Title: The Simulated CGM at 200 pc

Speakers: Scott Lucchini

Collection/Series: Cosmic Ecosystems

Subject: Cosmology

Date: July 31, 2025 - 10:00 AM

URL: https://pirsa.org/25070048

Abstract:

Simulations with fixed spatial resolution are an excellent tool to investigate the interplay between different phases of gas in and around galaxies because they mitigate the disparity in cell sizes due to density variations in traditional mass-based refinement schemes. Additionally, the moving-mesh technique implemented in Arepo has been shown to minimize numerical mixing and instability suppression. In this talk, I will introduce a new suite of cosmological zoom simulations with 200 pc resolution covering the inner CGM of a Milky Way-mass galaxy, utilizing the full IllustrisTNG galaxy formation model. At this high resolution, we find increased turbulent velocities, many small, cool cloudlets, and a smooth and homogeneous hot phase. I will outline these results and discuss the implications for high- and intermediate-velocity cloud studies and gas mixing in the CGM.

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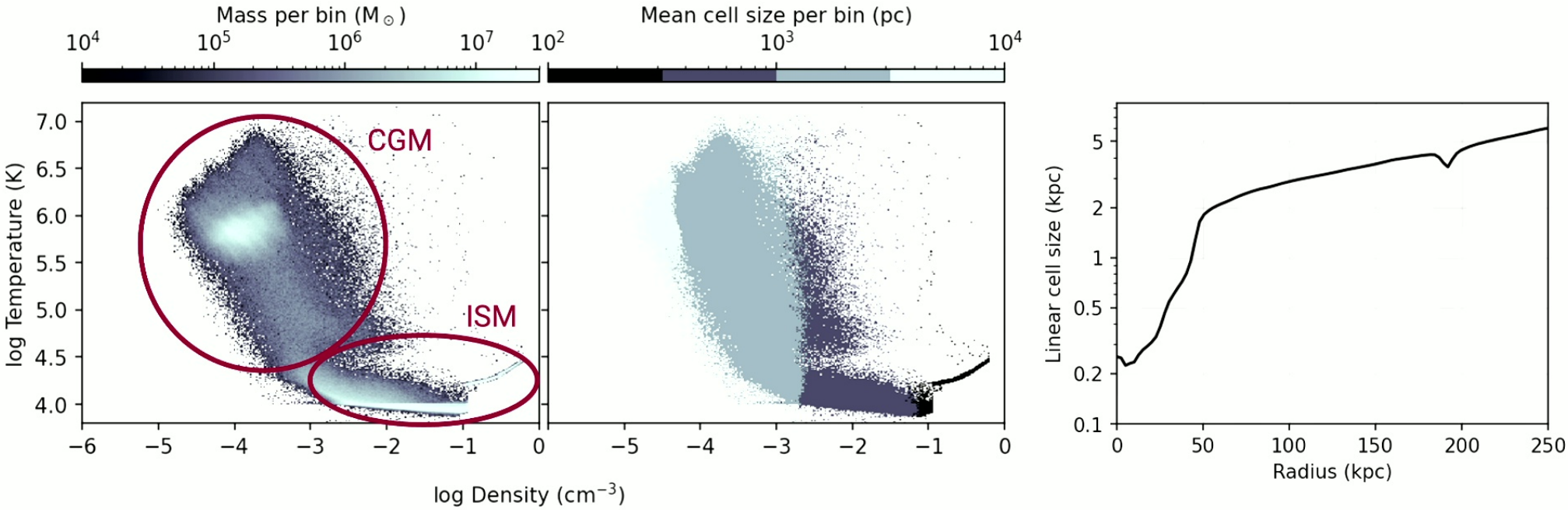
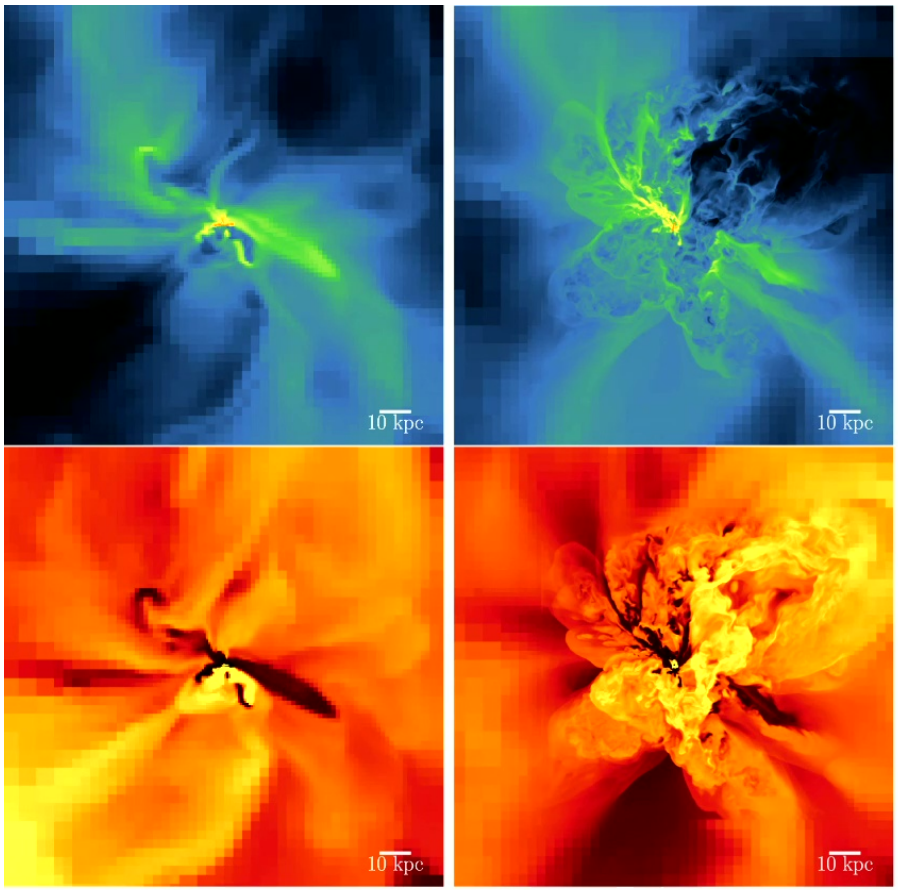
The Circumgalactic Medium at 200pc

The CGM in Cosmological Simulations



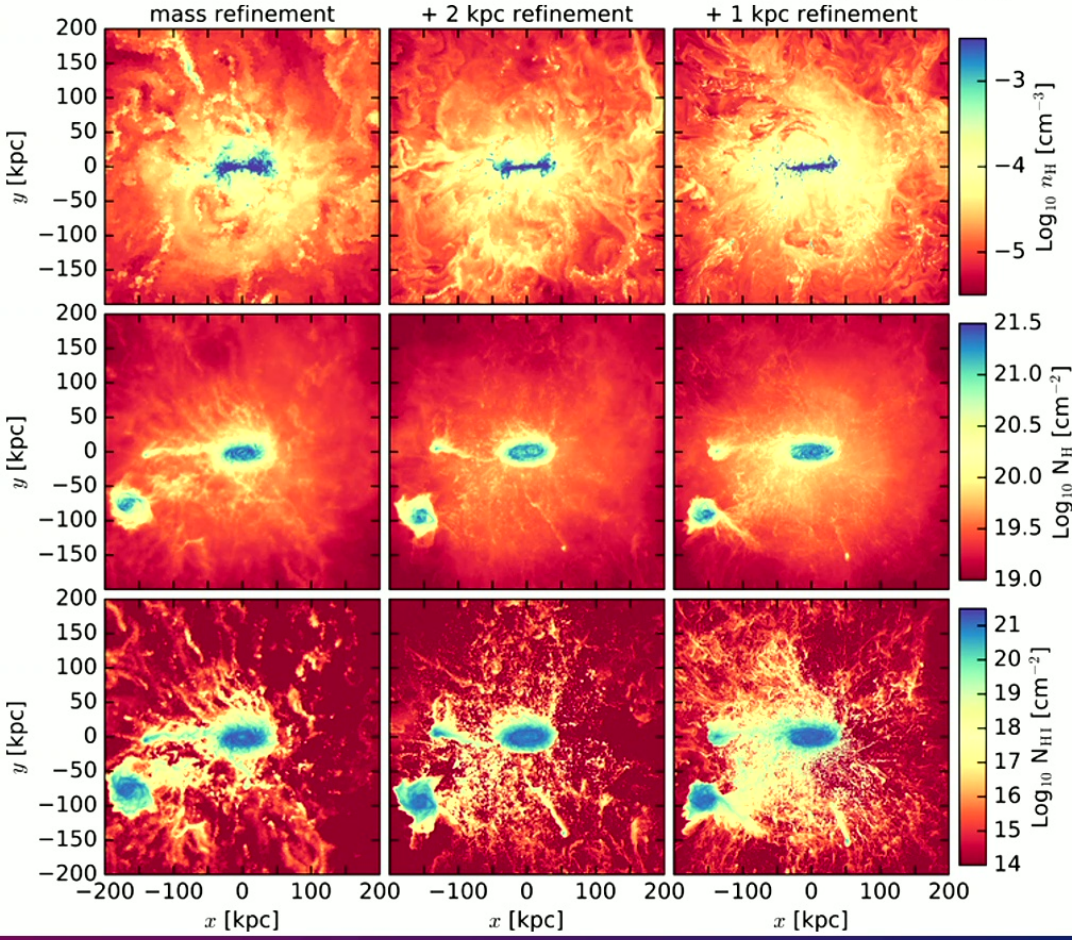


FOGGIE

Peeples+ (2019)

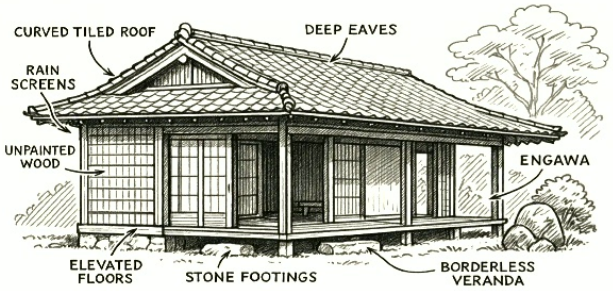
van de Voort+ (2019)

SURGE



ENGAWA simulations

ENhanced Galactic Atmospheres With Arepo



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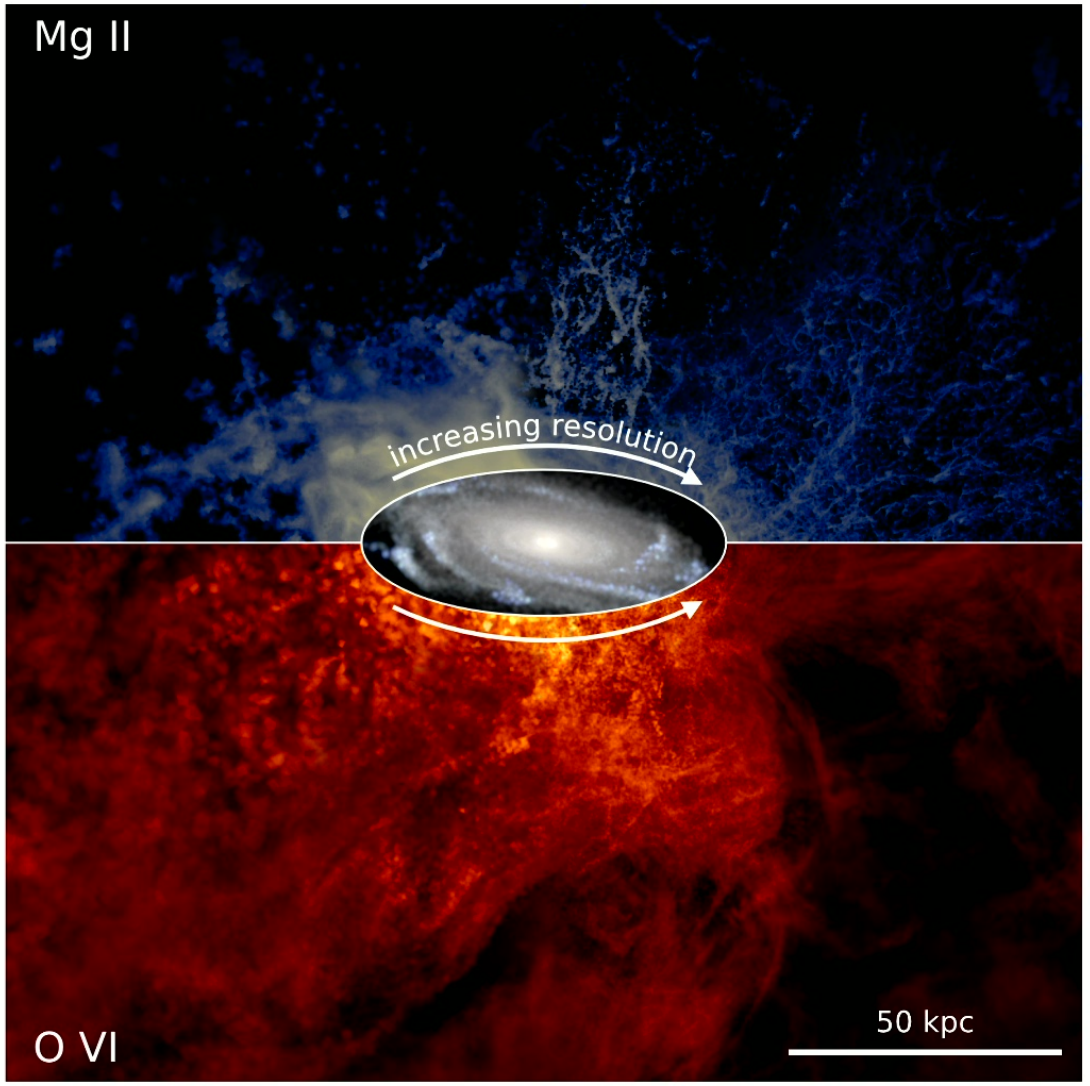
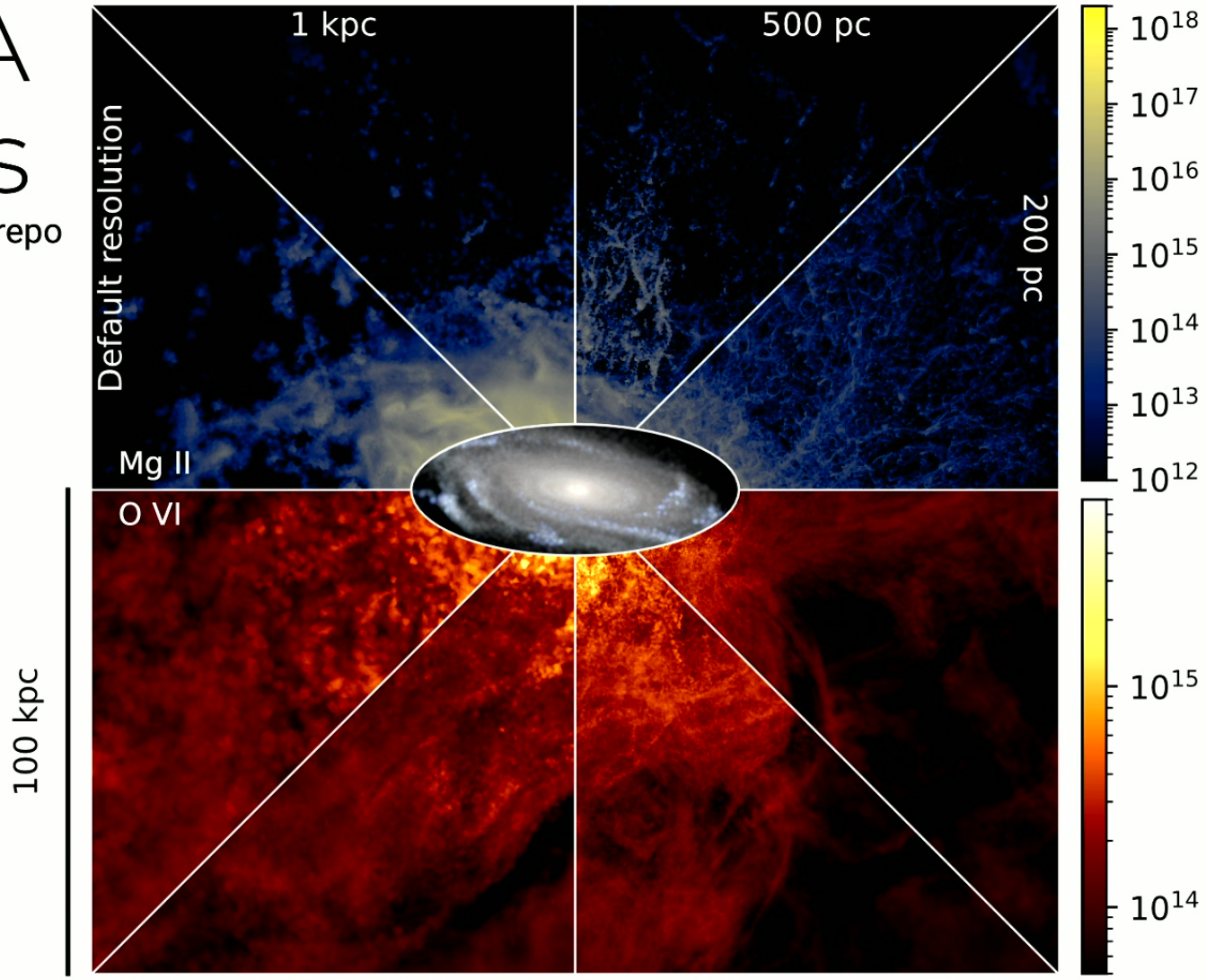


ENGAWA simulations

ENhanced Galactic Atmospheres With Arepo

Interaction between hot phase and cool phase

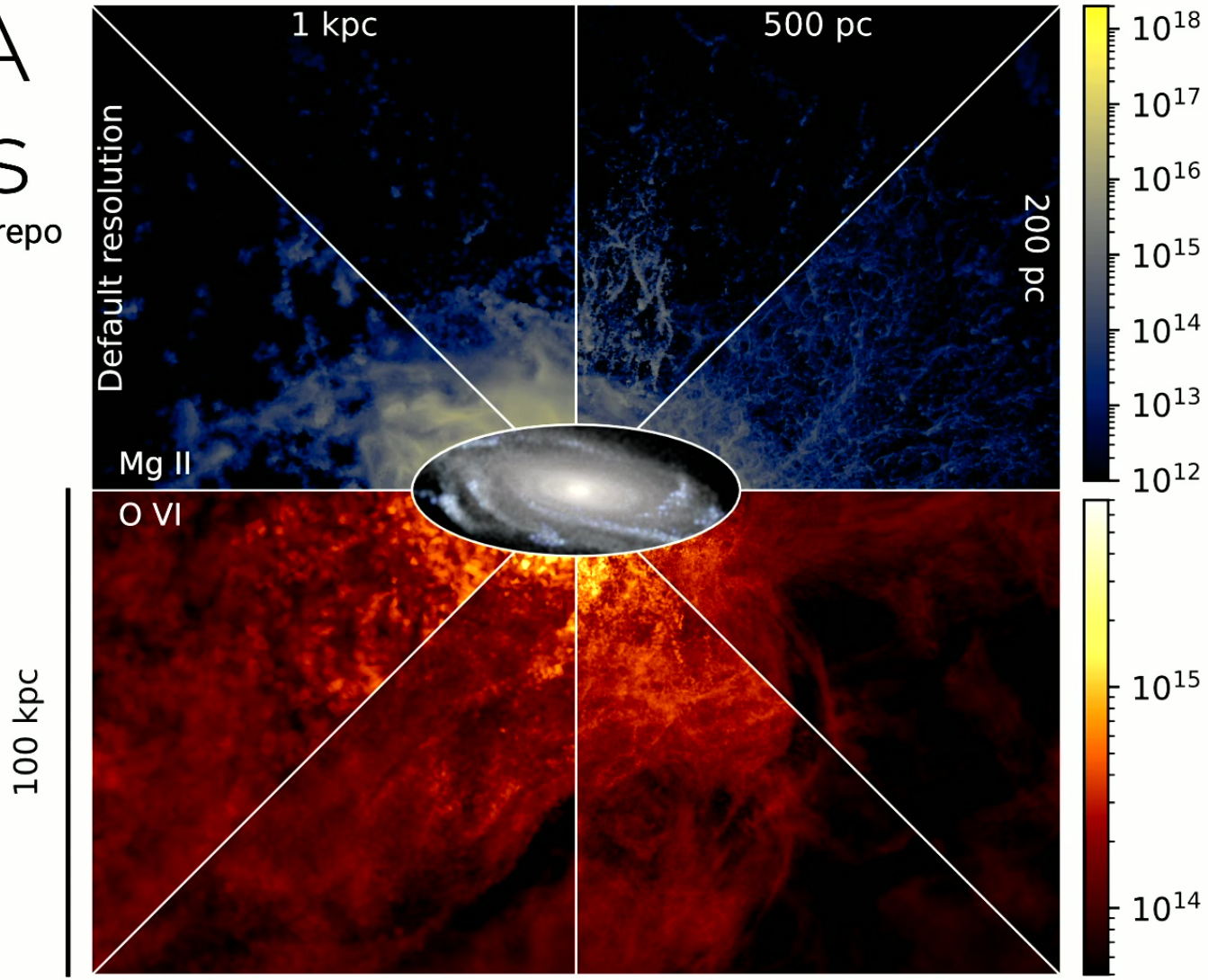
Interaction between CGM and galactic disk

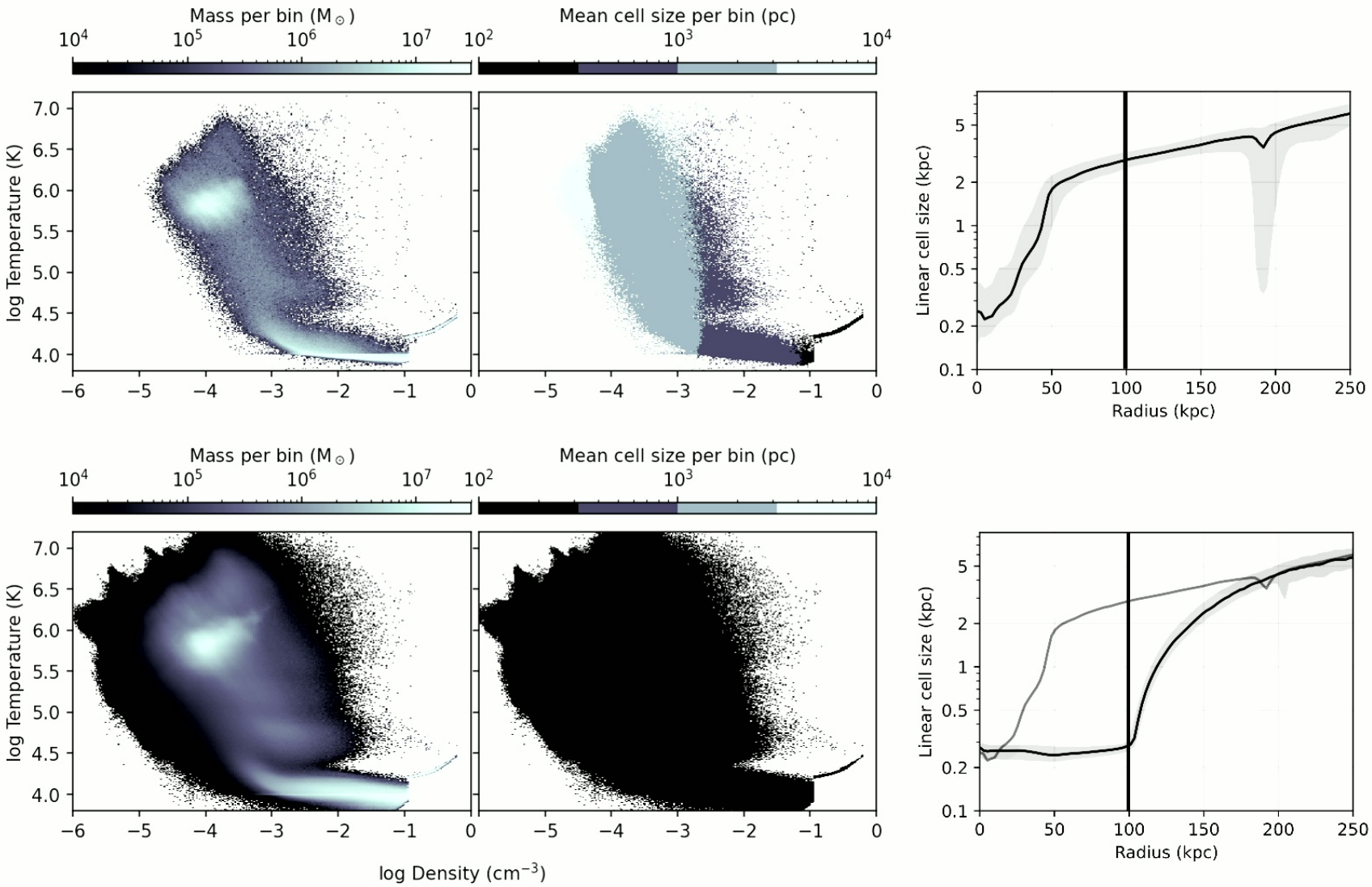


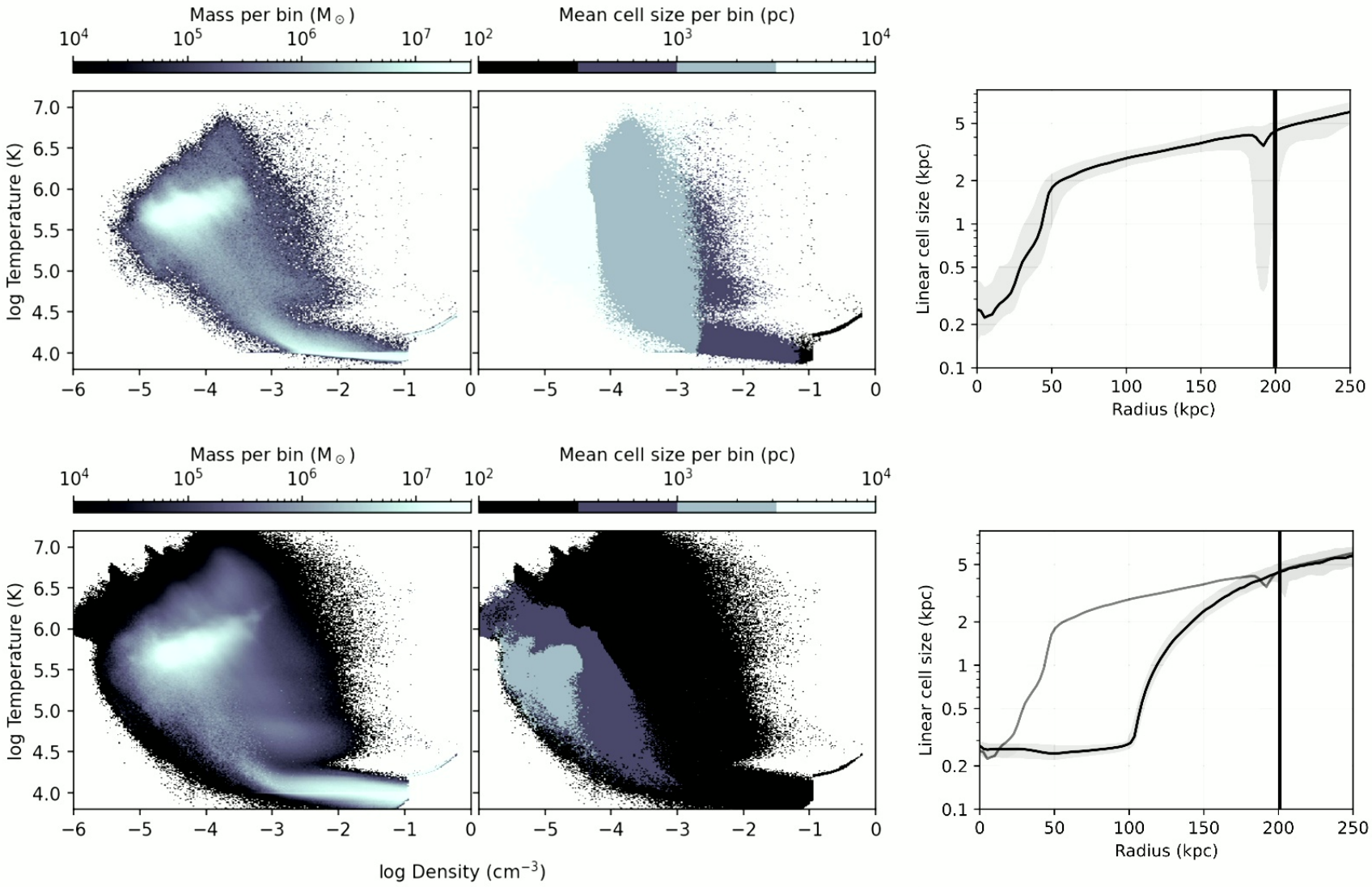
ENGAWA simulations

ENhanced Galactic Atmospheres With Arepo

- Auriga Level 4 ICs
- TNG feedback model
- Thermal + kinetic AGN
- Magnetic fields
- Fixed-volume refinement at $z < 0.3$




Mass per bin ($M_\odot$)
Mean cell size per bin (pc)
log Temperature (K)
log Density (cm^{-3})
Linear cell size (kpc)
Radius (kpc)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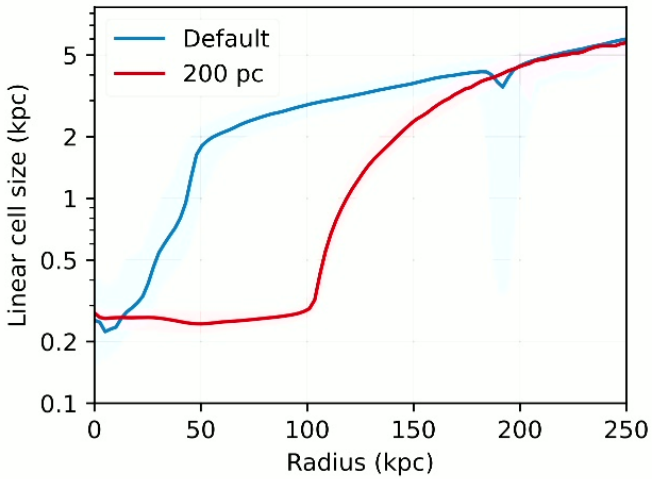
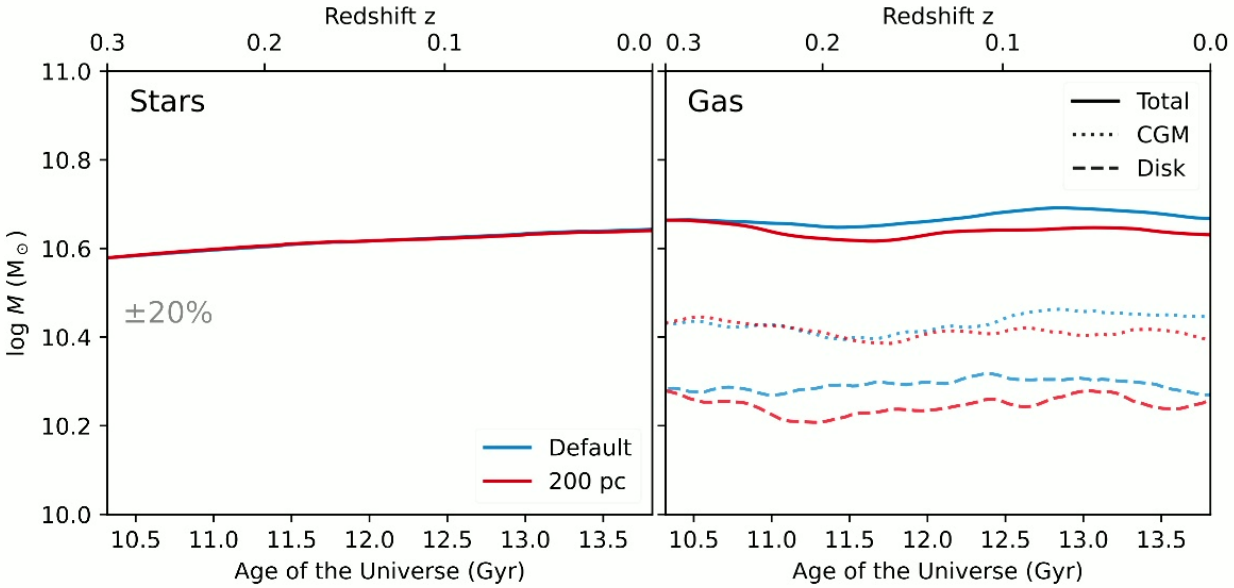
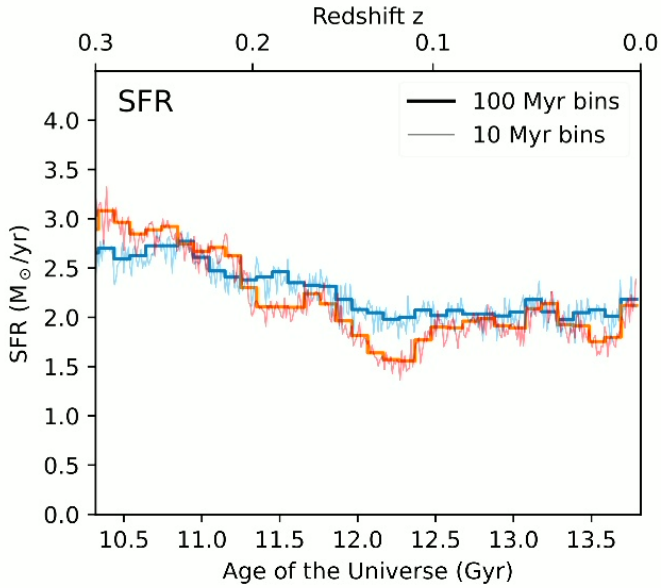
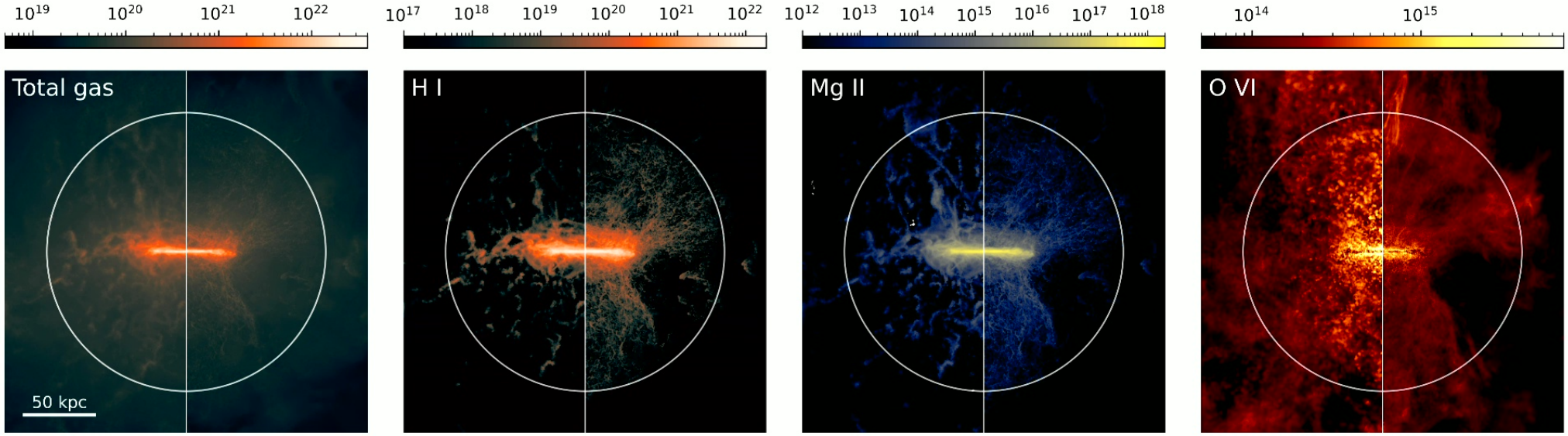
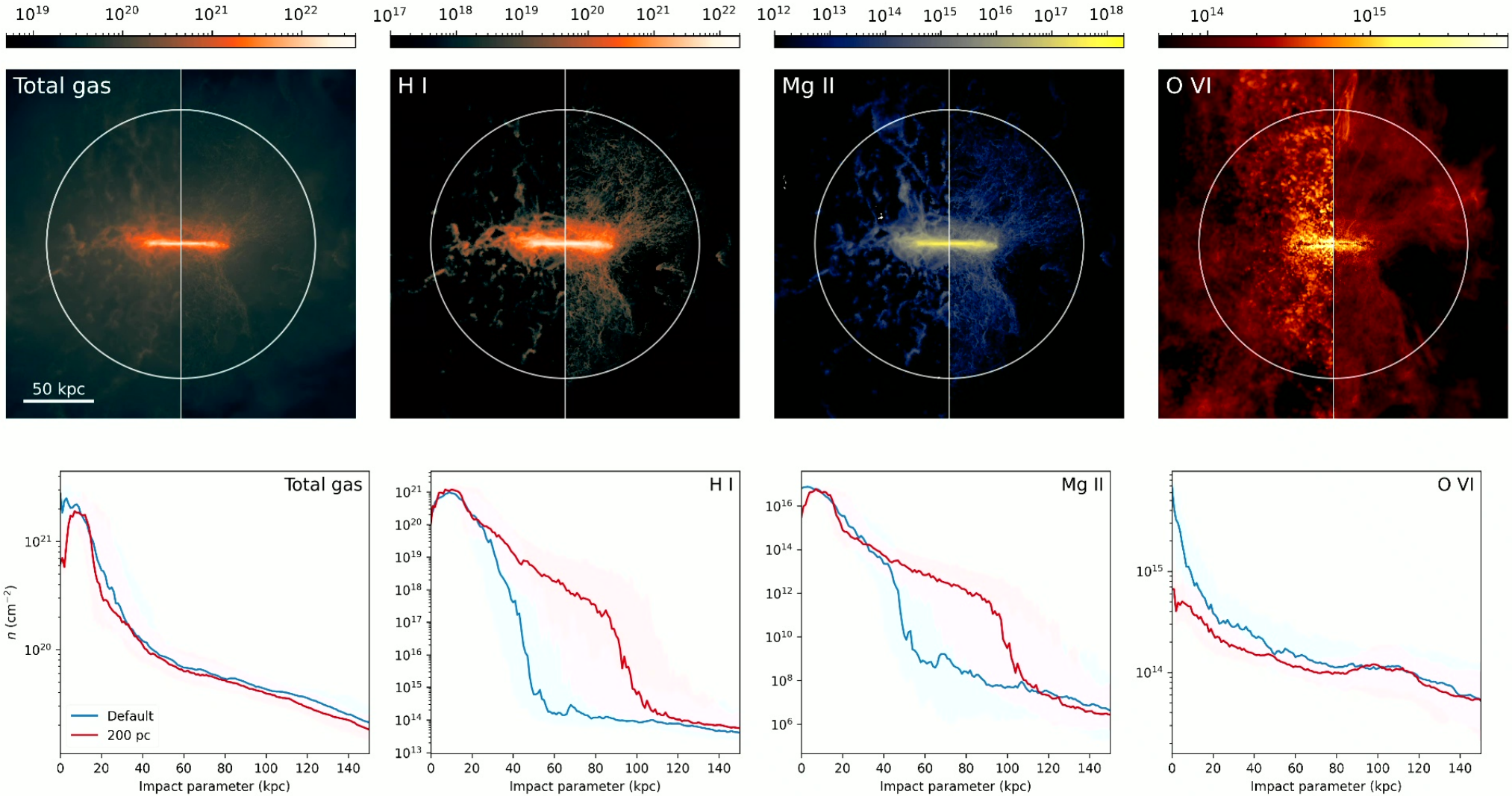

Default
200 pc
Linear cell size (kpc)
Radius (kpc)


Redshift z
Stars
±20%
log M (M⊙)
Default
200 pc
Age of the Universe (Gyr)

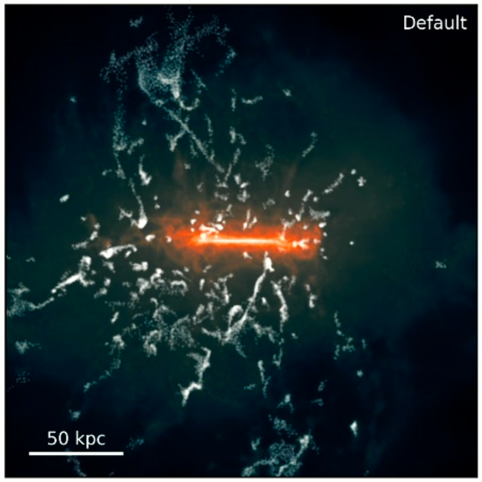
Redshift z
Gas
Total
CGM
Disk
Age of the Universe (Gyr)

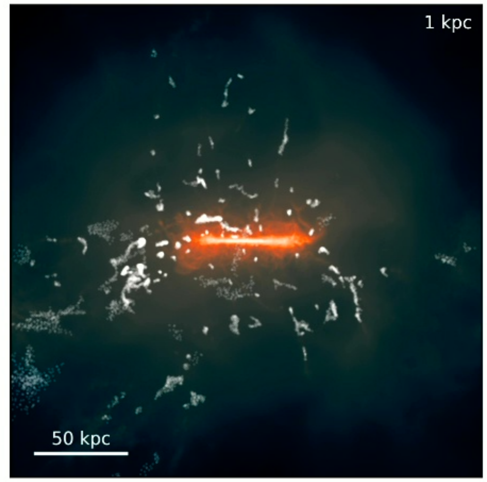

Redshift z
SFR
100 Myr bins
10 Myr bins
SFR (M⊙/yr)
Age of the Universe (Gyr)

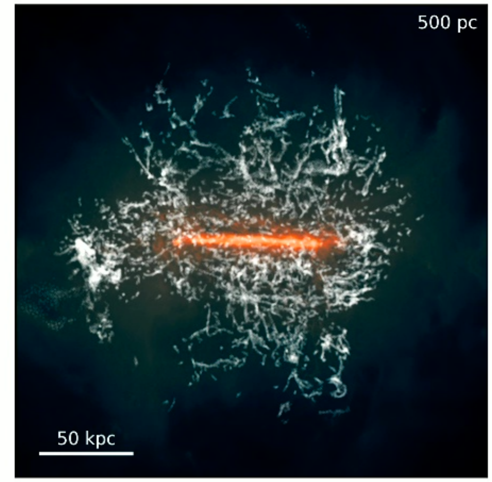

10^{19} 10^{20} 10^{21} 10^{22}
Total gas
50 kpc
10^{17} 10^{18} 10^{19} 10^{20} 10^{21} 10^{22}
H I
10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18}
Mg II
10^{14} 10^{15}
O VI


Total gas
H I
Mg II
O VI
50 kpc
Total gas
H I
Mg II
O VI
n (cm⁻²)
Default
200 pc
Impact parameter (kpc)
Impact parameter (kpc)
Impact parameter (kpc)
Impact parameter (kpc)

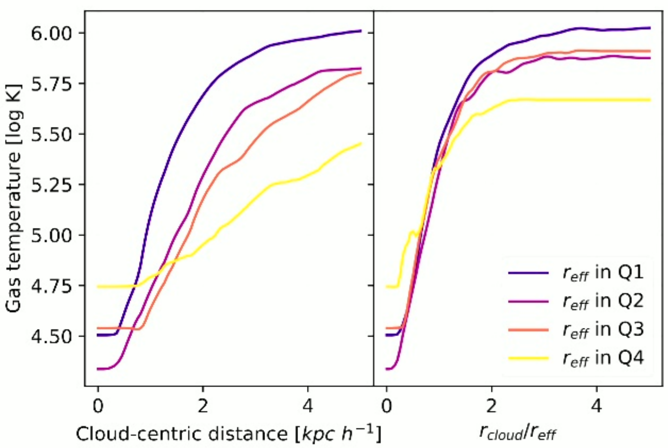
Cece Abramson
Caltech



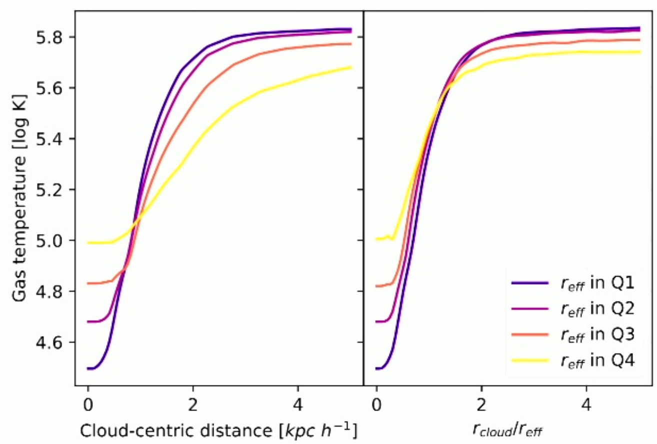




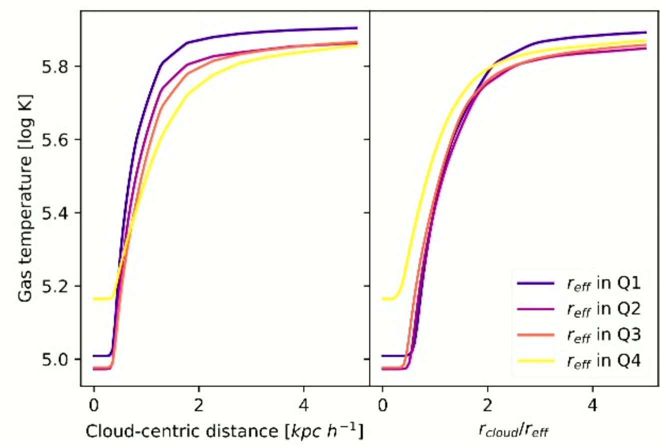
Default



1 kpc

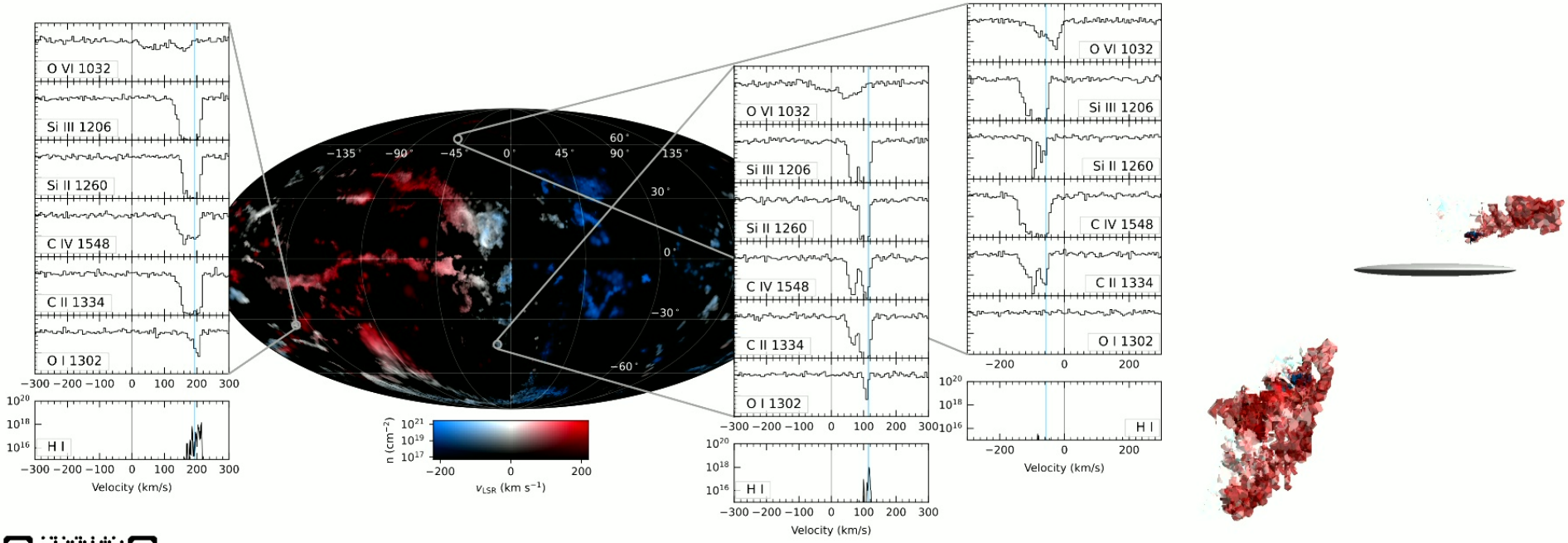


500 pc



Invisible Accretion:

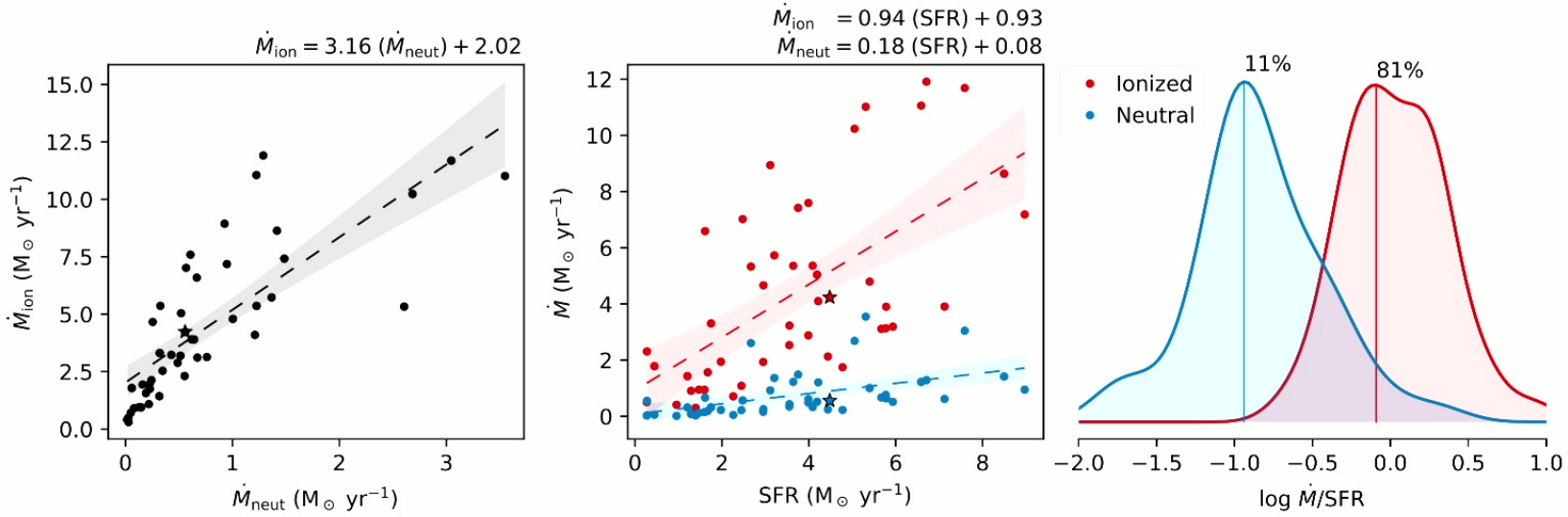
Ionized Envelopes of TNG50 HVCs can Sustain Star Formation



arXiv:2507.18687

Lucchini, Han, Hernquist, et al. ApJ, accepted. (2025)

Invisible Accretion:
Ionized Envelopes of TNG50 HVCs can Sustain Star Formation



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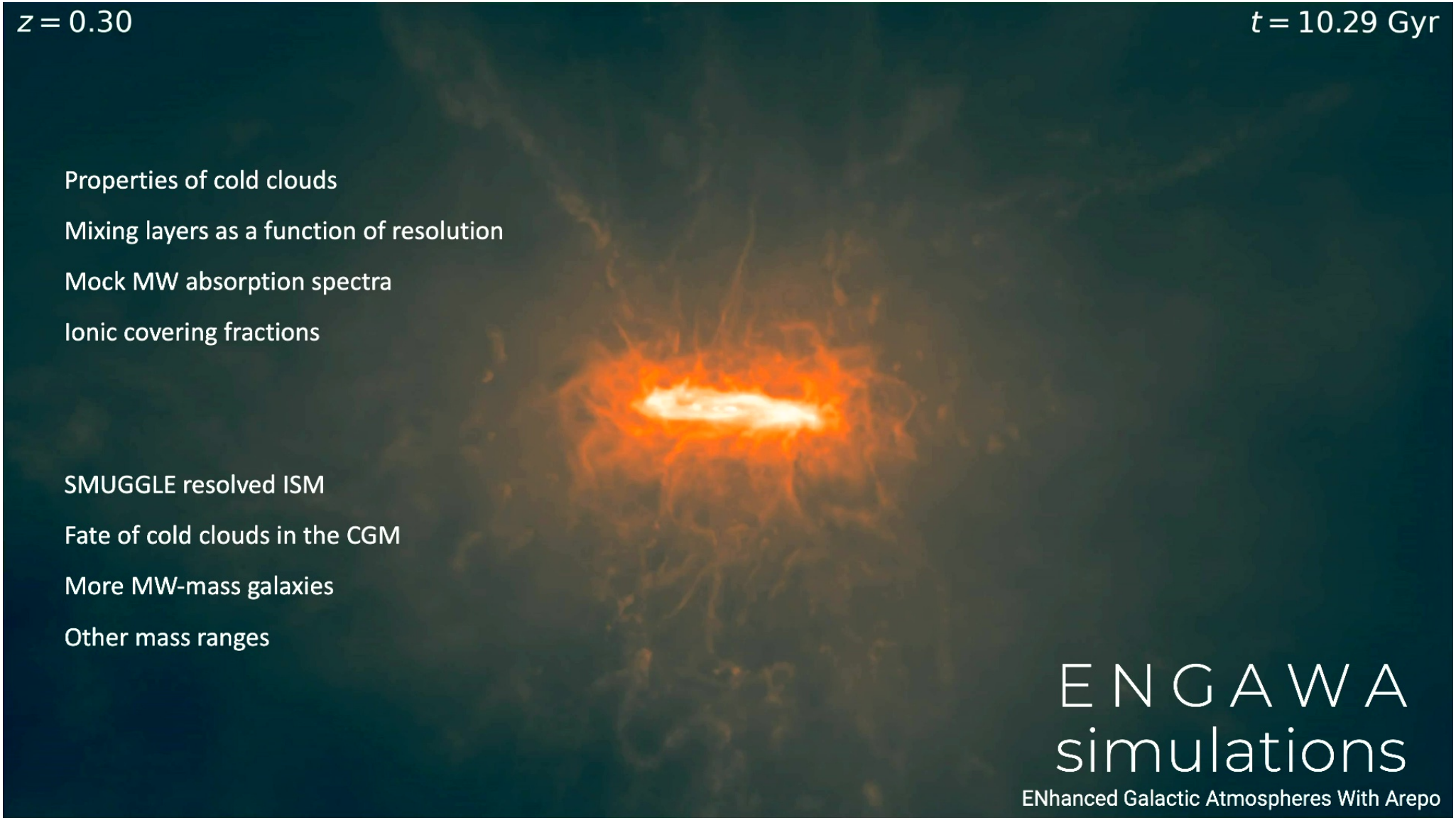
$z = 0.30$
$t = 10.29$ Gyr
Properties of cold clouds
Mixing layers as a function of resolution
Mock MW absorption spectra
Ionic covering fractions
SMUGGLE resolved ISM
Fate of cold clouds in the CGM
More MW-mass galaxies
Other mass ranges
ENGAWA simulations
ENhanced Galactic Atmospheres With Arepo