CUNY Computational Astrophysics

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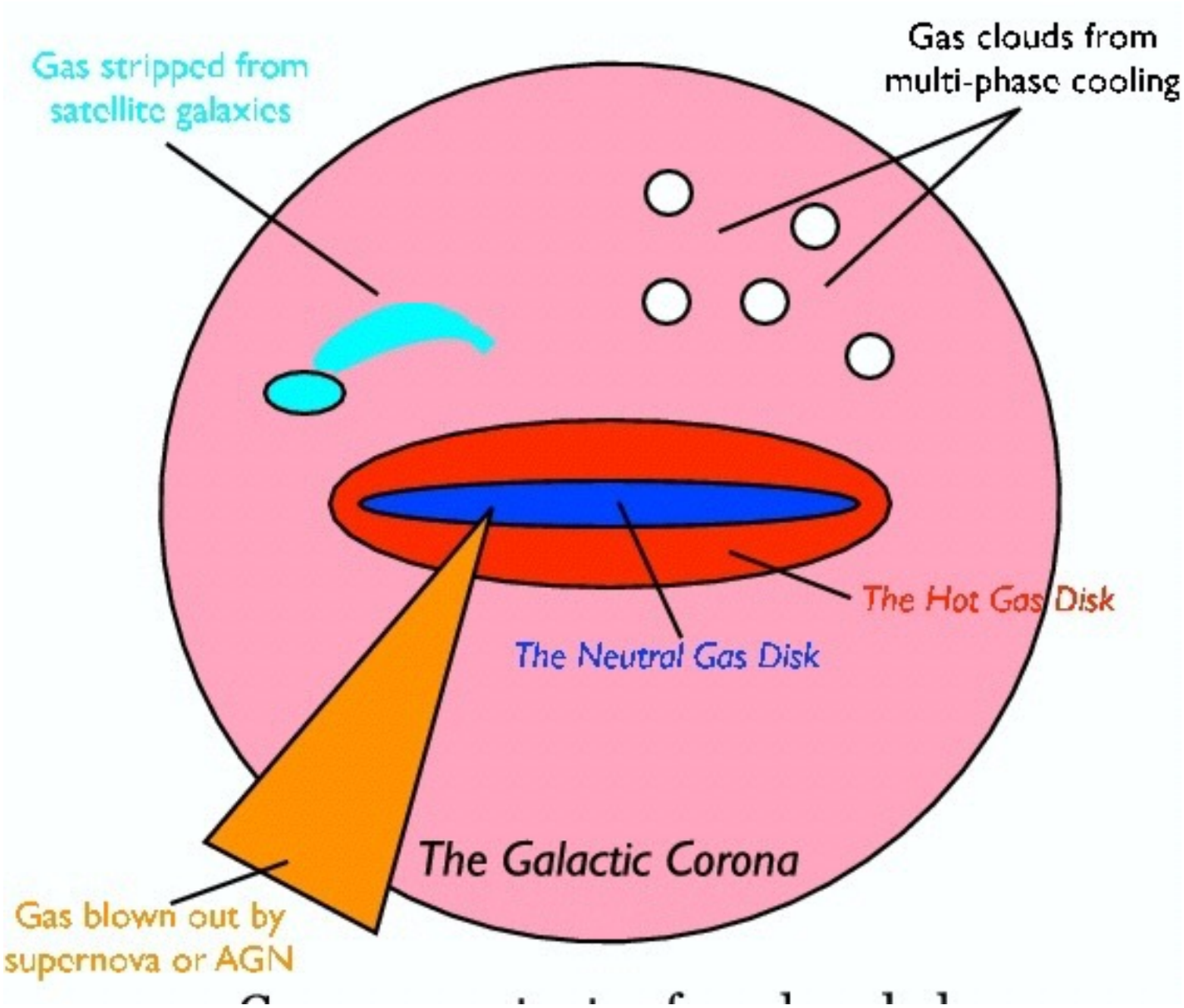
Galaxy Formation and Cosmology

- CUNY has 12 astronomy faculty spread out over 7 campuses. Other people do computational work, Quinn Minor (dark matter in dwarfs), Viviana Acquaviva (stellar population sysnthesis, optimization, data analysis). I'm not up on what they are doing, so I'll just talk about myself.

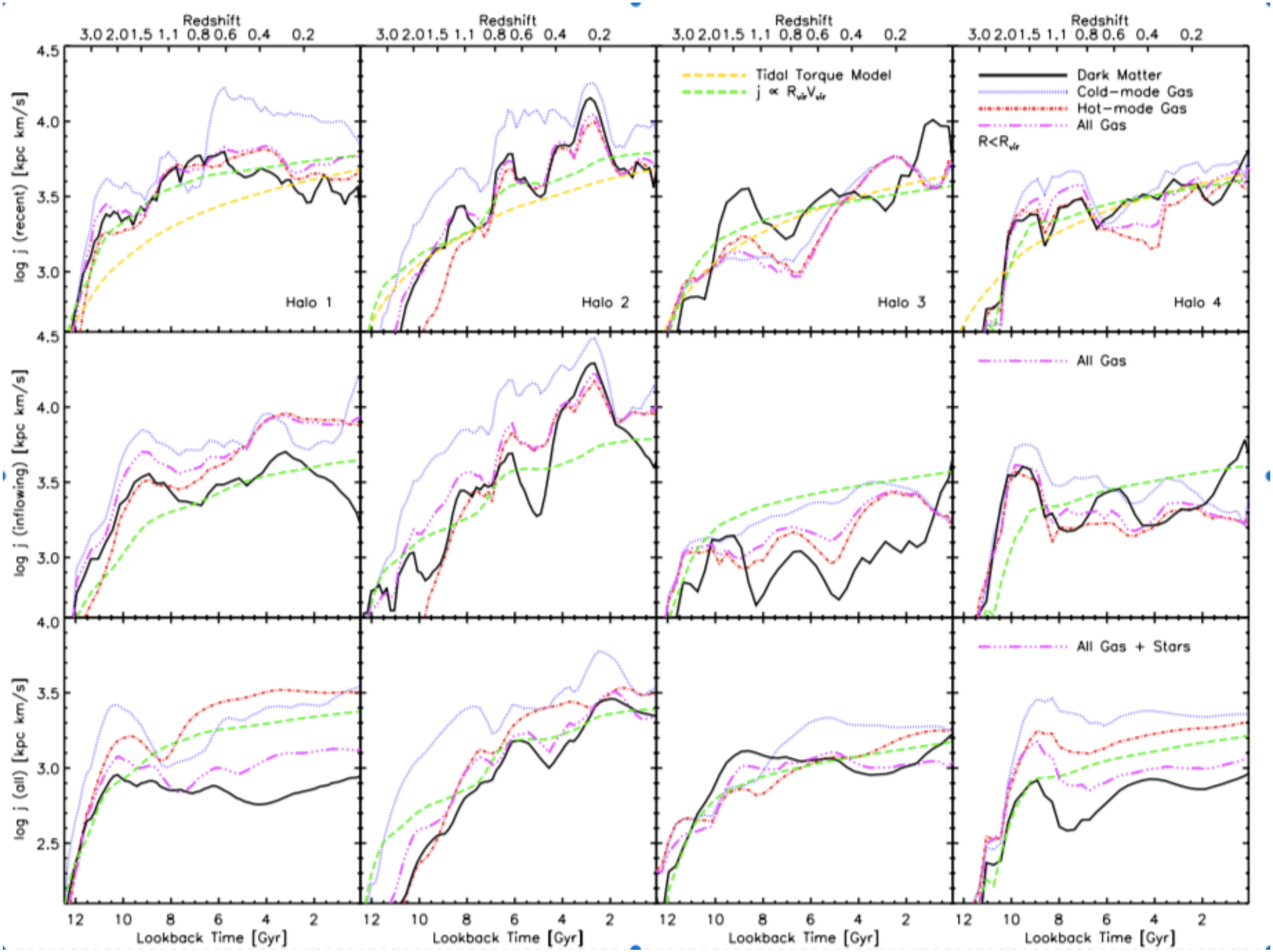
- I work on different aspects of galaxy formation using analytic, semi-analytic and numerical modeling.

- I often focus on the gaseous halos of galaxies.

Gas Halos



Maller 2005



Stewart et al. 2013

Cold-mode

Halo 2
z=1.37

1.0 < T < 2.0 Gyr
0.6 < T < 1.0 Gyr
0.3 < T < 0.6 Gyr
T < 0.3 Gyr

z
x

y
x

Hot-mode

z
x

y
x

Scylla Project

- Cosmological Zoom in simulation of MW mass halo with six codes.

- AMR - Enzo, Ramses, ART

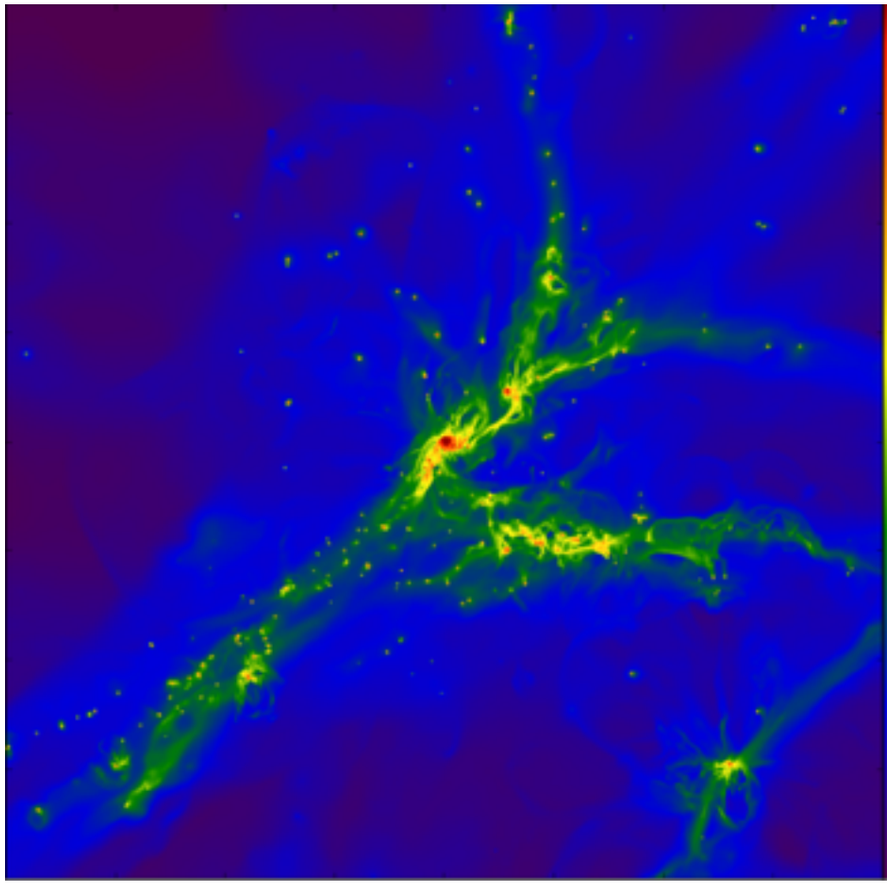
- SPH - PSPH (ChaNGa)

- MM - Arepo

- Starting run is the Enzo run of Ryan Joung

  m_{dm} = 1.75e5 spatial = 95/h kpc

  Joung et al. 2012

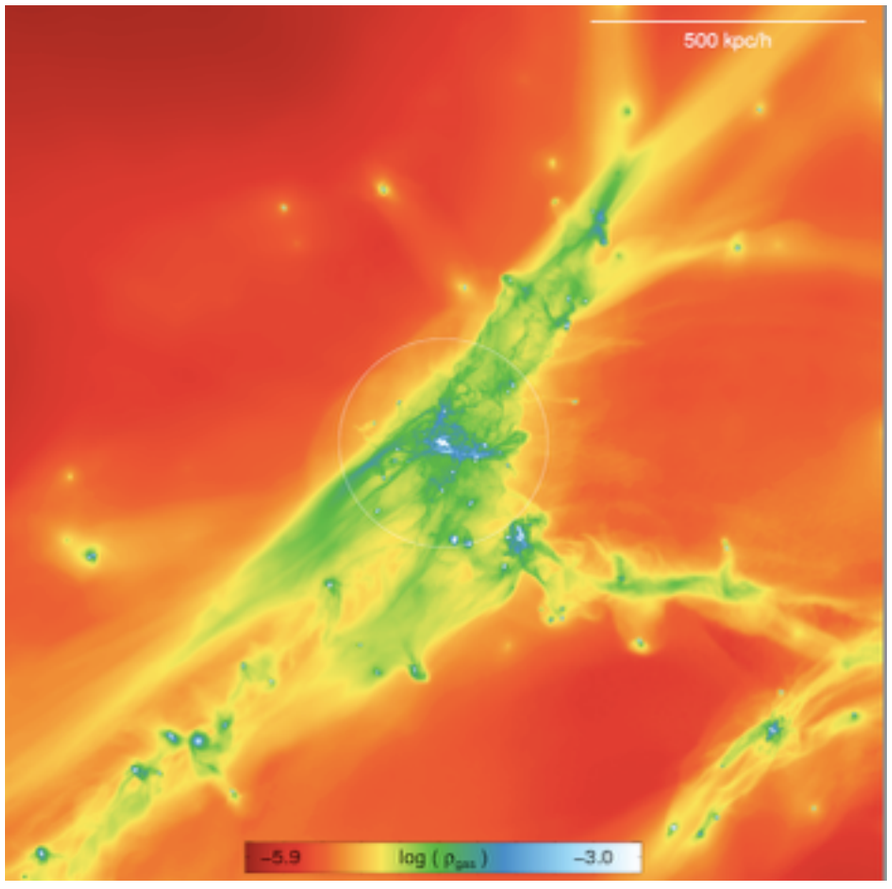


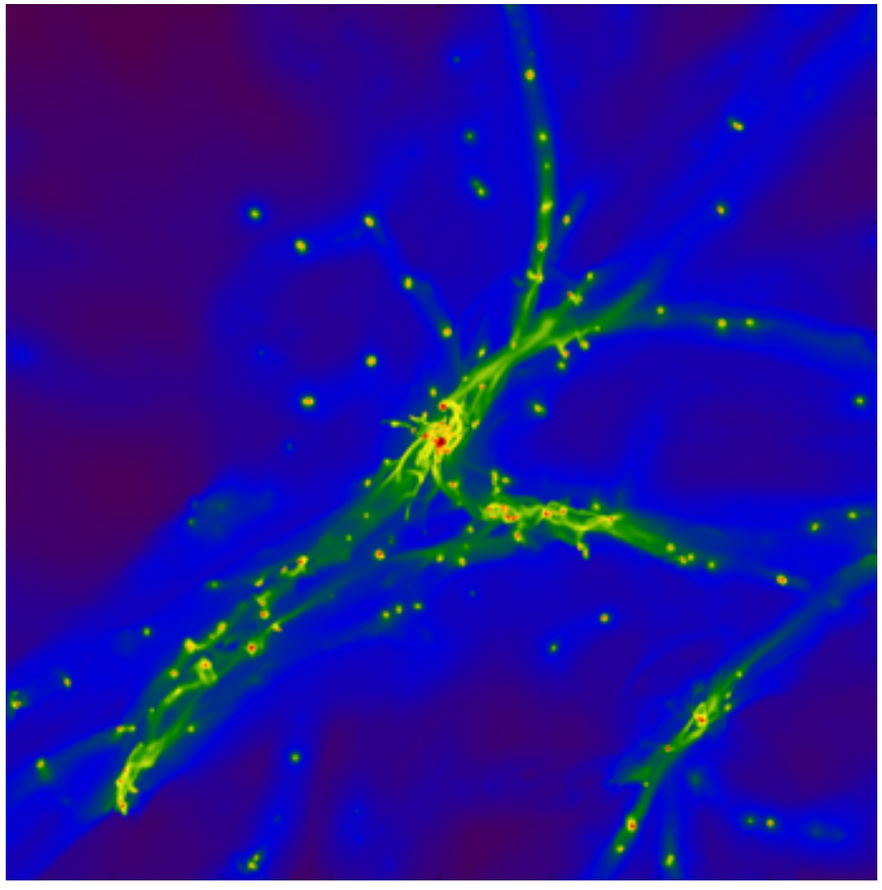
yt

Arepo

Ramses

Enzo





Halo: Baryon and Dark Matter Components

RAMSES
ENZO

$BaryonMass[M_\odot]$

10^{11}
10^{10}
10^{9}

10^{10}
10^{11}
10^{12}

$DarkMatterMass[M_\odot]$

Halo Masses

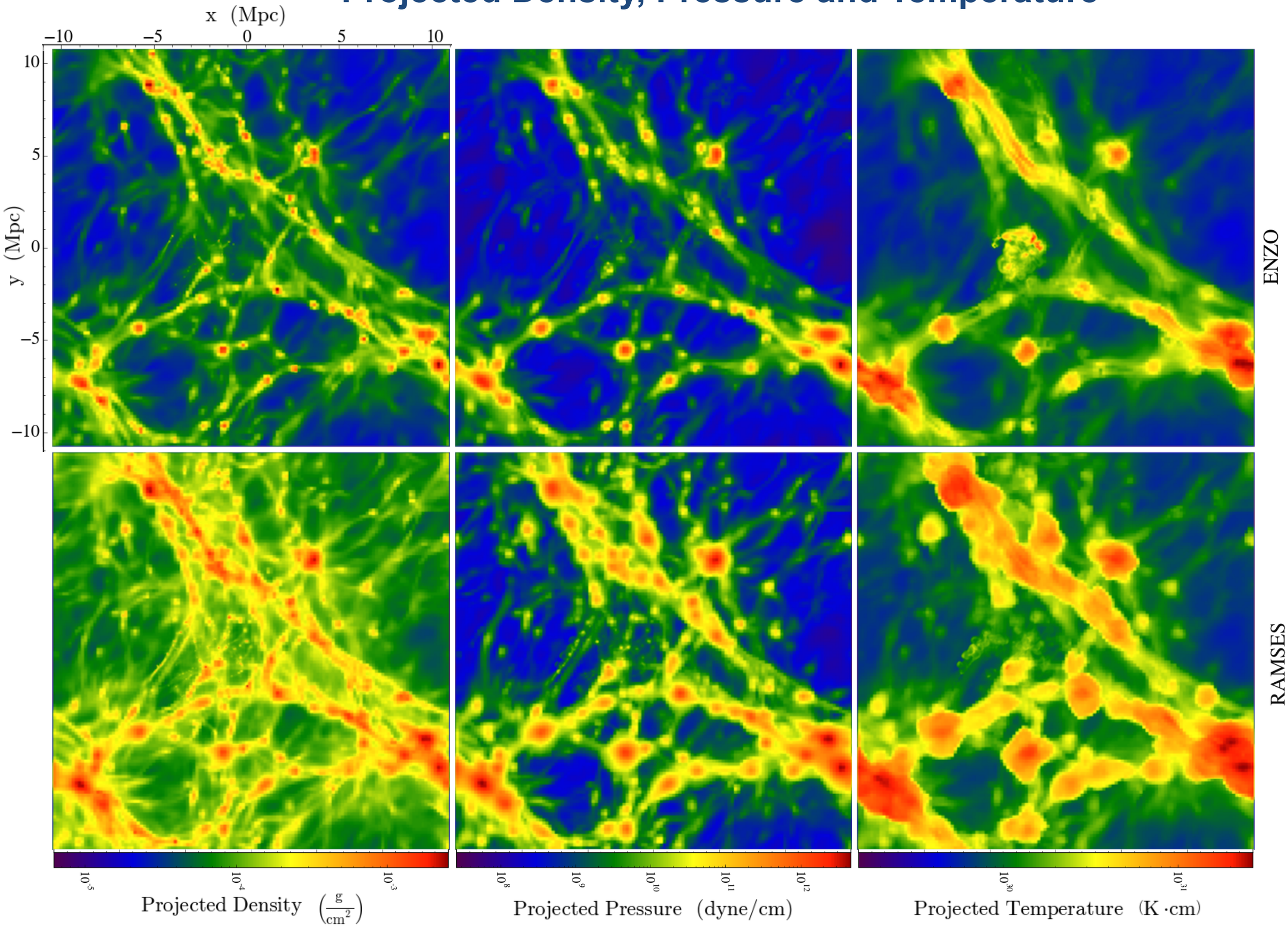
$Halomass\ [M_\odot]$

10^{12}
10^{11}
10^{10}

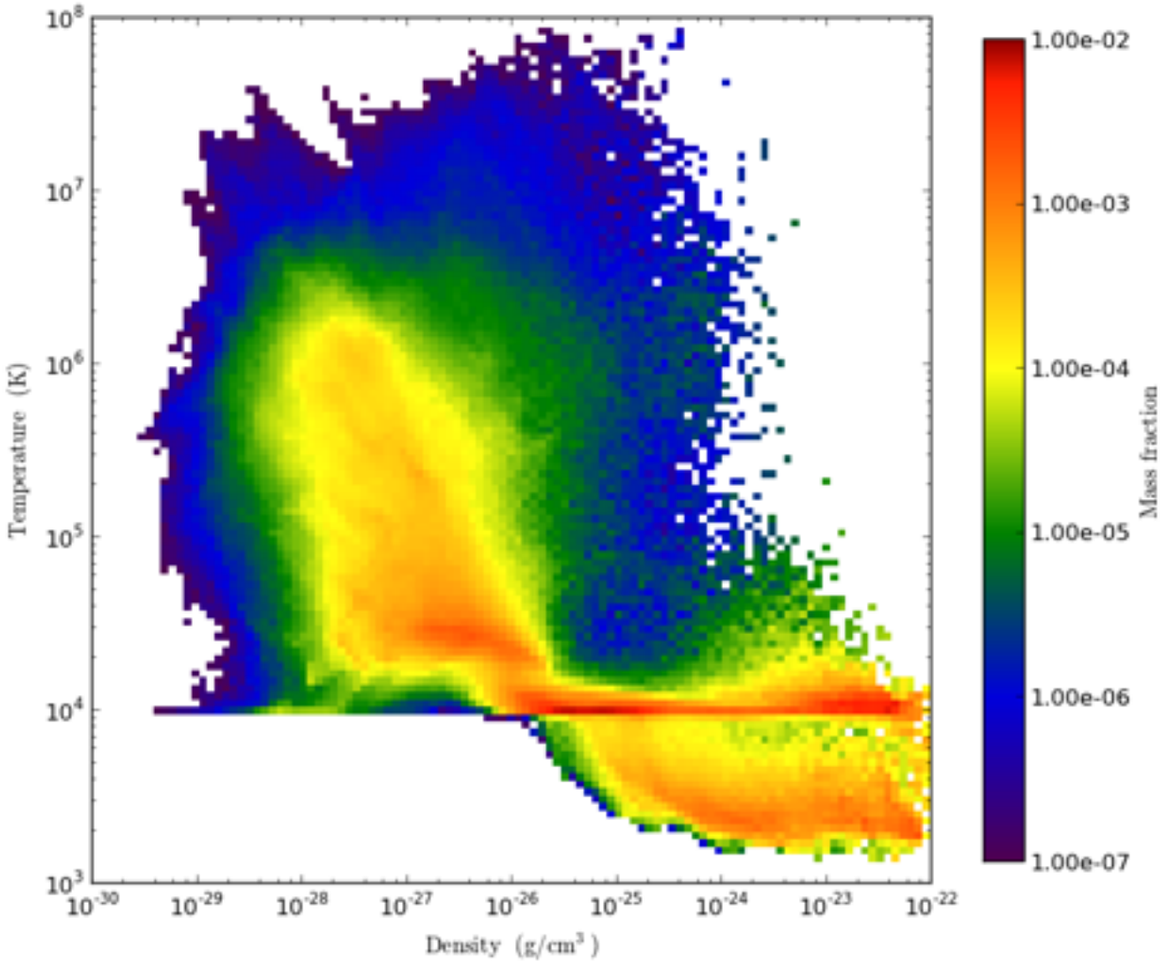
0
5
10
15
20
25

Halo

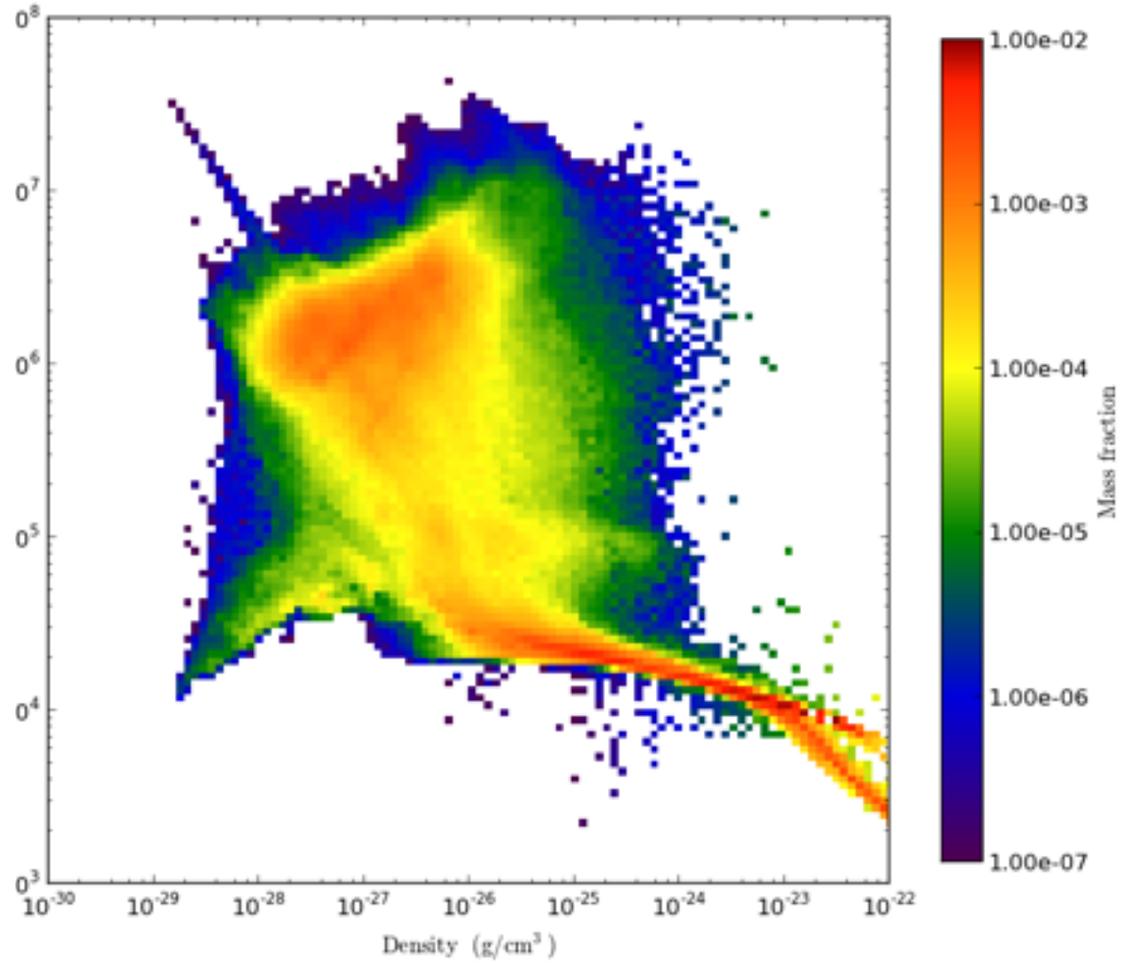
Projected Density, Pressure and Temperature



- Lots of data, lots and lots of projects to do. Mostly by undergrads.
- I’m working on trying to make yt easy to use for undergrads with no programming background.



Ramses



Enzo

Fluffy Simulations

- Cosmological simulations without star formation or feedback.
- Impose a pressure floor that scales with density to give a fixed Jeans length.
- Disadvantages:
  - Doesn't form galaxies
- Advantages:
  - Removes most of the uncertain physics
  - Different codes should give the same results
  - Results should converge with resolution
  - Gives a type of *starting conditions* for galaxy formation; total mass of gas, gas accretion rates, gas angular momentum, gas temperatures, etc. These should be more relevant then the dark matter values which are often used as the starting point for galaxy formation modeling.

Fluffy Simulations

- Fluffy simulations because you get unrealistic baryon blobs instead of galaxies. I call these marshmallow galaxies to highlight that they are completely artificial.

- Fluff is a marshmallow flavored spread.

CUNY-HPC

- CUNY has a midsize high performance computing center for all CUNY faculty.
- Machines:
  - Penzias - 1152 cores, Intel
  - Salk - 2816 cores, CRAY
- Undersubscribed