

Heidelberg Institute for
Theoretical Studies



Modeling AGN feedback in the next generation cosmological volume simulations

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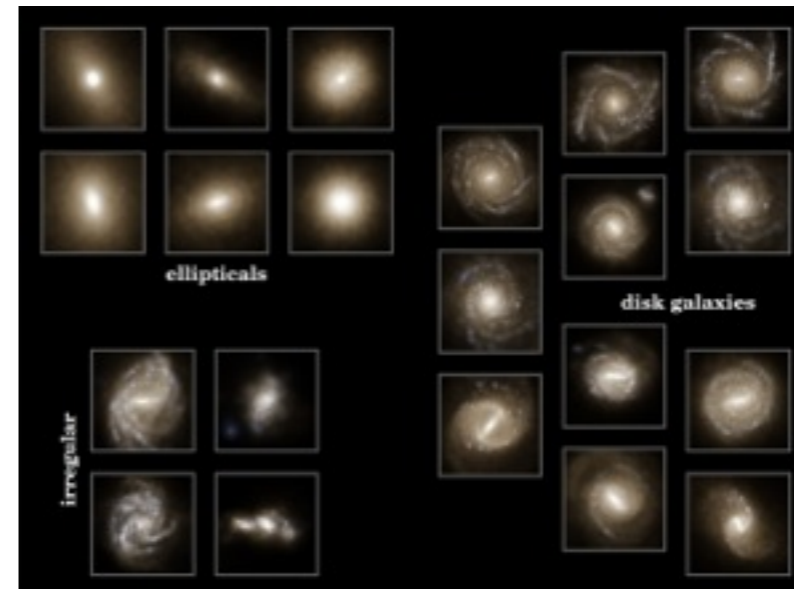
Volker Springel,
Lars Hernquist, Annalisa Pillepich, Federico Marinacci, Rüdiger Pakmor,
Dylan Nelson, Shy Genel, Mark Vogelsberger, Jill Naiman, Paul Torrey

Simulations of Cosmological Volumes:

- 50 – 500 Mpc simulation box, uniform mass resolution of $10^5 - 10^7 M_{\odot}$ per gas cell
- Gravitational softening ≈ 1 kpc
- Computationally very expensive (> 10 M core h), several months runtime
- Aim: simulate the formation of a representative sample of galaxies (of different masses, environments etc.)

The Illustris simulation

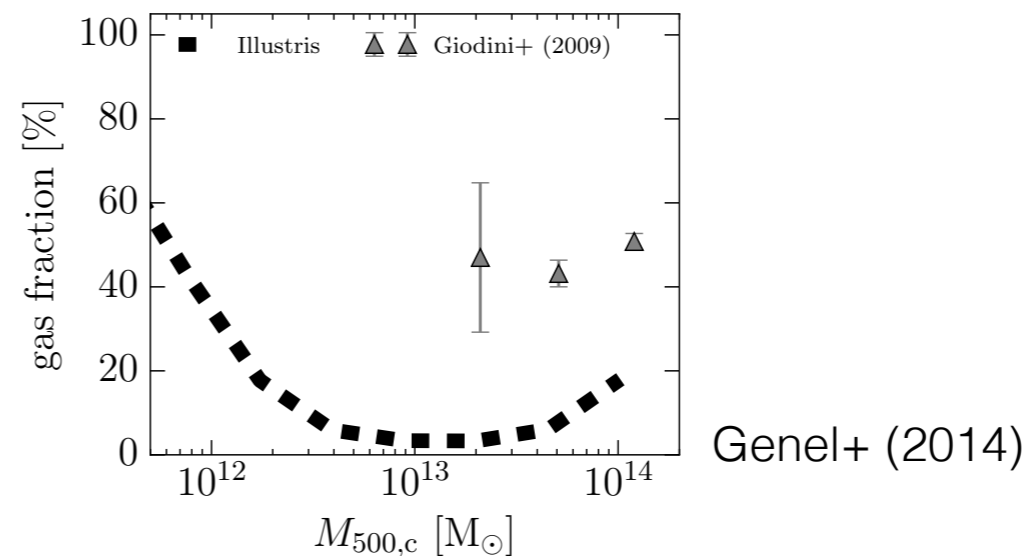
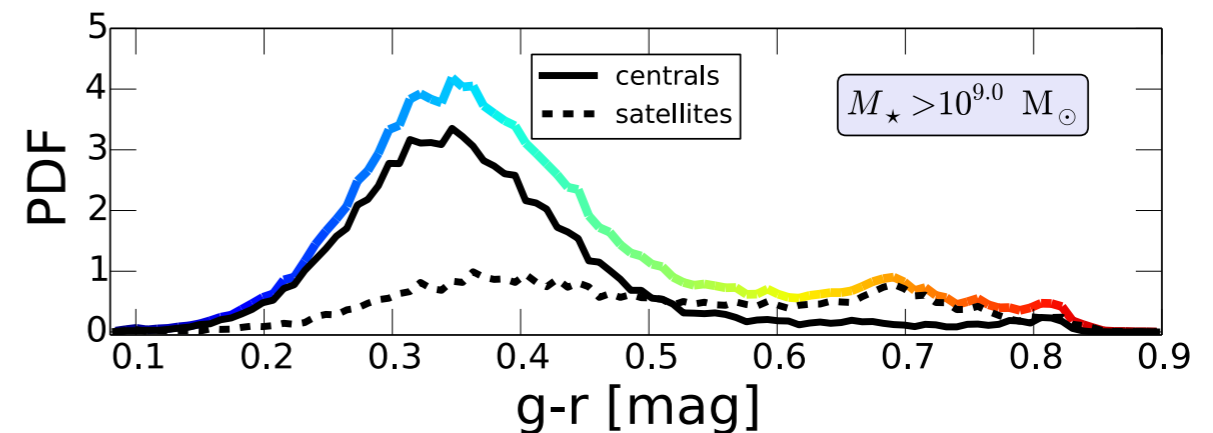
- Success: morphologies



Vogelsberger+ (2014)

But:

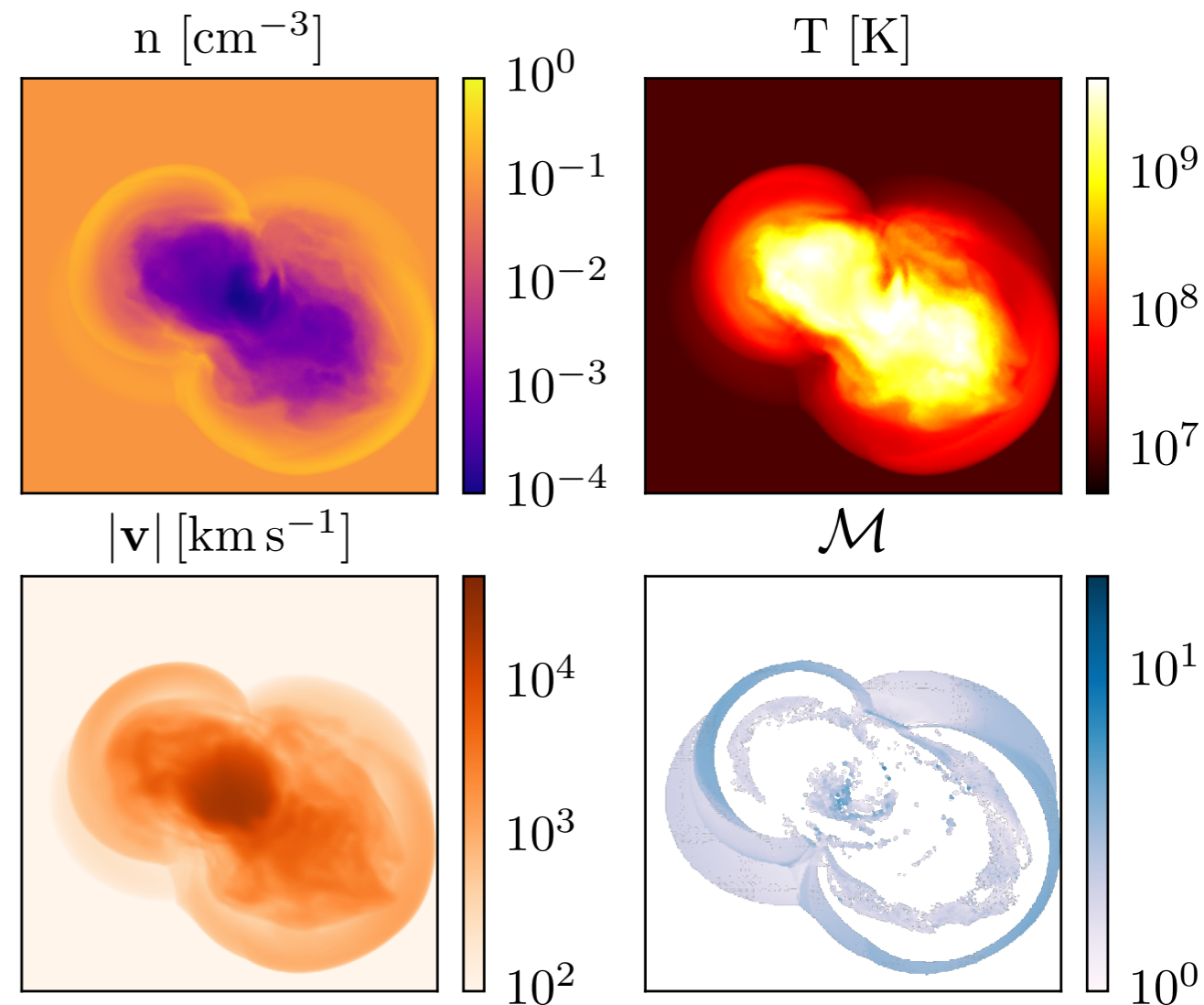
- Too inefficient quenching at low z
- Too efficient in diluting gas



Genel+ (2014)

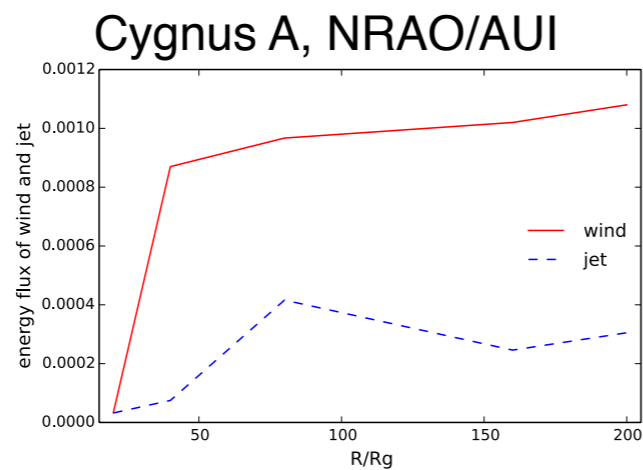
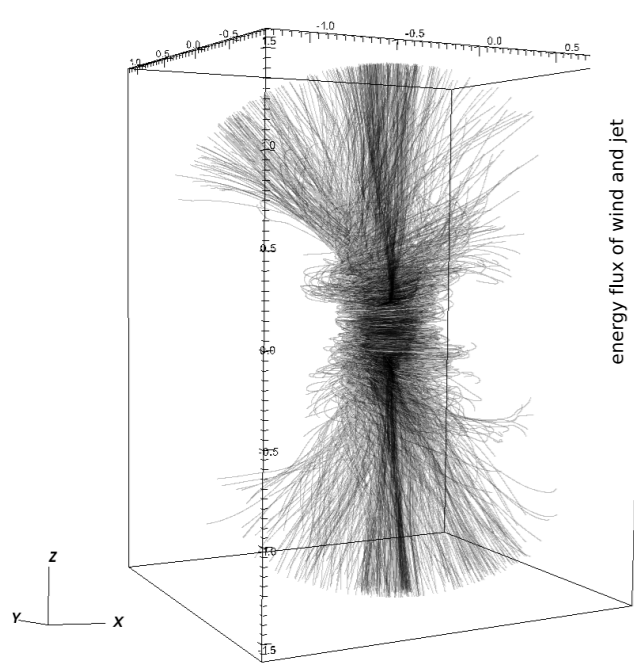
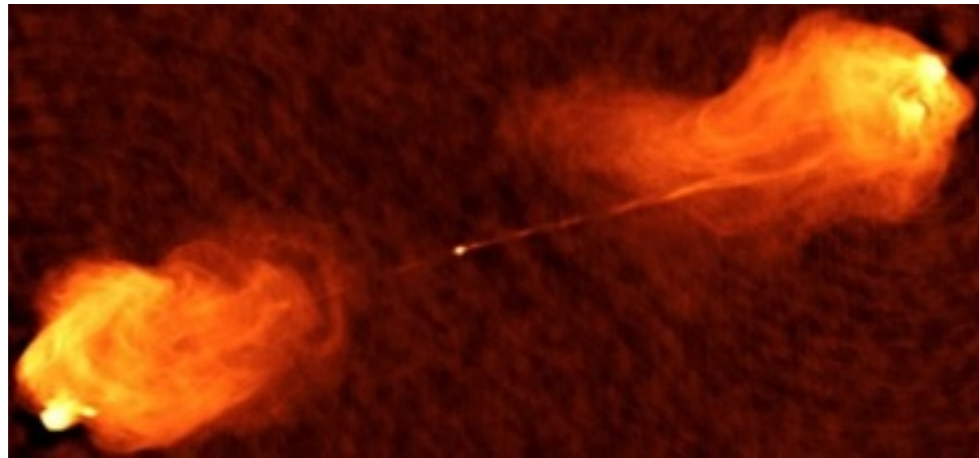
Beyond Illustris: Improvements

- High accretion state (quasar mode): thermal heating
- Low accretion state (“radio” mode):
new, pulsed kinetic feedback implementation
- Kicks central gas in a random direction
- Energy thermalizes via shocks within a few Myr

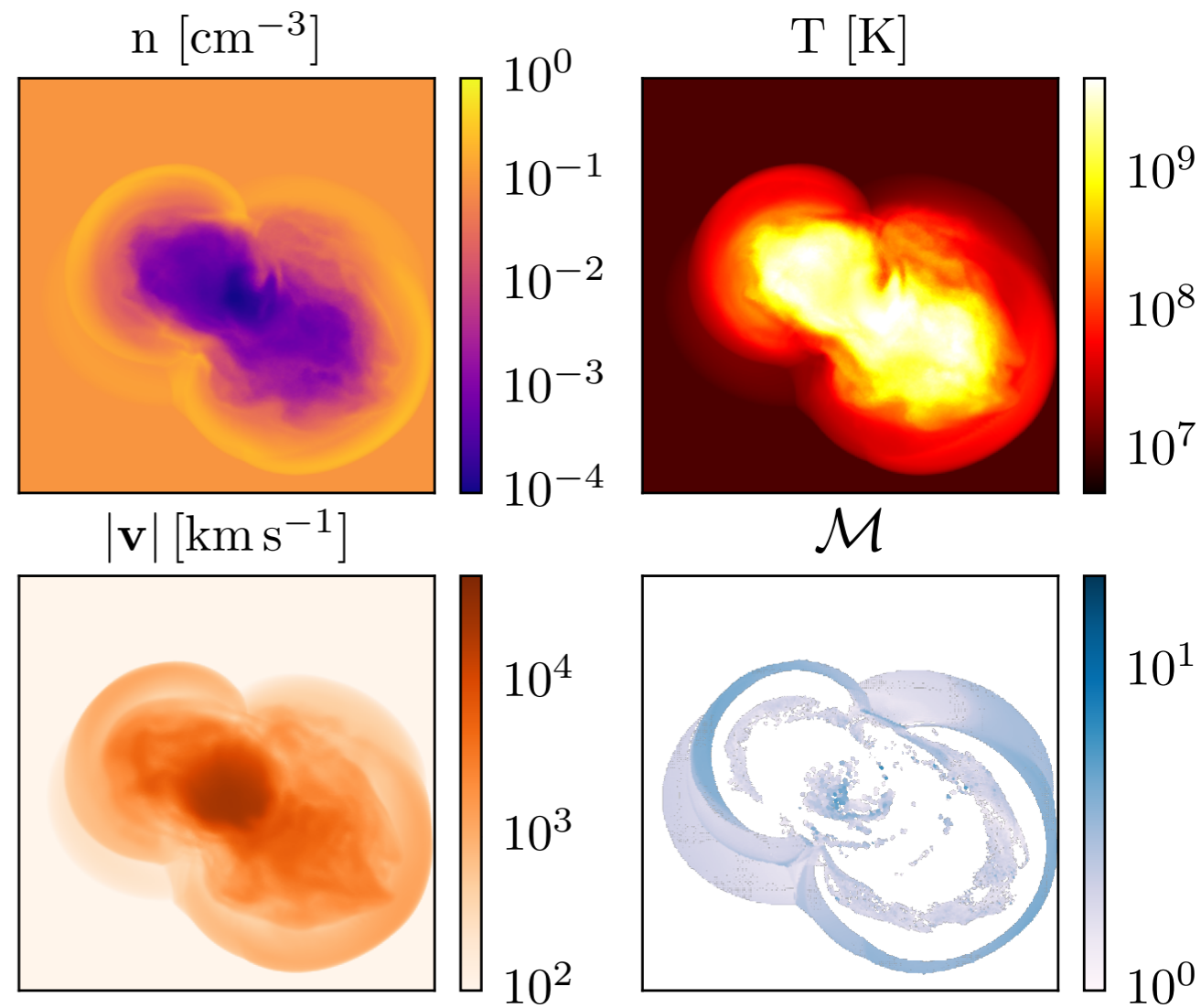


RW+ (subm.), arXiv:1607.03486

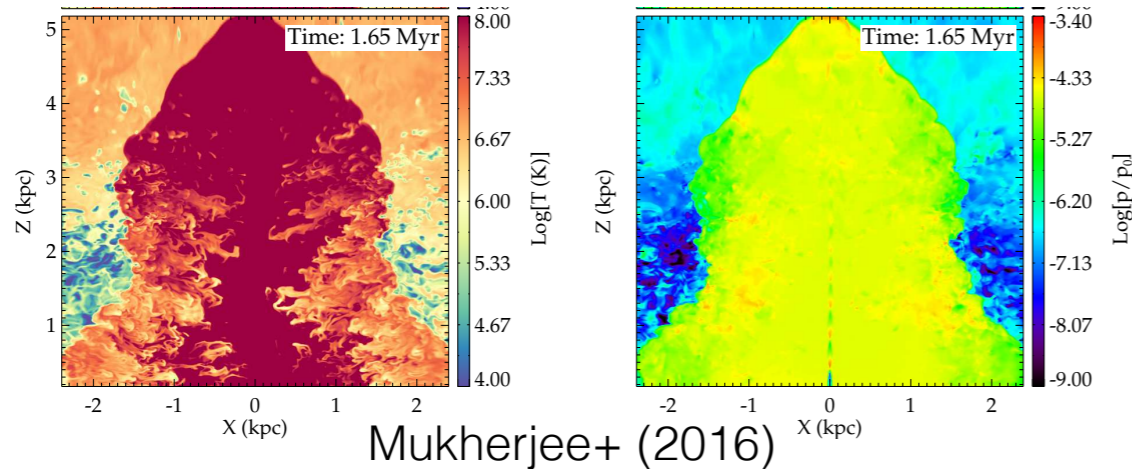
Central heating? Not Jets?



Yuan+ (2015)



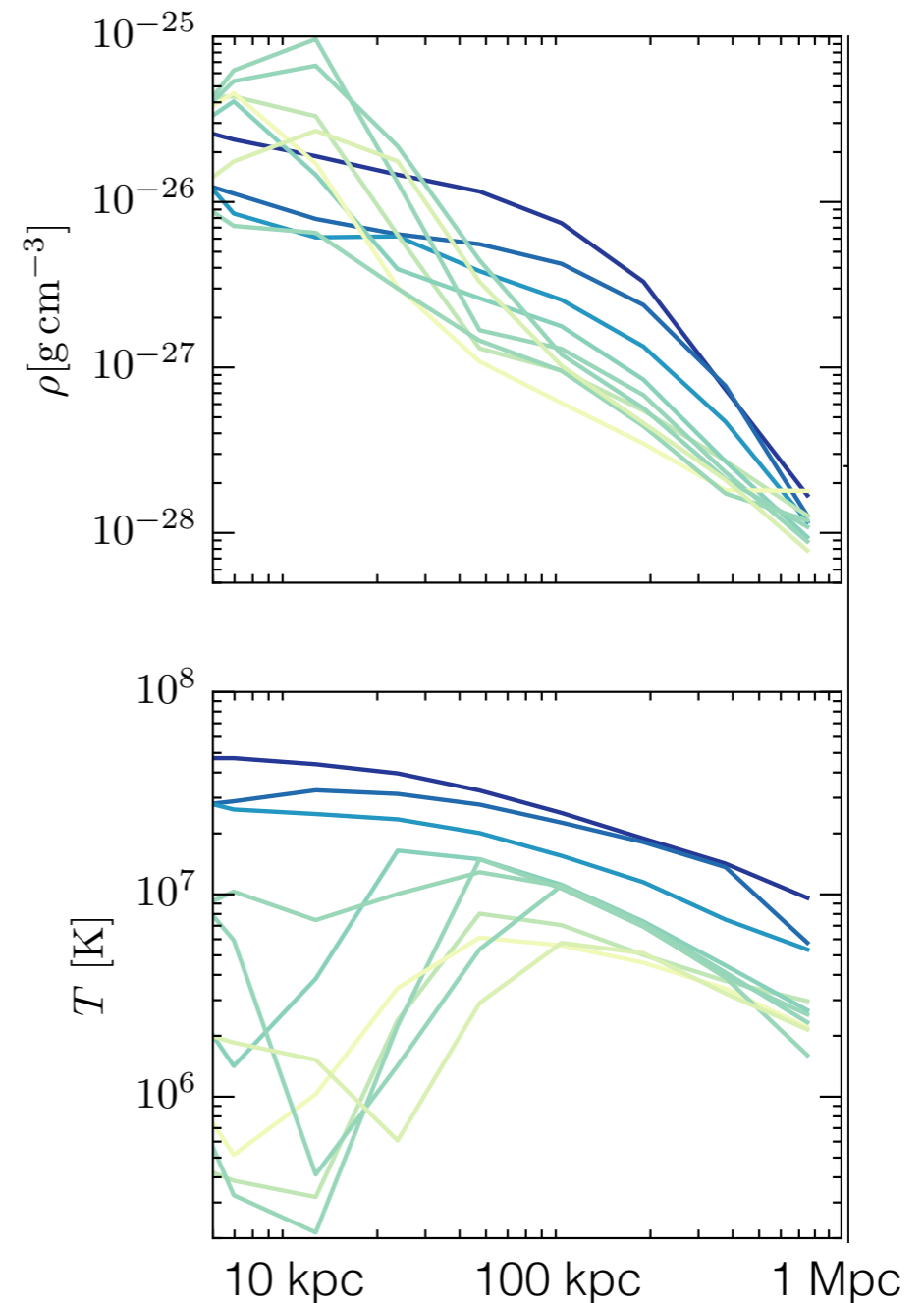
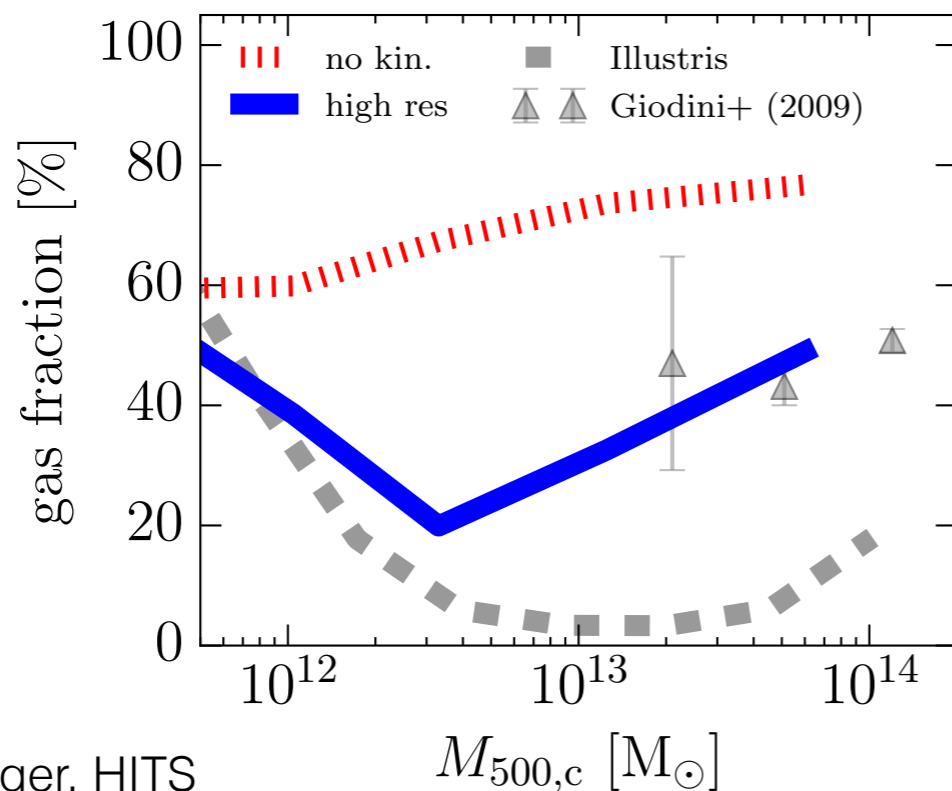
RW+ (subm.), arXiv:1607.03486



Mukherjee+ (2016)

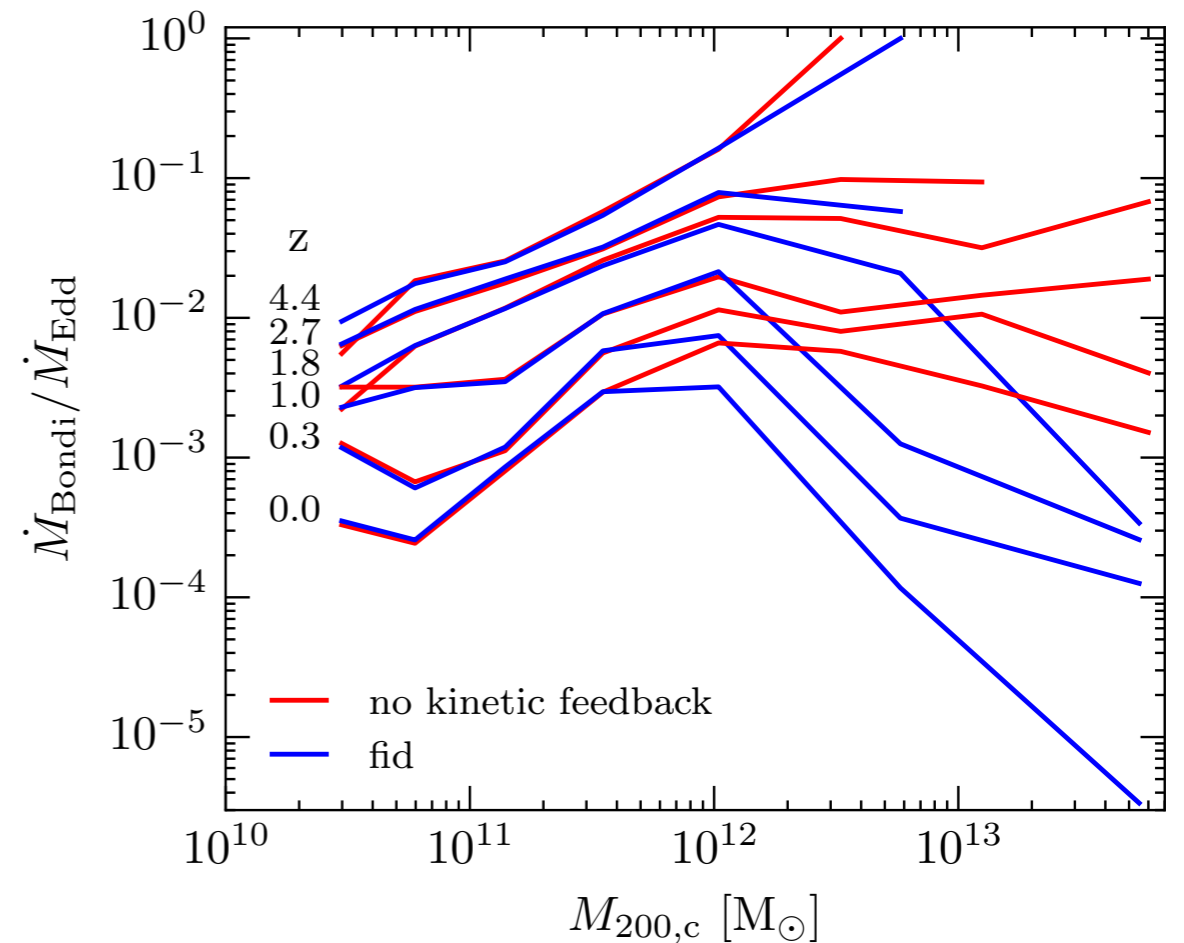
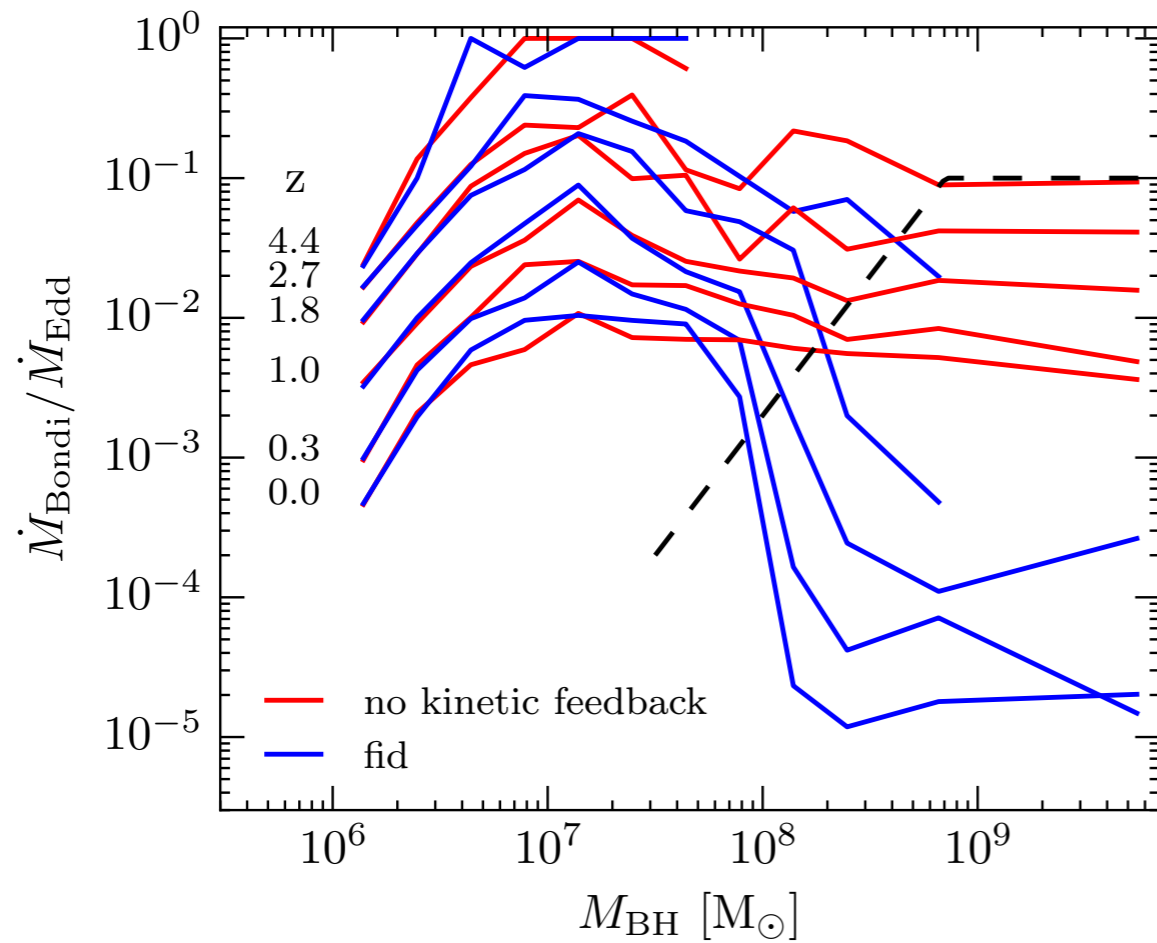
Gas properties

- Kinetic feedback affects gas fractions, but does not overly expel gas
- Individual profiles reveal that gas temperatures in the center are realistic



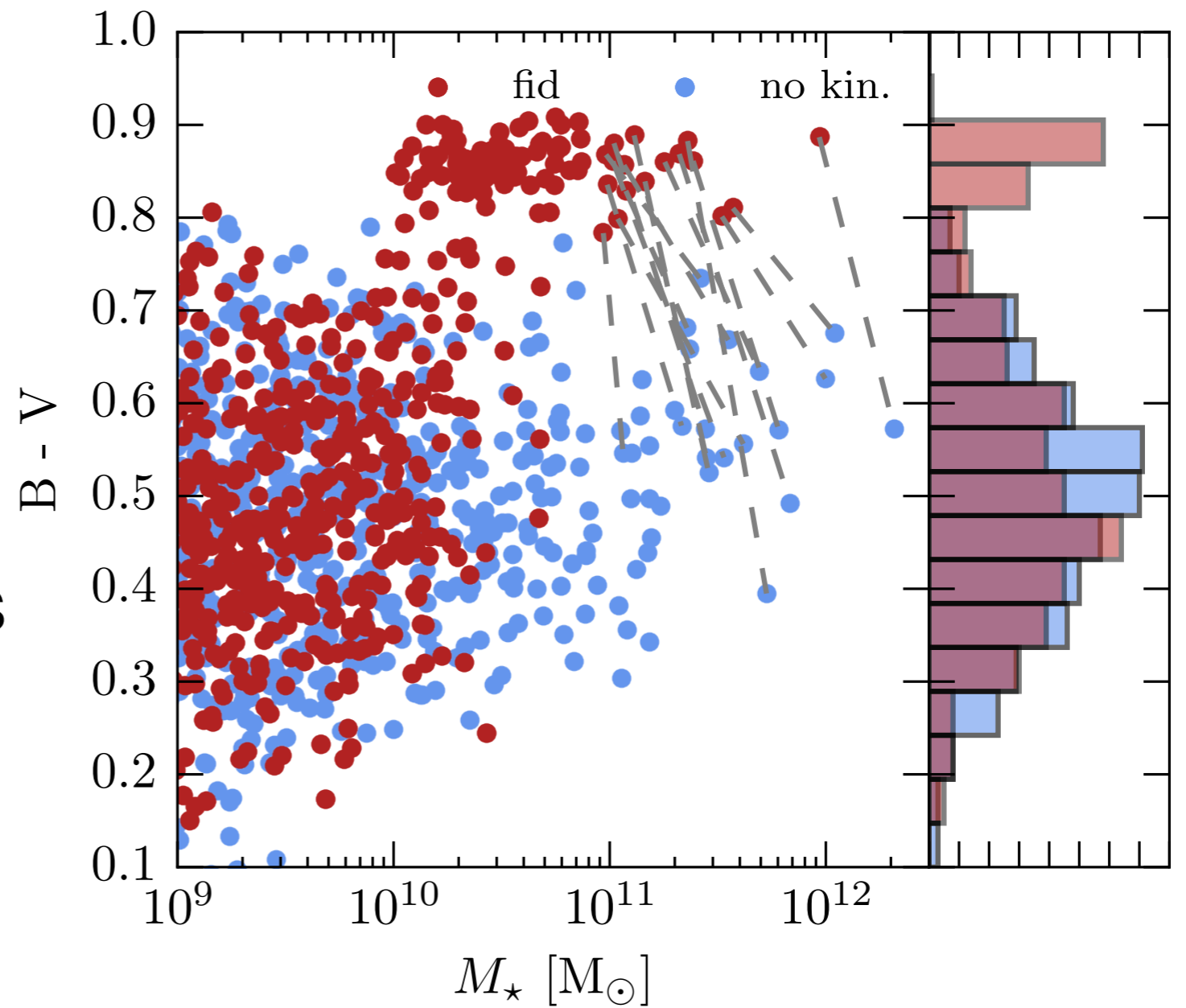
RW+ (subm.), arXiv:1607.03486

Which feedback mode?



Galaxy colors

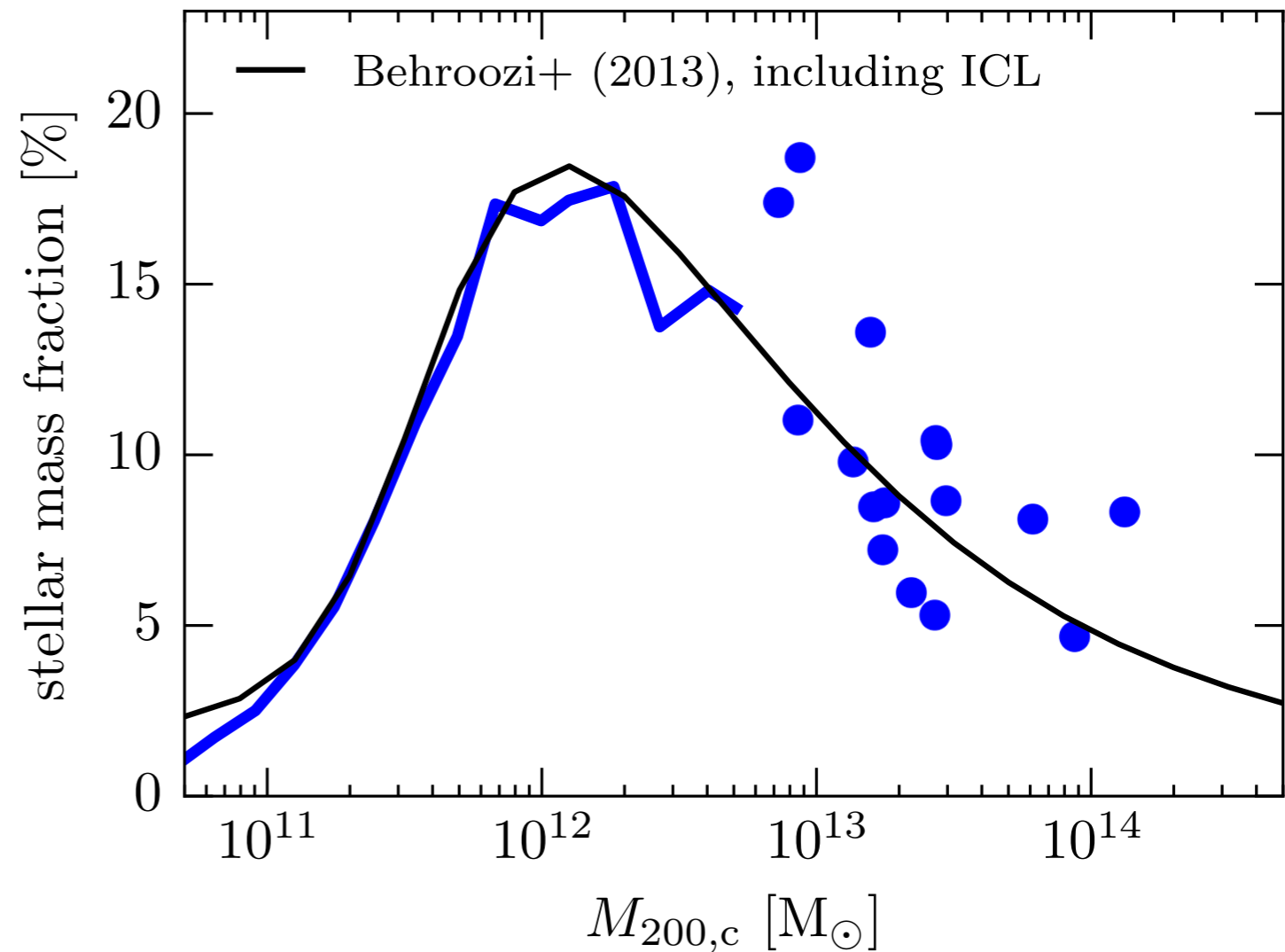
- Colors of centrals
- Kinetic feedback is responsible for the emergence of massive, red galaxies
- Bimodal distribution arising



RW+ (subm.), arXiv:1607.03486

Star formation efficiency

- Clear decrease in star formation efficiency at the high mass end
- Taking into account intra-cluster light and baryonic effects on the total mass, in very good agreement with abundance matching



RW+ (subm.), arXiv:1607.03486

Summary

- New AGN model
- Improves the existing Illustris model significantly
- Larger simulations in progress

