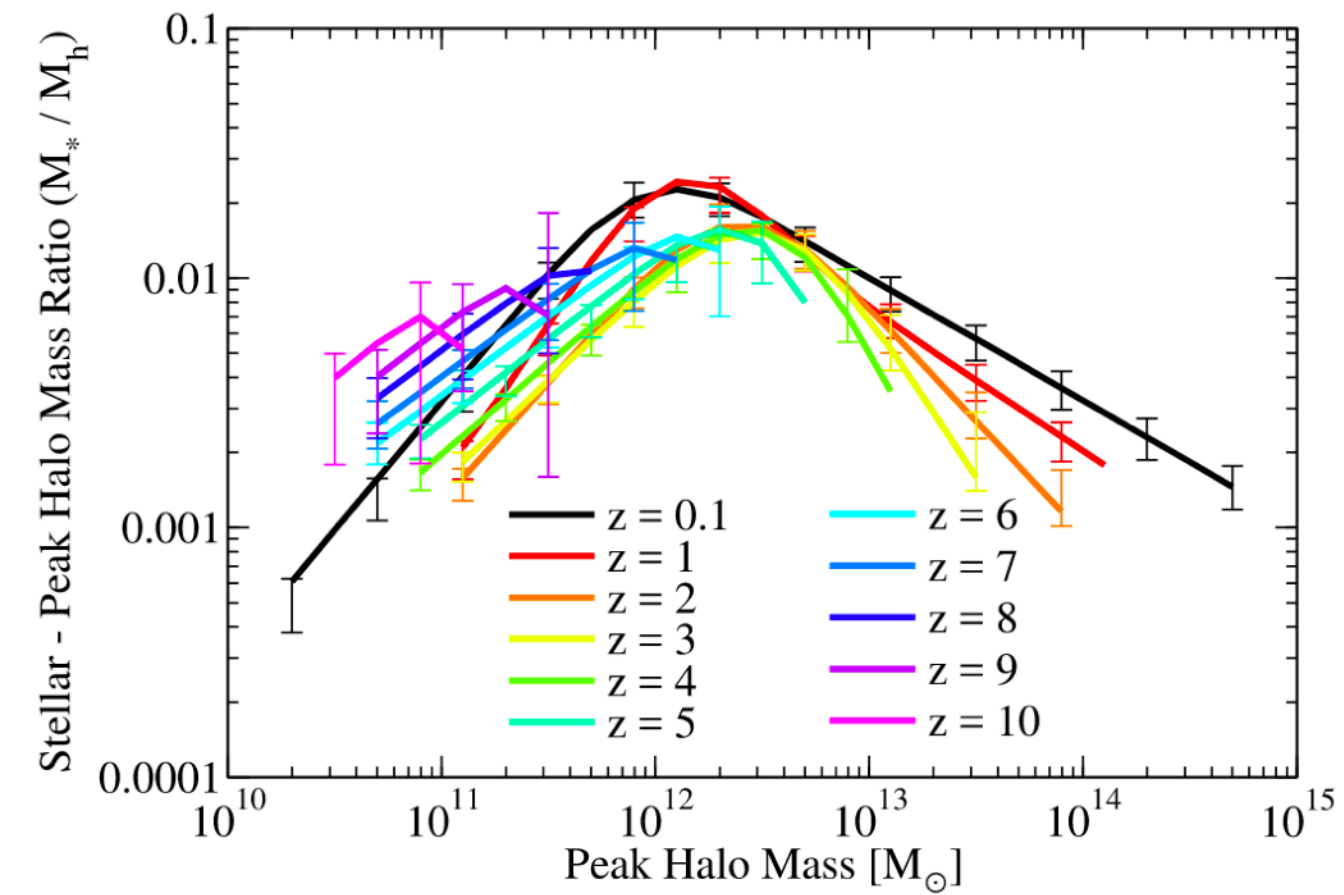


"Advanced abundance matching"

Markov Chain Monte Carlo



Stellar mass-halo mass relation



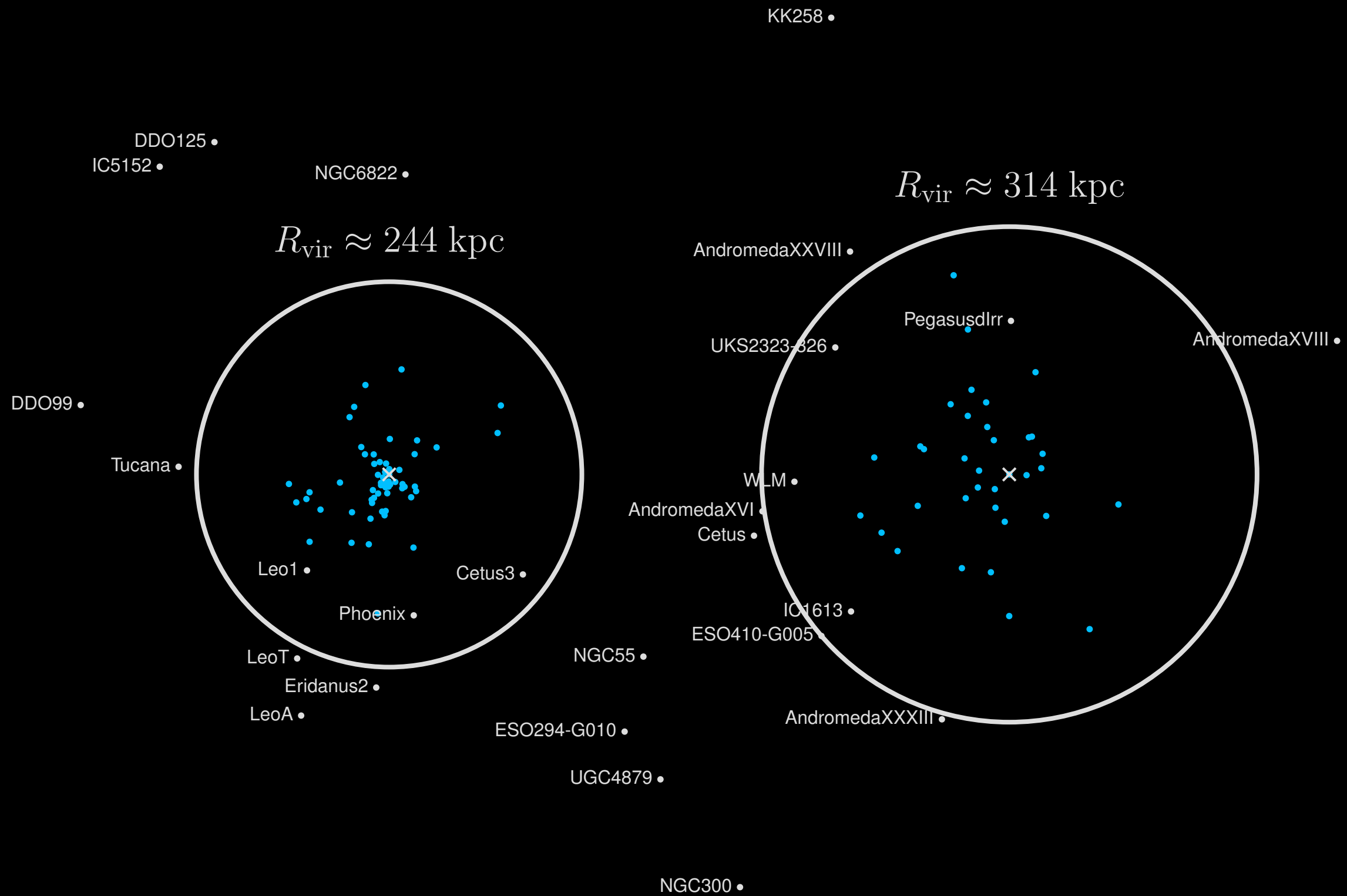
$z = 3.6$

$T = 1.78 \text{ Gyr}$

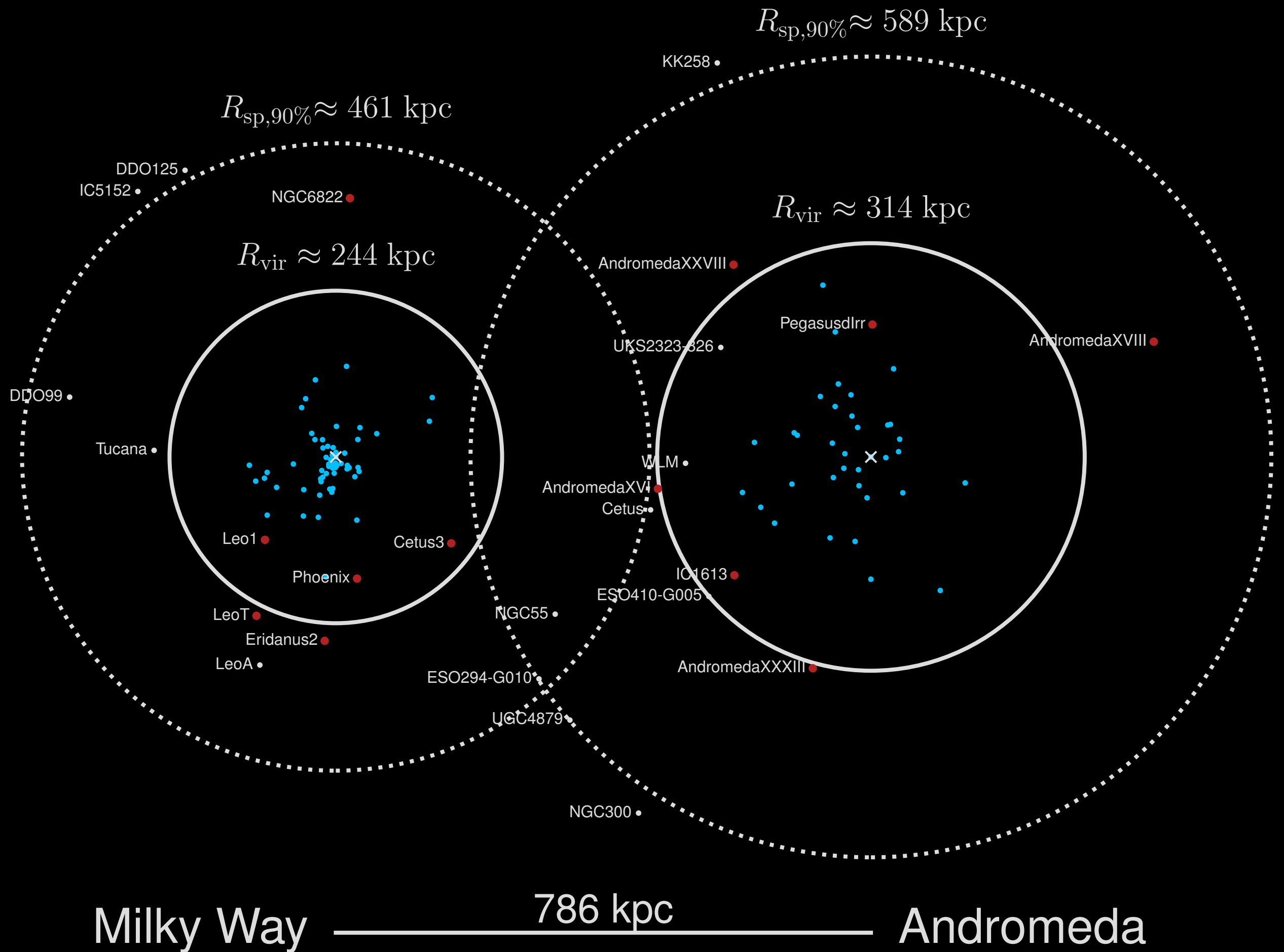


500 kpc

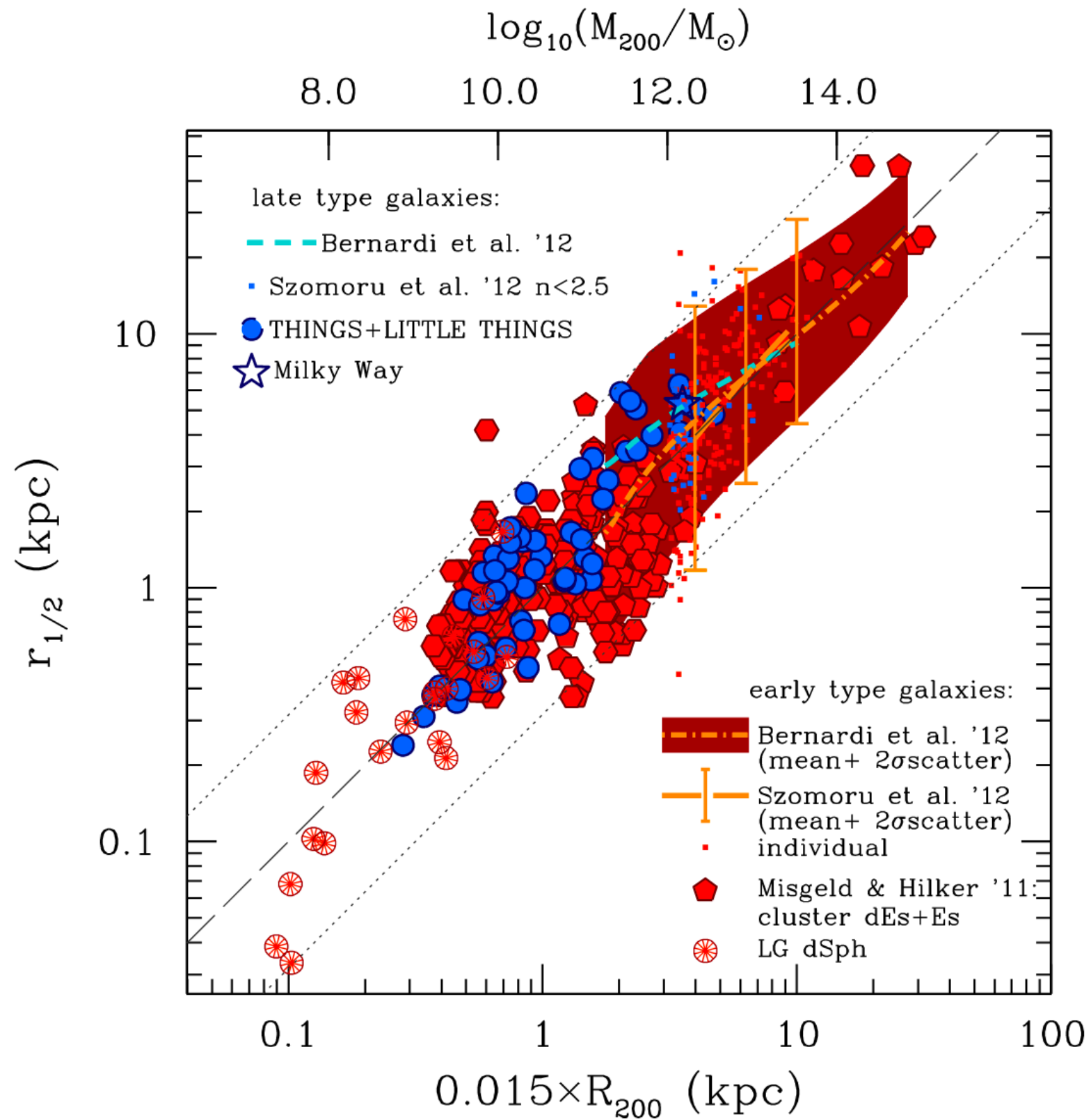
Aquarius Simulation, Springel et al. 2008 ([youtube](#))



Milky Way 786 kpc Andromeda



Size-size relation



Reading

- CFN §10.10.1
- MvdBW §15.3