

Baryonic Effects on SIDM Simulations

Ryan Low

N-Body Simulations of 2-Component Dark Matter

Overview

- Baryonic Physics in Simulation
 - Necessity of Baryonic Physics
 - Differences in implementation
 - CAMELS
- Can Baryonic Effects be Disentangled from SIDM Effects?
 - Elastic SIDM
 - 2 Inelastic Models
- Effects of IllustrisTNG on Λ CDM Simulations
 - Halo Statistics
 - Velocity Dispersion
 - Matter Power Spectra

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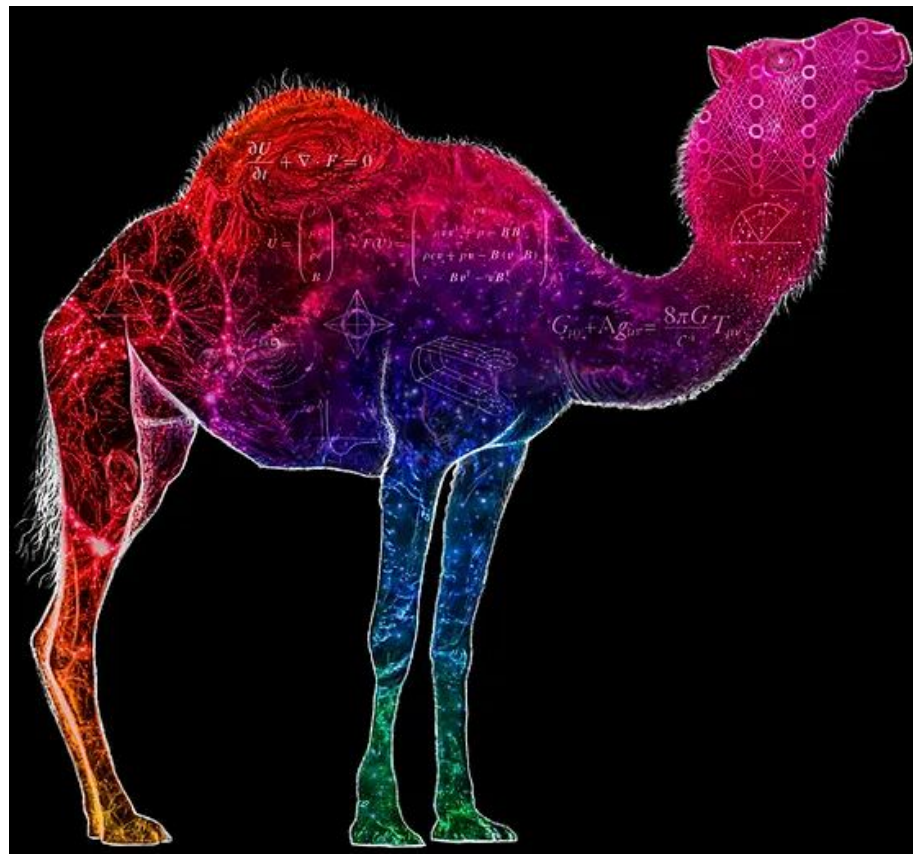
Simulating Baryons

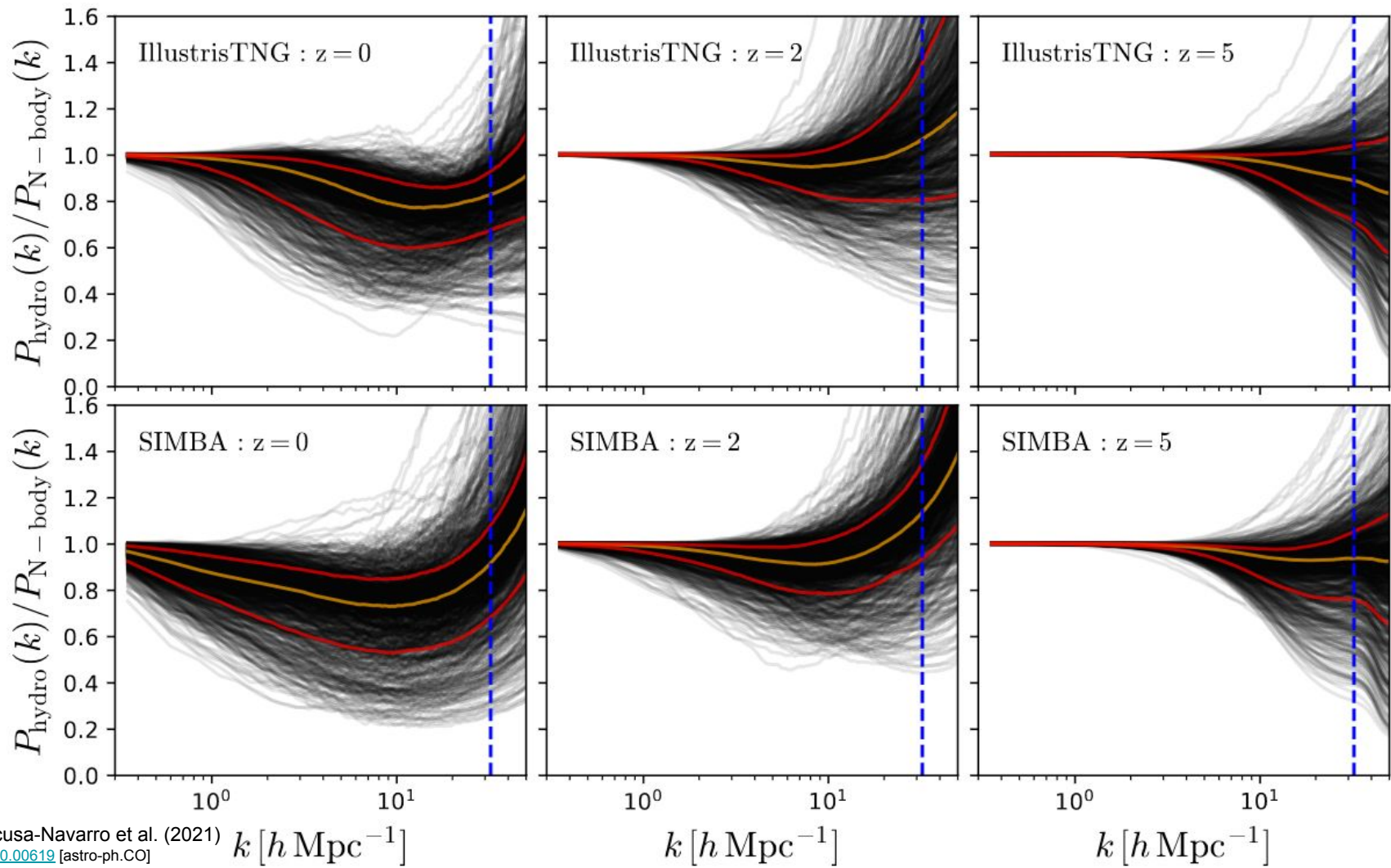
- Obviously, the universe has baryons!
- Simulating baryons is expensive however...
 - Behaviors at different scales
 - Solving magnetohydrodynamics coupled to gravity
 - Formation of stars, black holes, etc.
 - Orders of magnitude greater computational time!
- Generally,
 - Baryonic mass deepens potentials
 - Stellar feedback and winds can drive mass away from halos

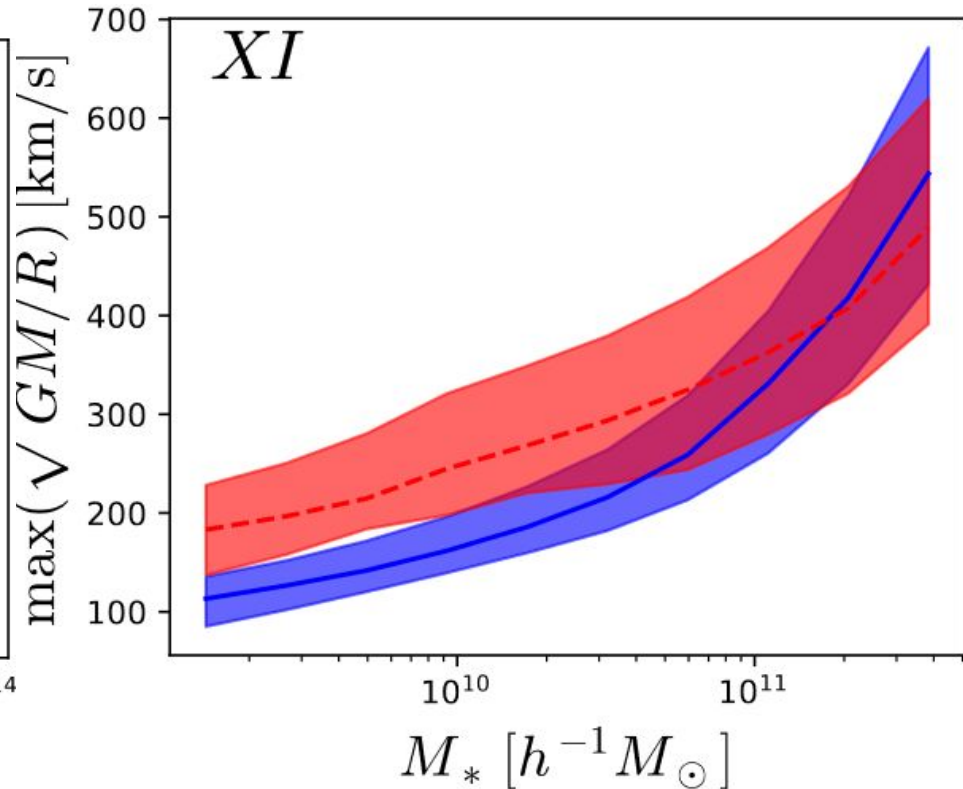
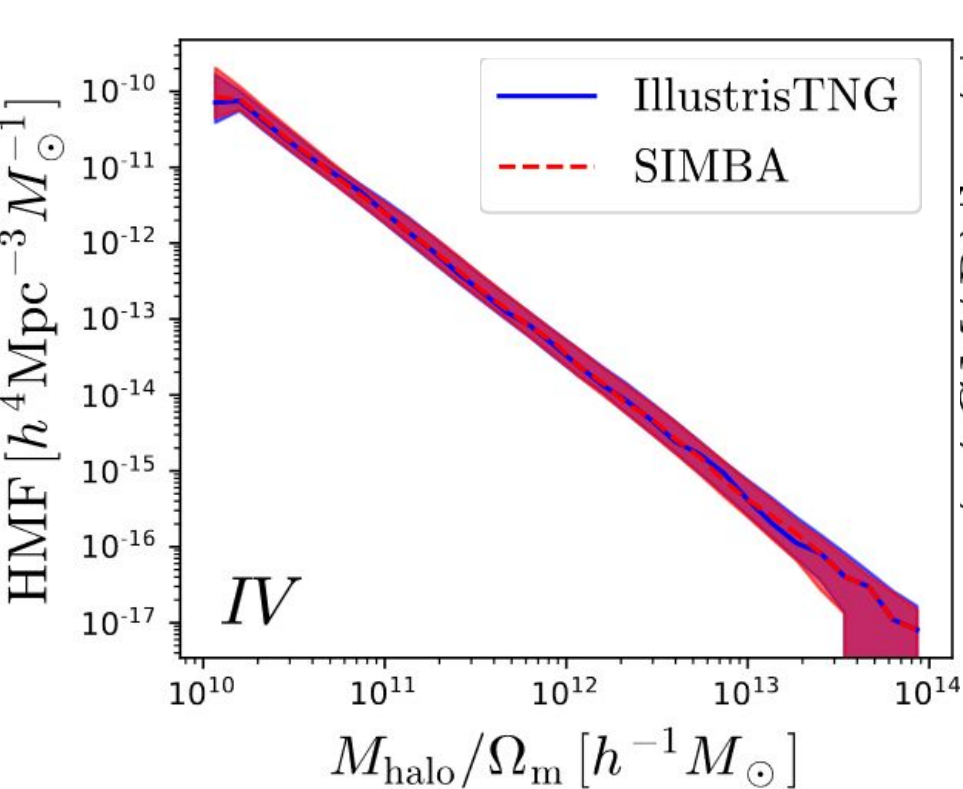


Marginalizing over Baryon Treatment - CAMELS

- Many choices on how to simulate baryons
- Massive (>4000) set of simulations to vary over cosmological and astrophysical parameters
- Uses many different baryonic codes and subgrid procedures



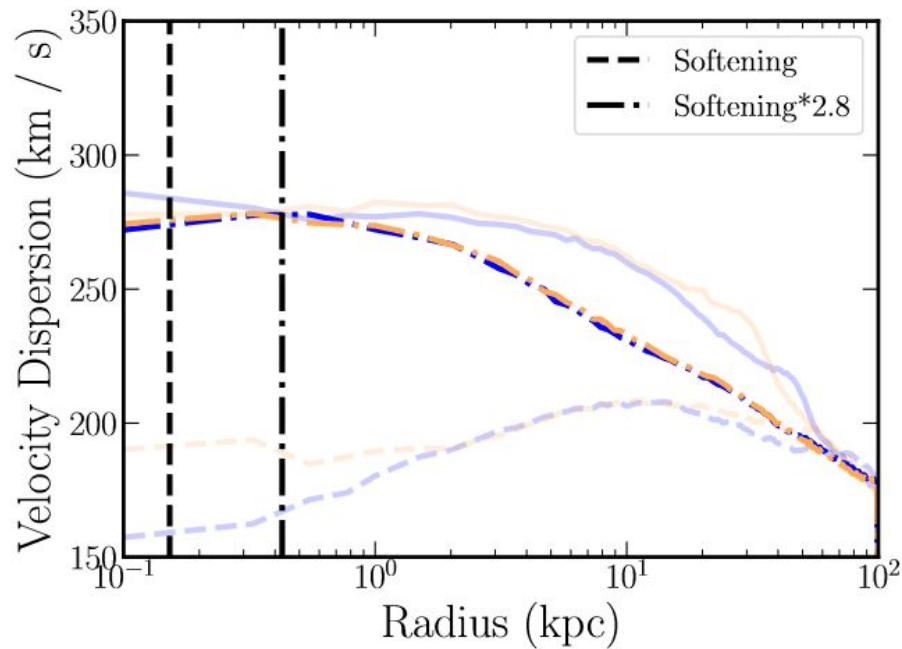
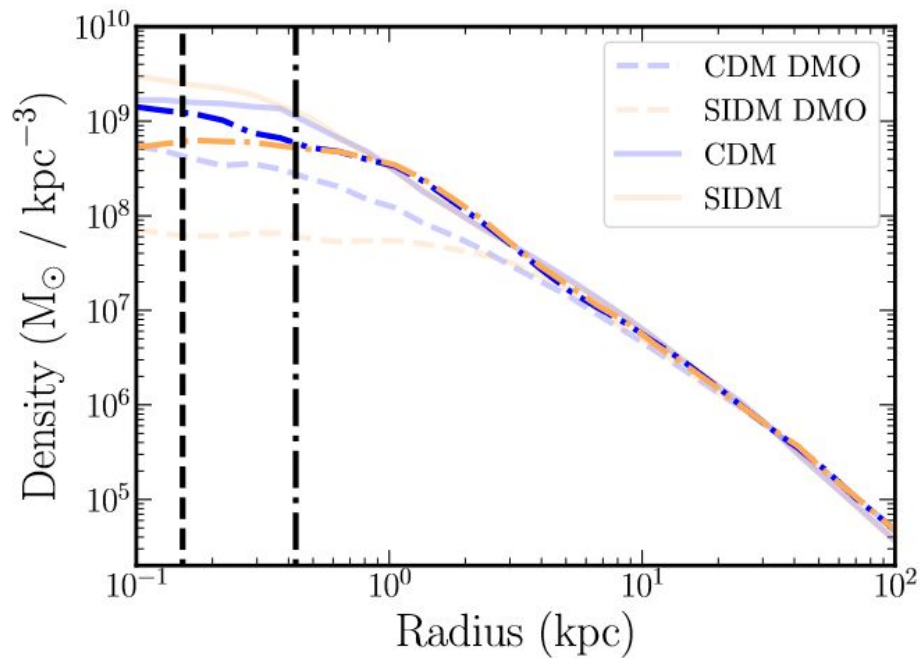


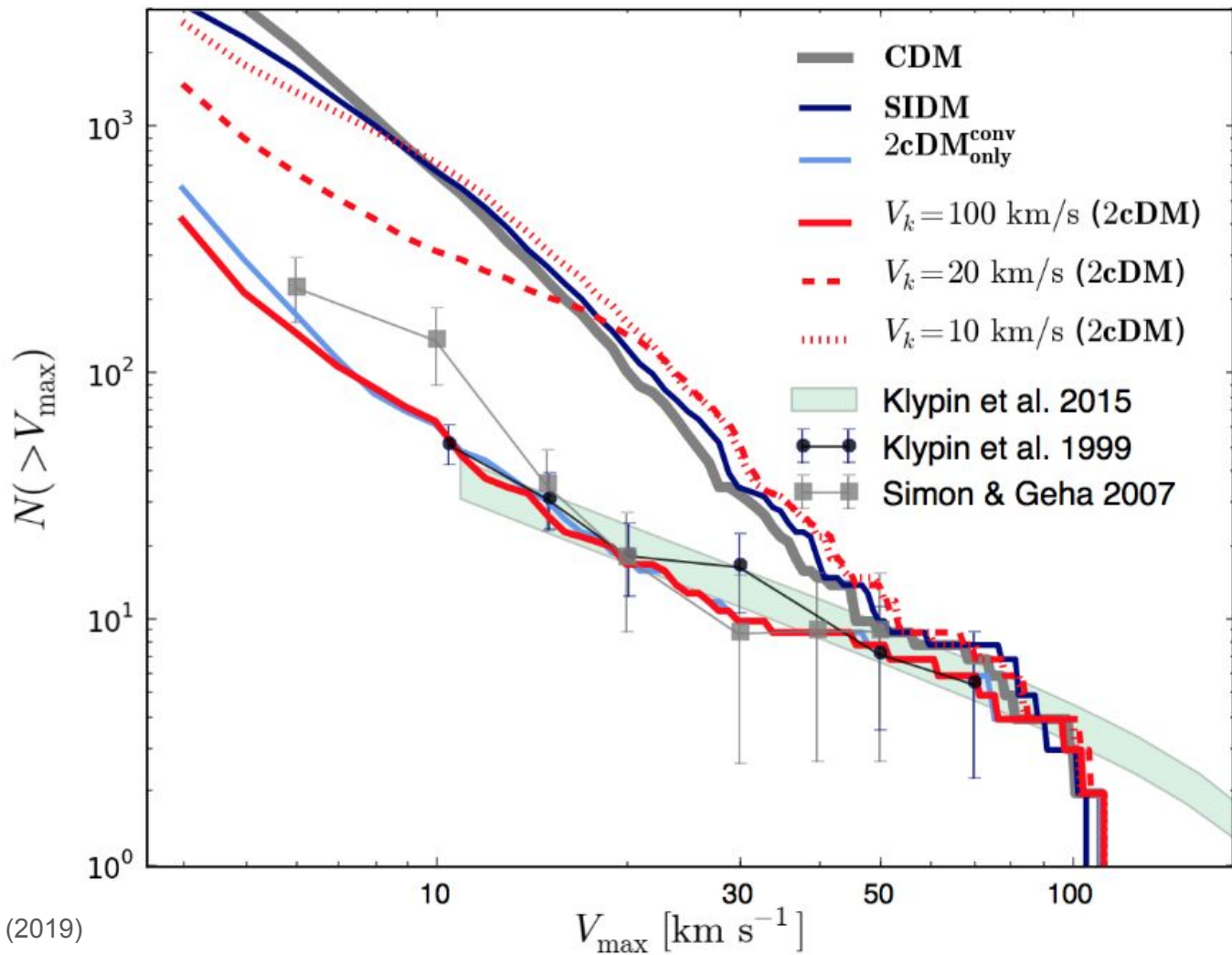


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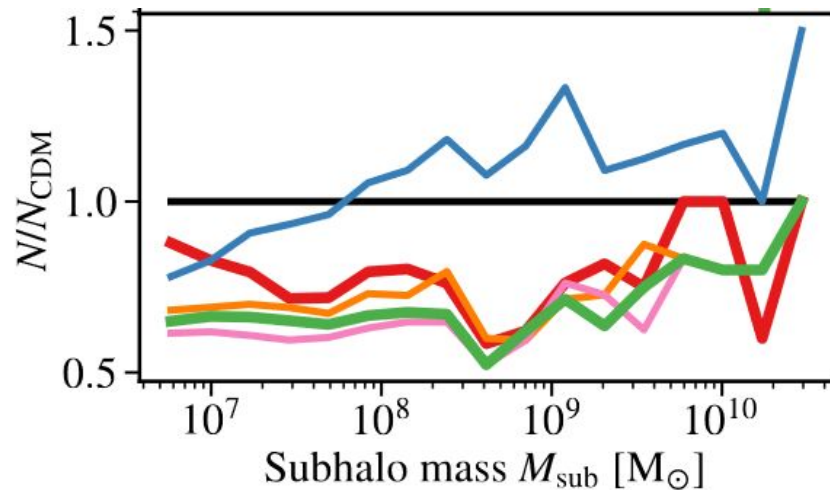
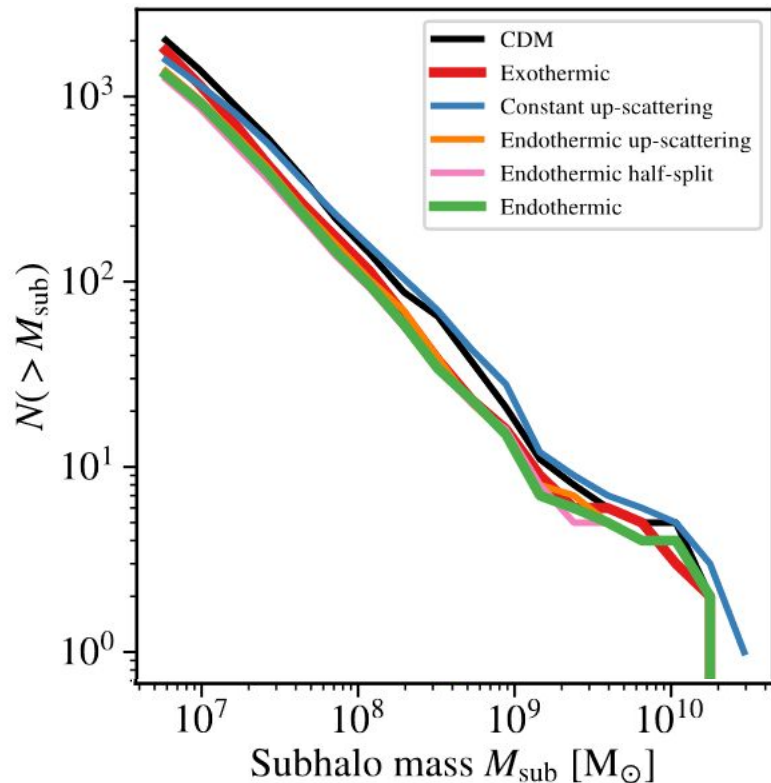
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Elastic SIDM Effects





An Endothermic Model

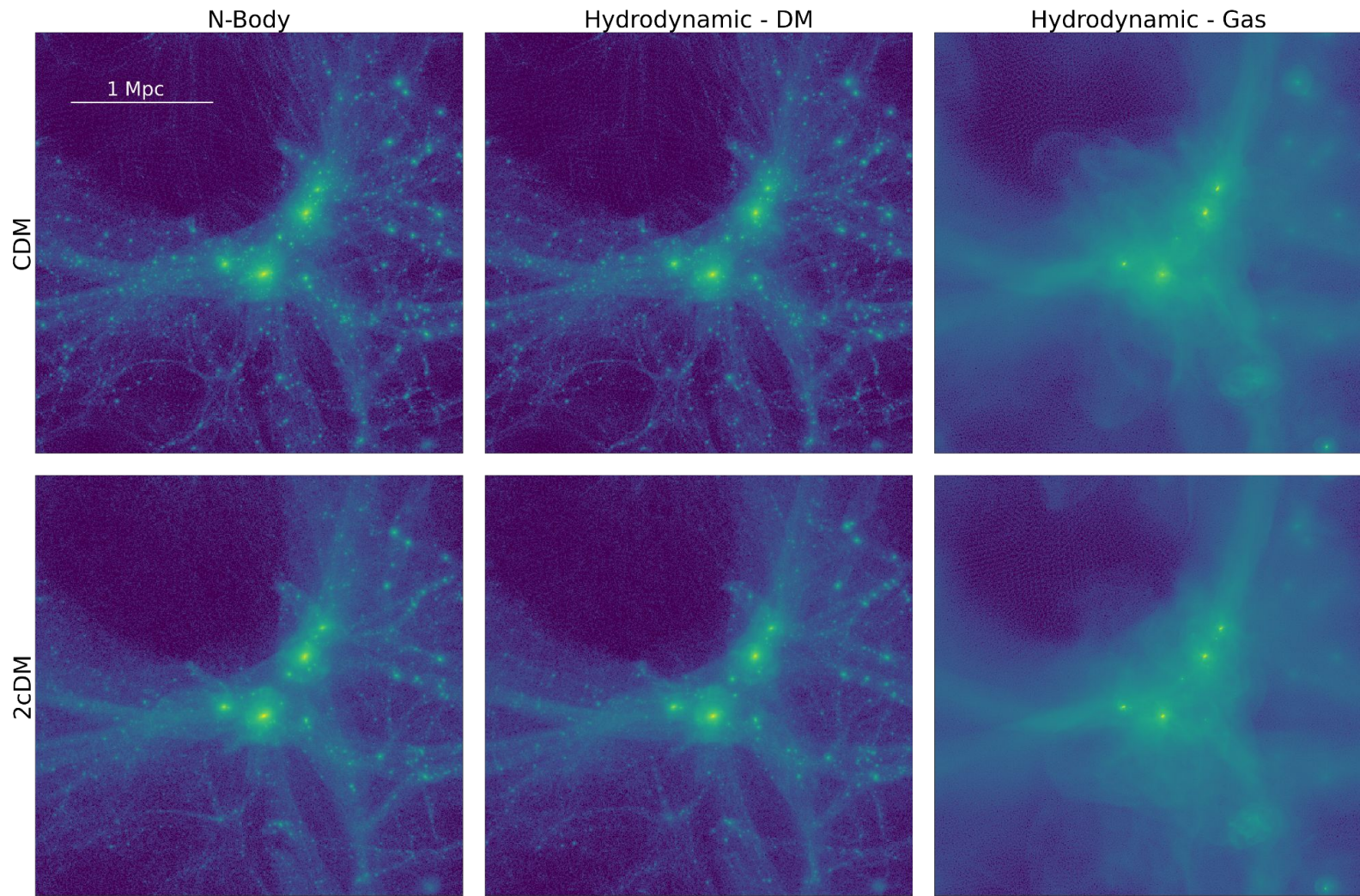


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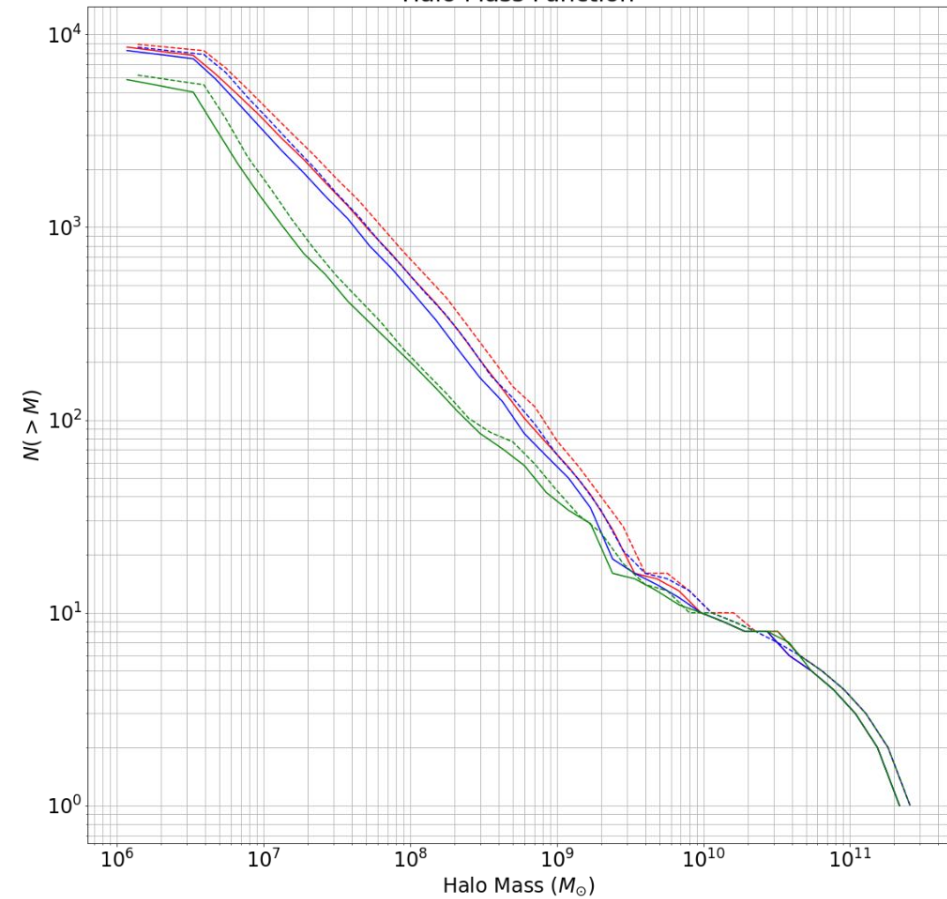
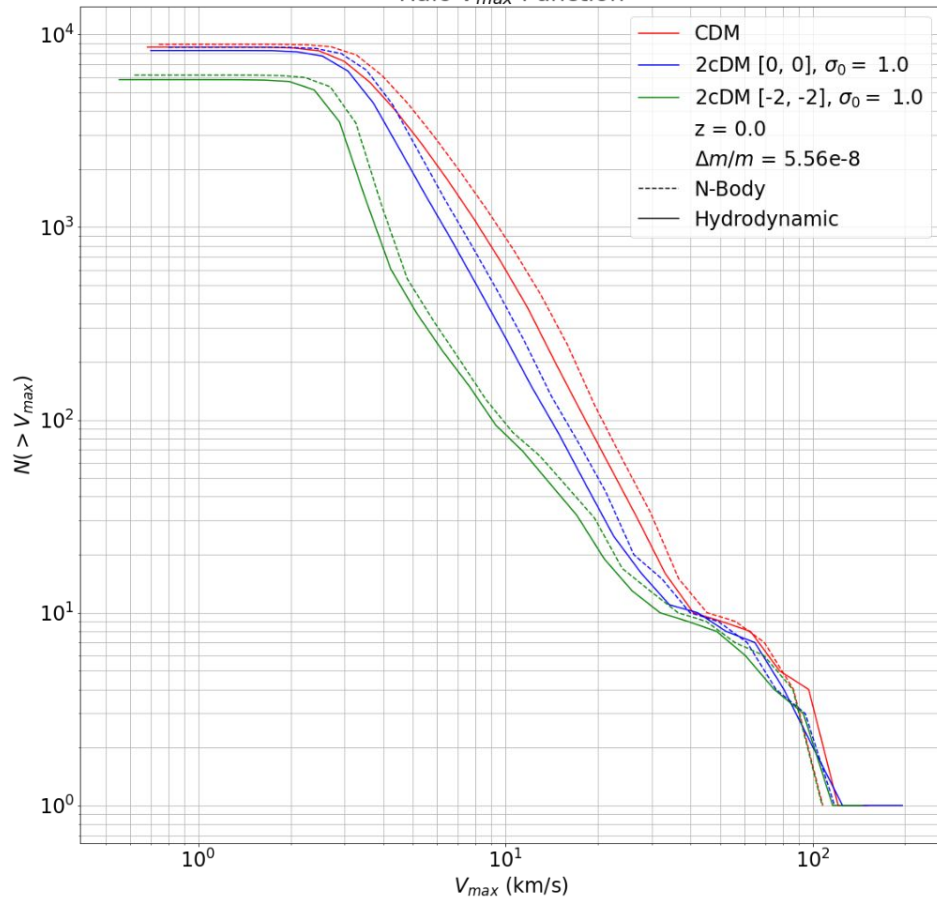
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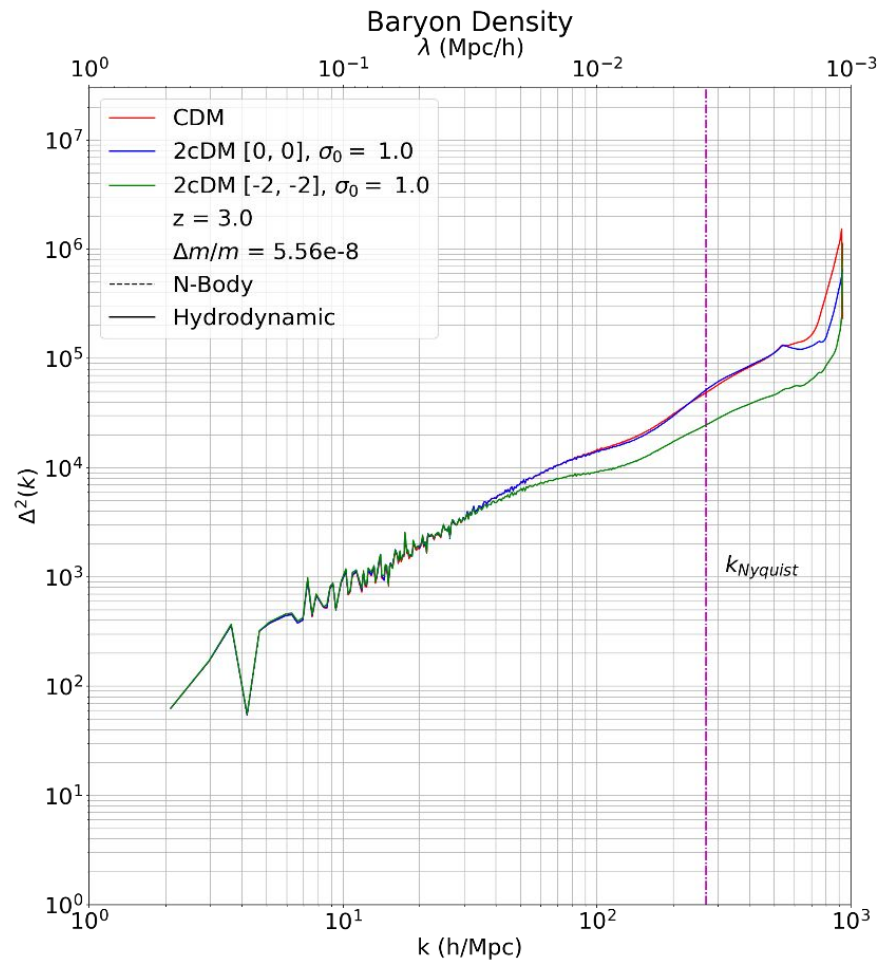
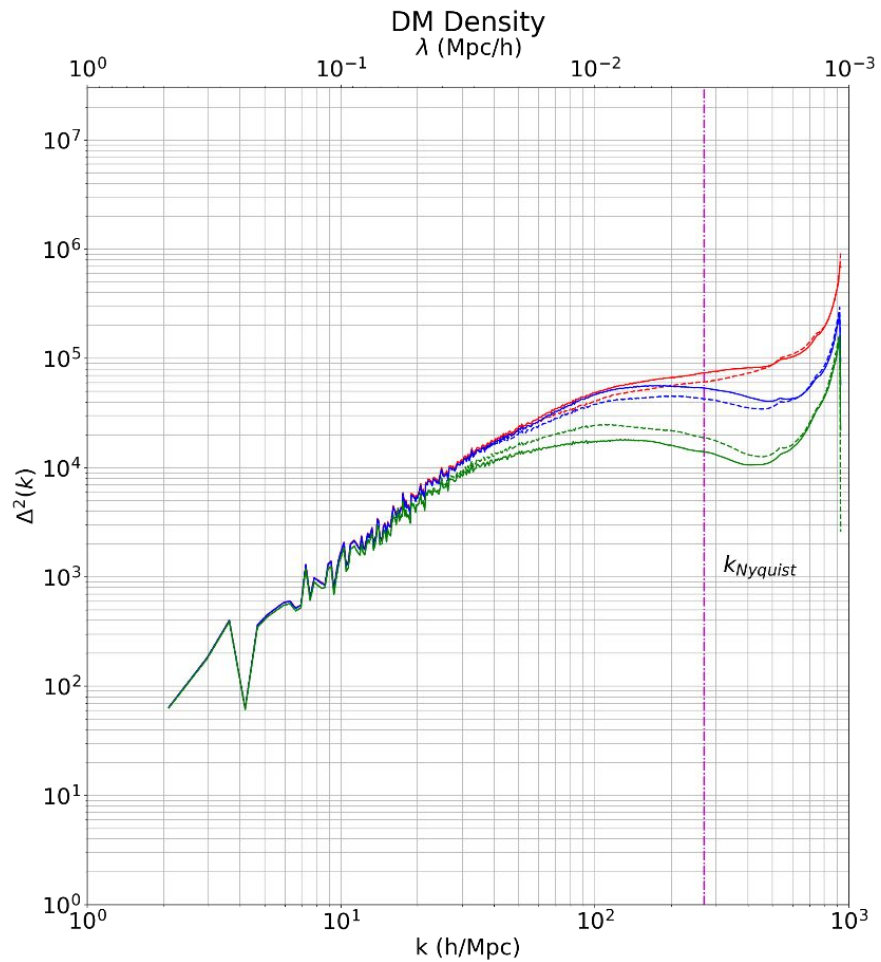
Fiducial Simulation Set

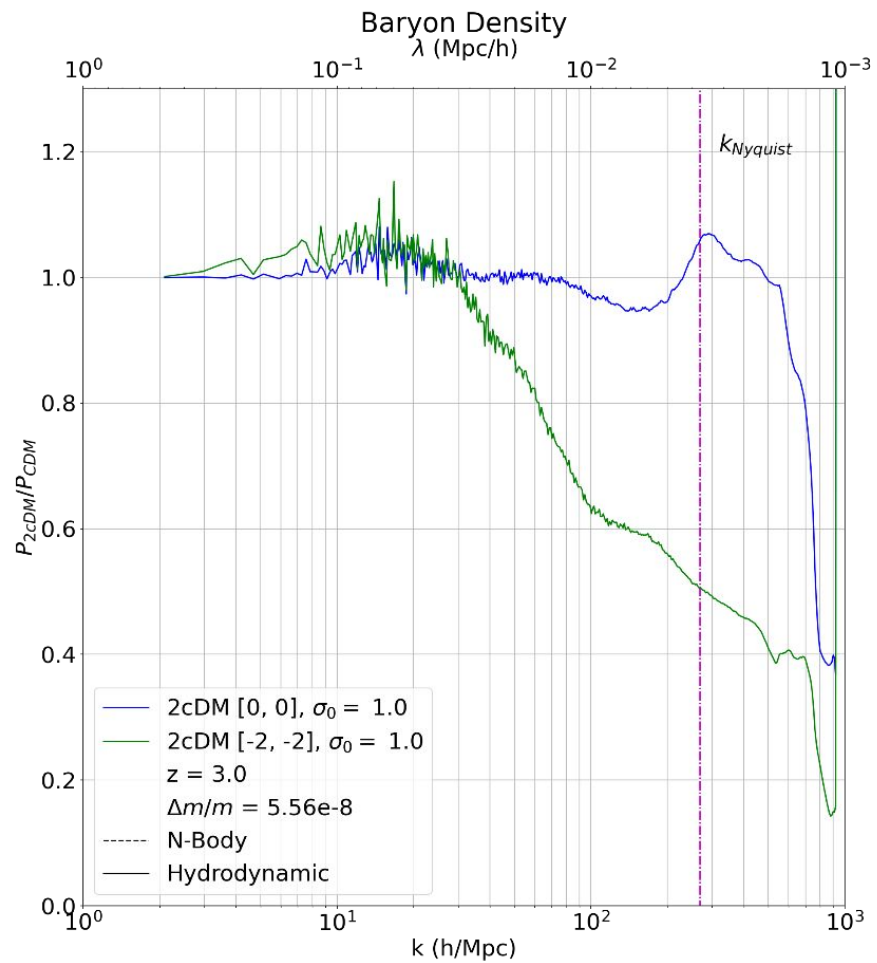
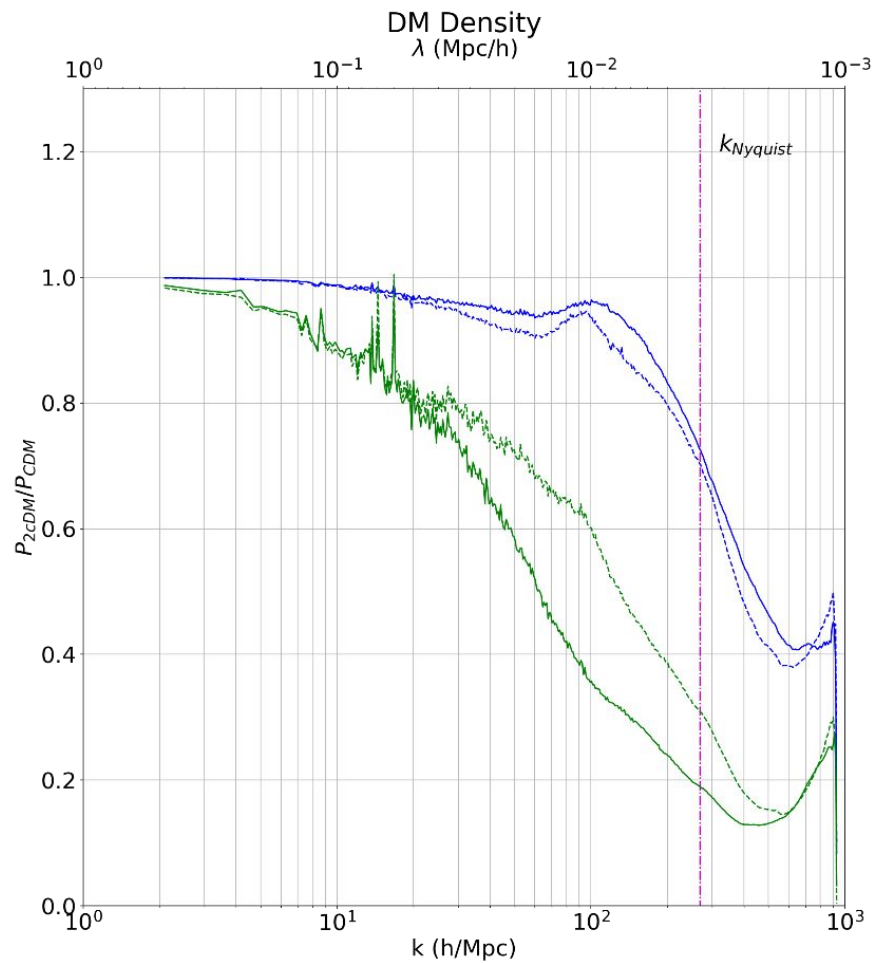
- 256^3 Particles
- 3 Mpc/h Periodic Box
 - Softening length: 0.4040 kpc
 - N-Body mass resolution: $1.38 \times 10^8 M_{\text{Sun}}$
 - Hydro mass resolution: $1.17 \times 10^8 M_{\text{Sun}}$
- N-Body
- Hydrodynamical (IllustrisTNG)
 - All with same ICs, seed
- 2cDM Parameters:
- $\sigma_0 = 1 \text{ g/cm}^3$
- Power laws (ps, pc):
 - (0, 0)
 - (-2, -2)
- $V_k = 100 \text{ km/s}$

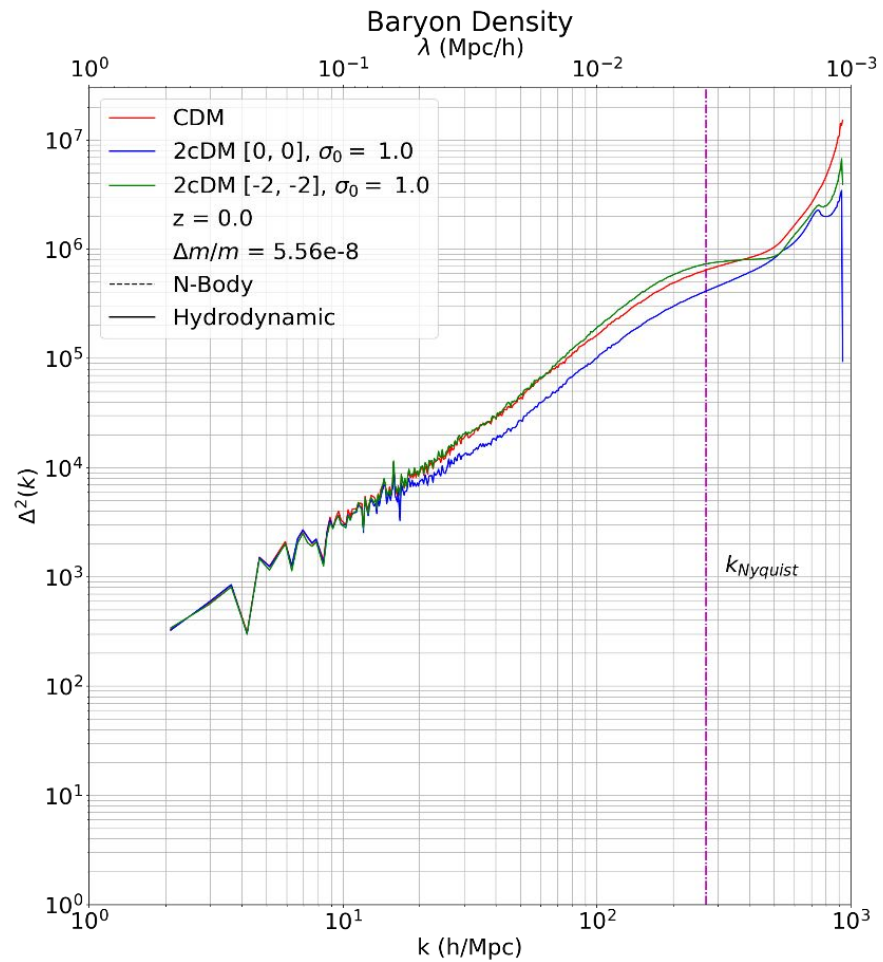
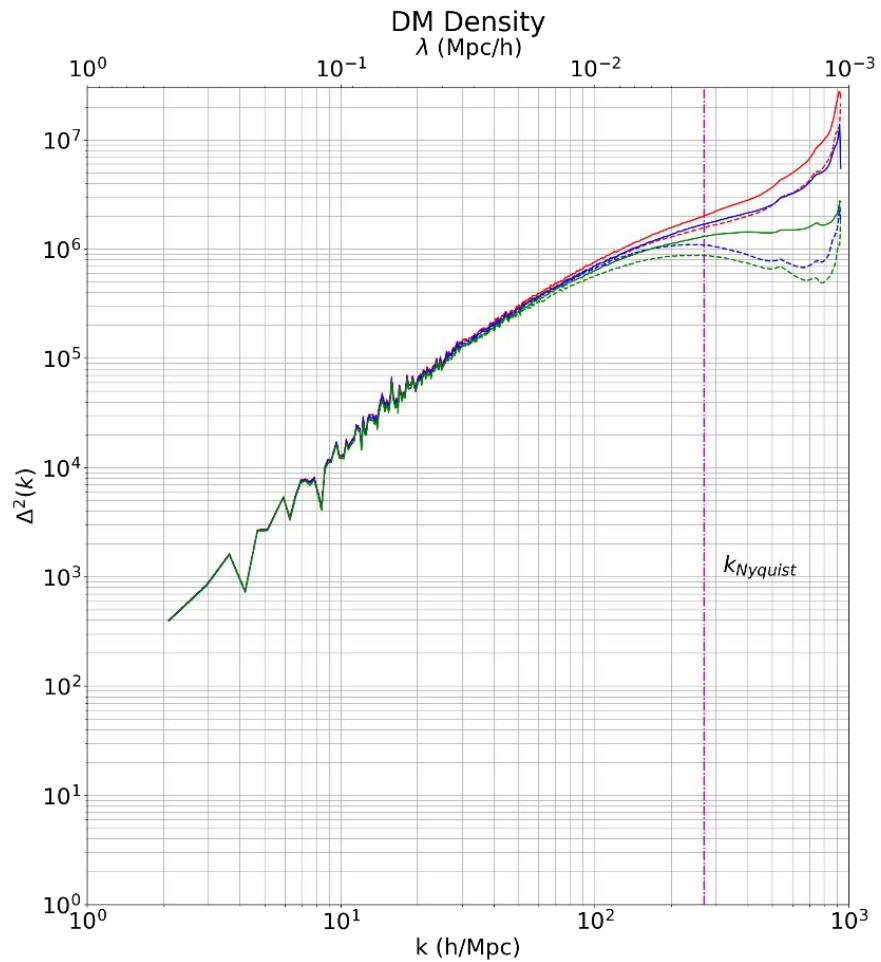


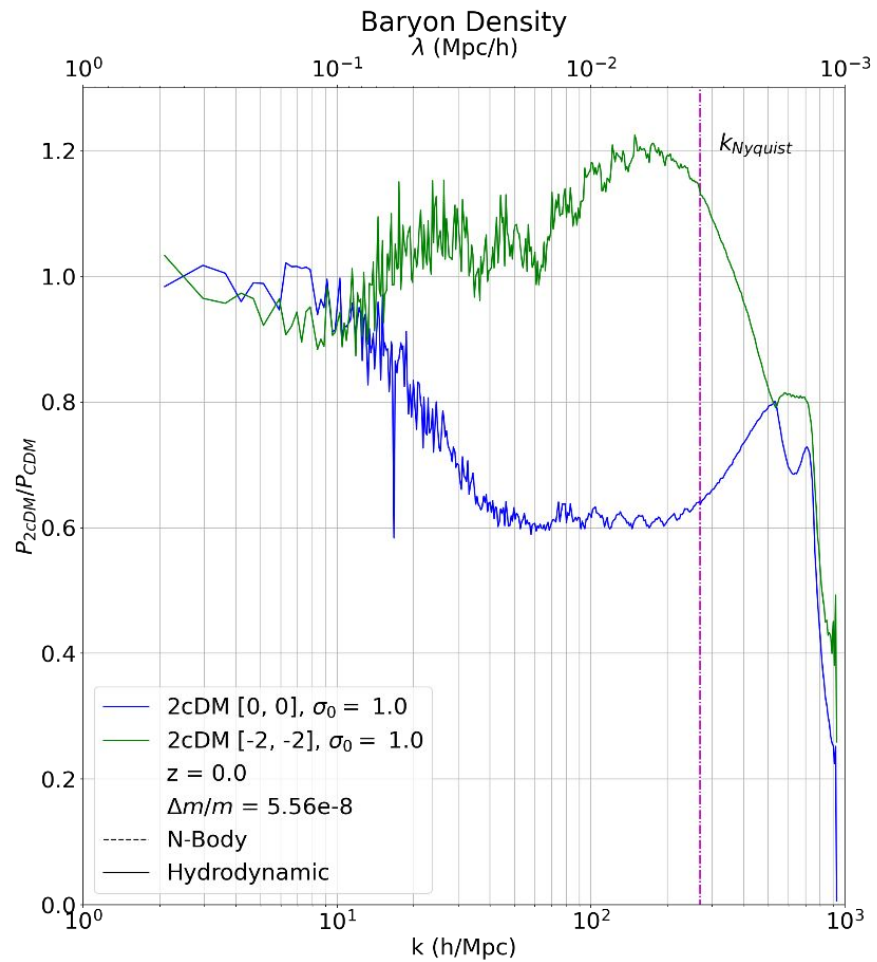
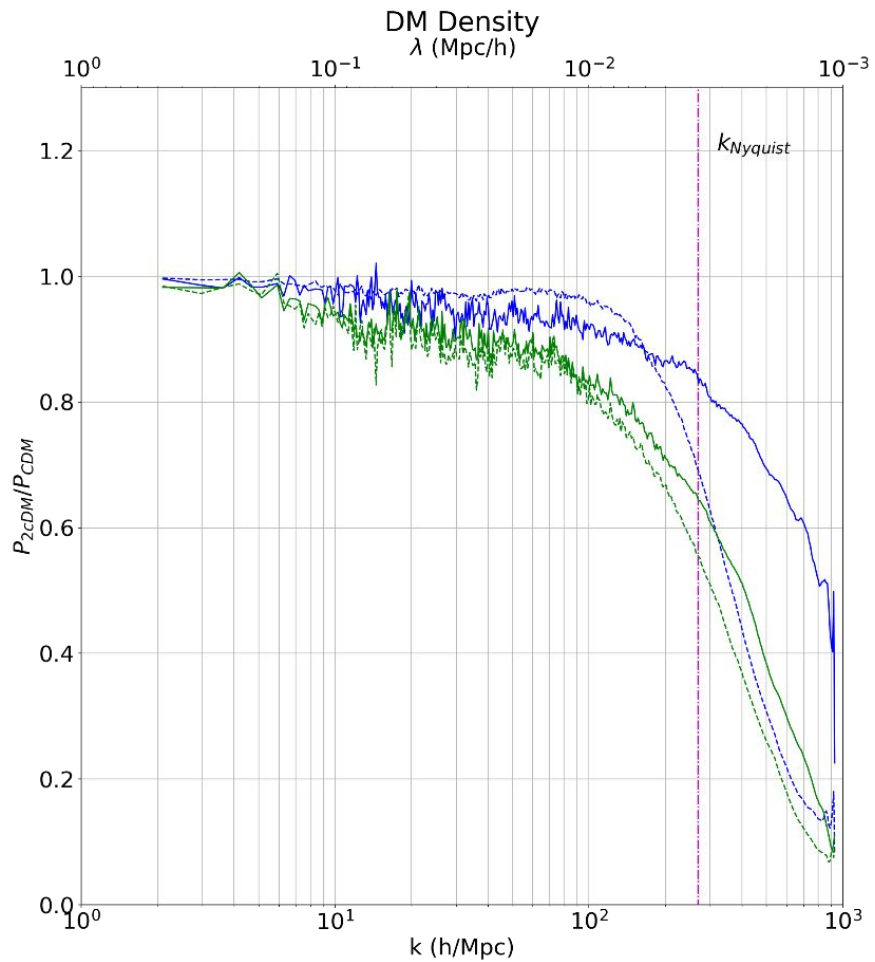
Halo Mass Function

Halo V_{max} Function









Summary

- Baryons can have many different effects on structure depending on astrophysical parameters and baryonic treatment
- Effects can still, in principle, be disentangled from DM physics signatures
- Baryons appear to amplify existing Λ CDM signatures in some cases, suppress them in others