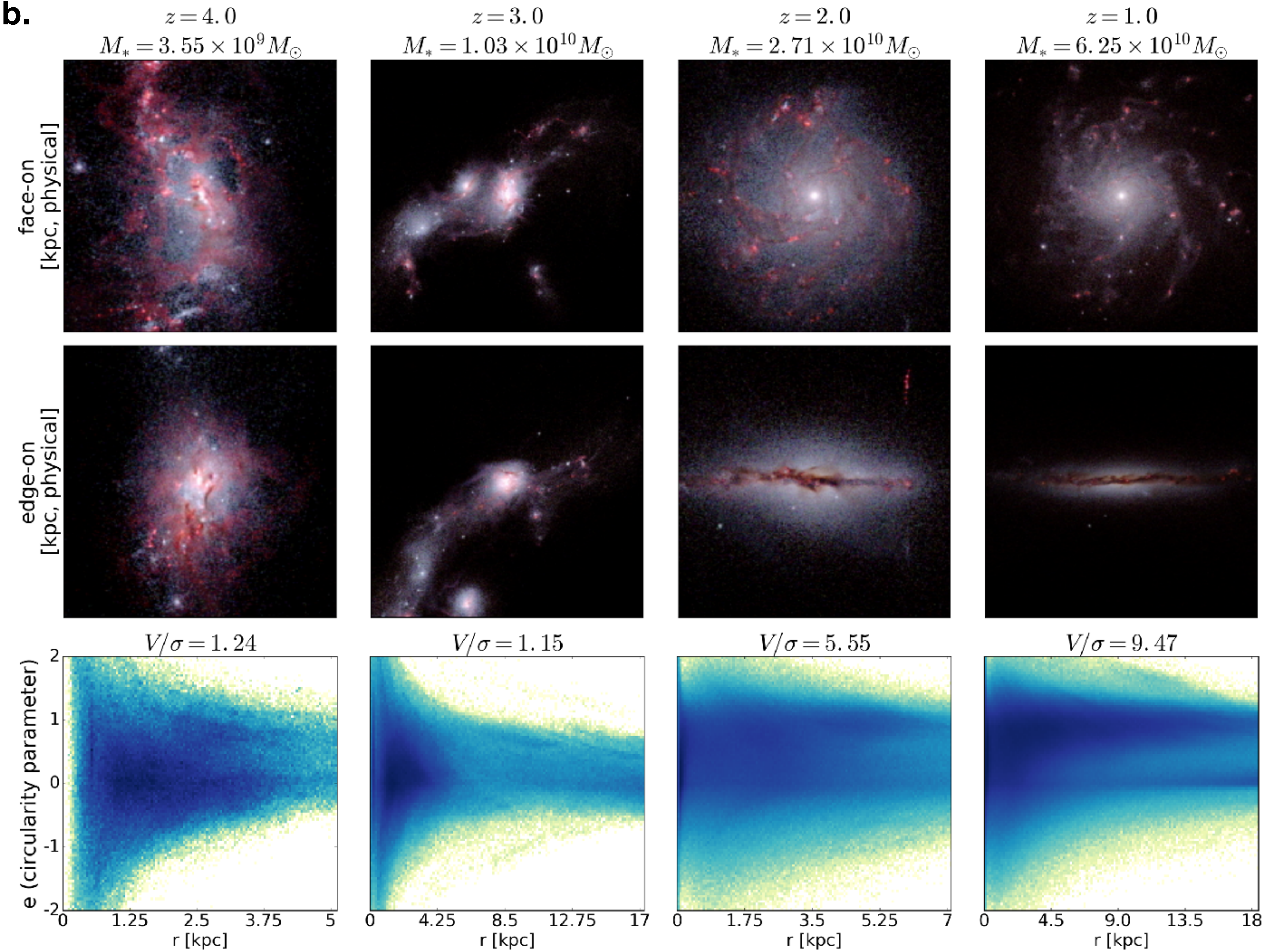
High-resolution Cluster Simulation

- Ramses Sciences at Yonsei 2018 -

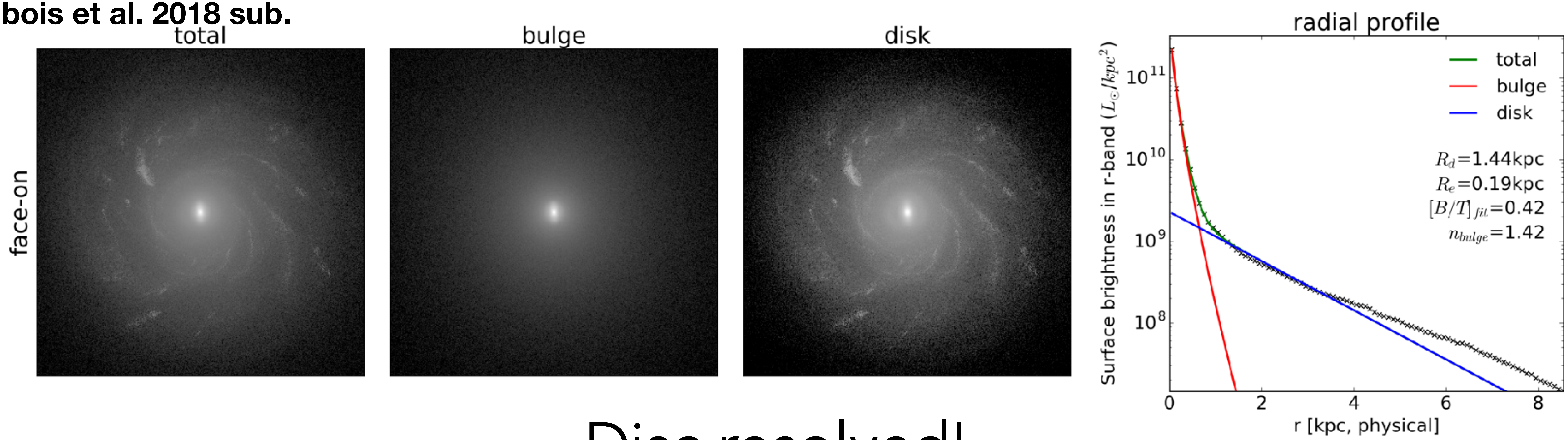
Sukyoung K. Yi

Dubois et al. 2018 sub.

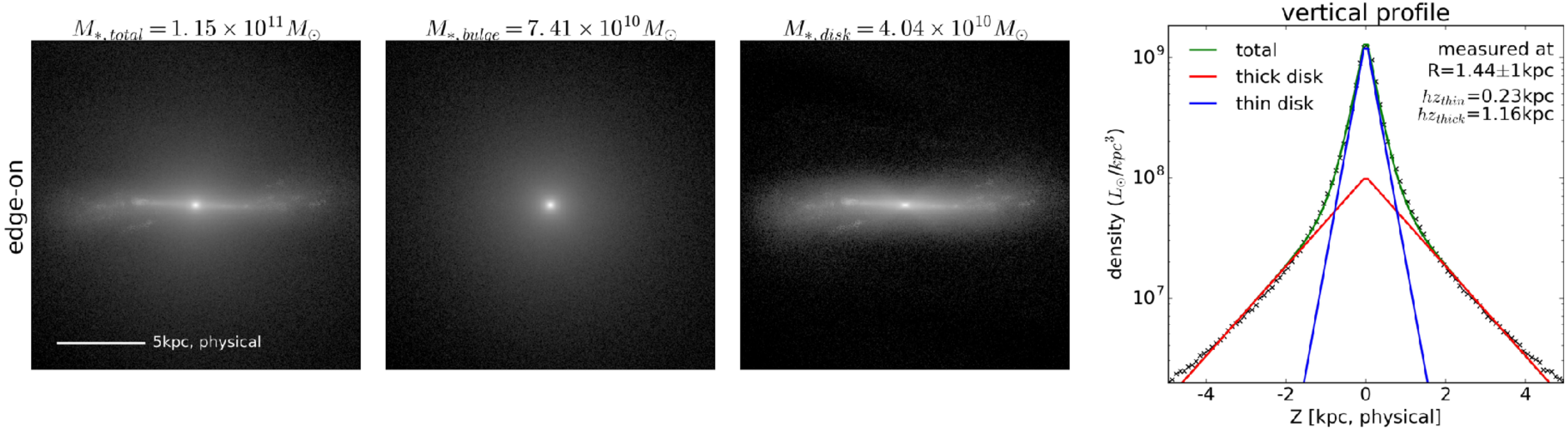
Disc settling



Dubois et al. 2018 sub.



Disc resolved!



Minjung Park in prep

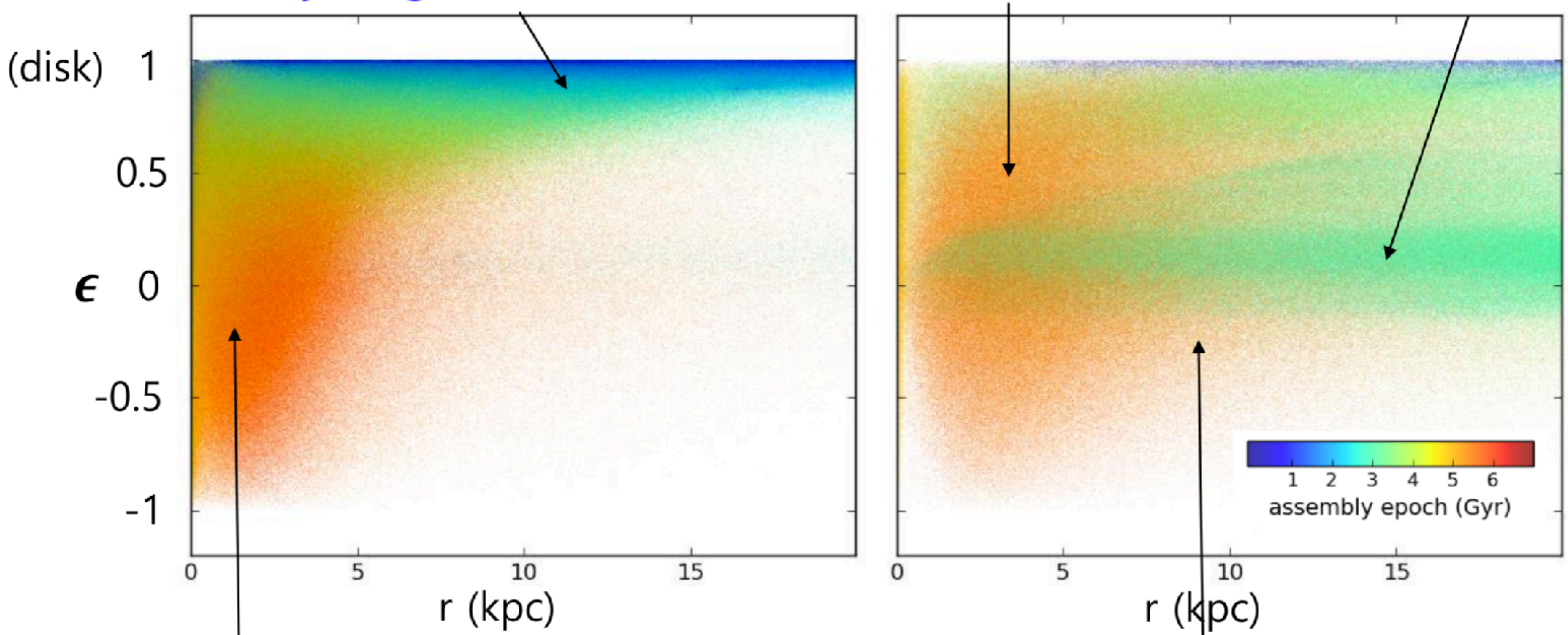
All Stars in an exampled disk-dominated (D/T>0.5) galaxy

insitu SF | **accretion**

young stars $\epsilon \sim 1$ (disk)

merger at **z~3**

merger at **z~1.5**



Old stars – disordered (inner regions) "bulge"

mostly disordered
recent accretion – **larger radii**

Origin of the structures of galaxies

Minjung Park in prep

Measured at z=0.7

Aligned (disk-origin)
66% ±8%

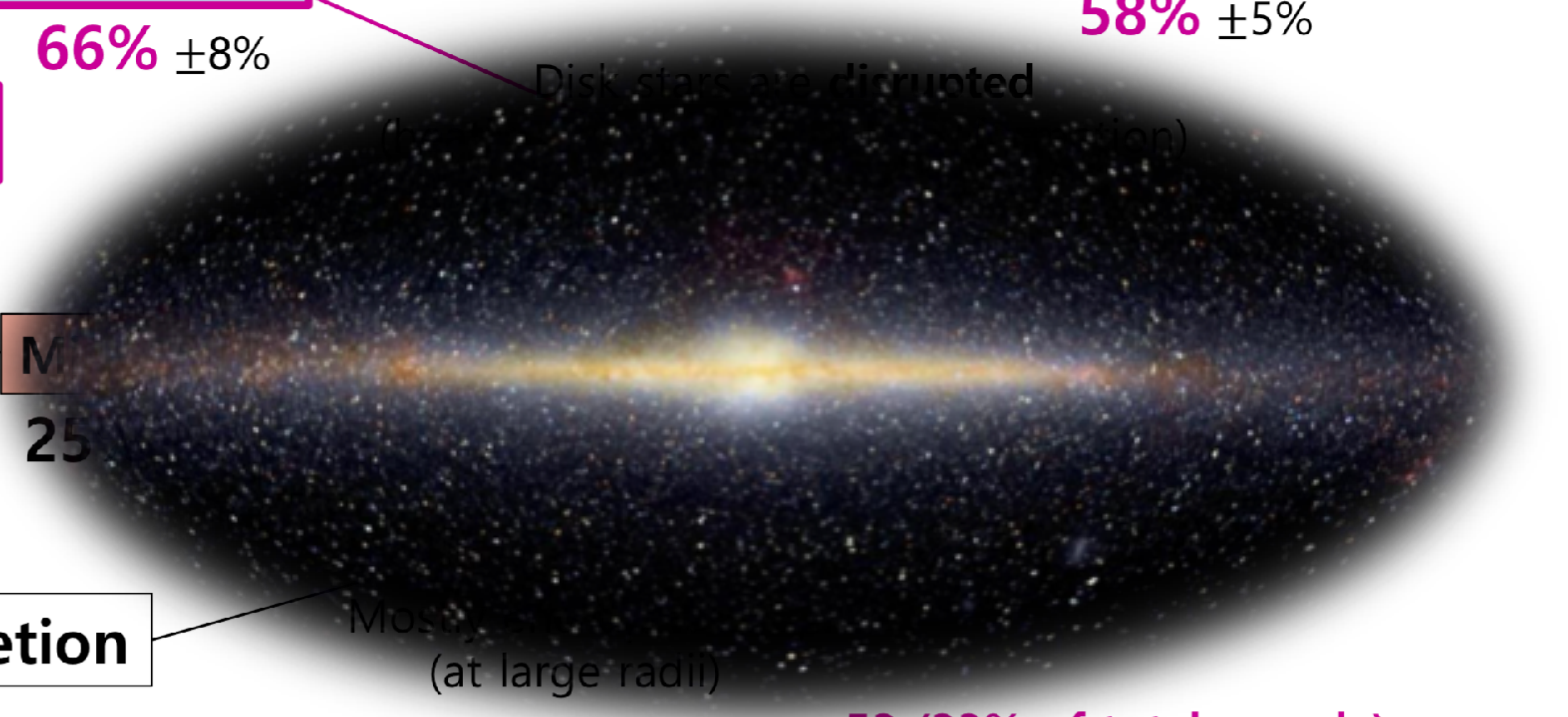
Massive galaxies → As **z** decreases

Disk ↑
58% ±5%

In situ SF
91% ±8%

Disk stars are disrupted

M
25



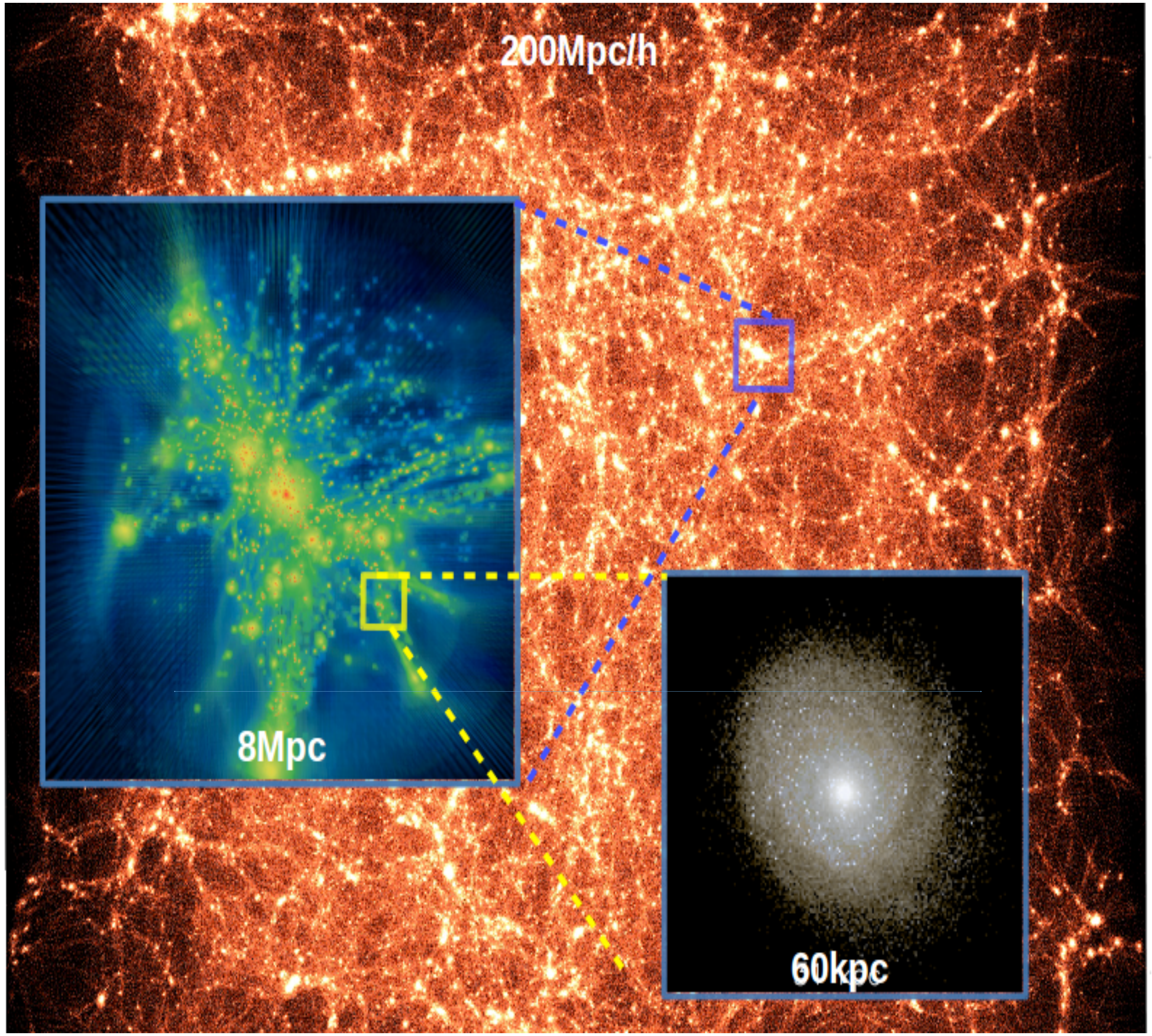
Accretion
9% ±8%

(at large radii)

53 (33% of total sample)

Yonsei Zoom-in Cluster Simulation (YZiCS)

- RAMSES (AMR, Teyssier 2002)
- KISTI 10M Chr
- Baryon recipes: SF, SN, AGN FB (HAGN: Dubois et al. 2014)
- 16 clusters in 200Mpc/h
- $13.5 < \log M/M_\odot < 15.0$
- $dm_* = 4e5$
- $dm_{DM} = 8e7$
- dx = 0.76kpc/h
- C.f. Bahe et al. 2013 (Gadget3, $dm_g \sim 1e6$, dx~1, noAGN, n~30 above 13.5)
- C.f. Barnes et al. 2017 (Gadget3, $dm_g \sim 2e6$, dx~1, AGN, n~30 above 14)



200Mpc/h

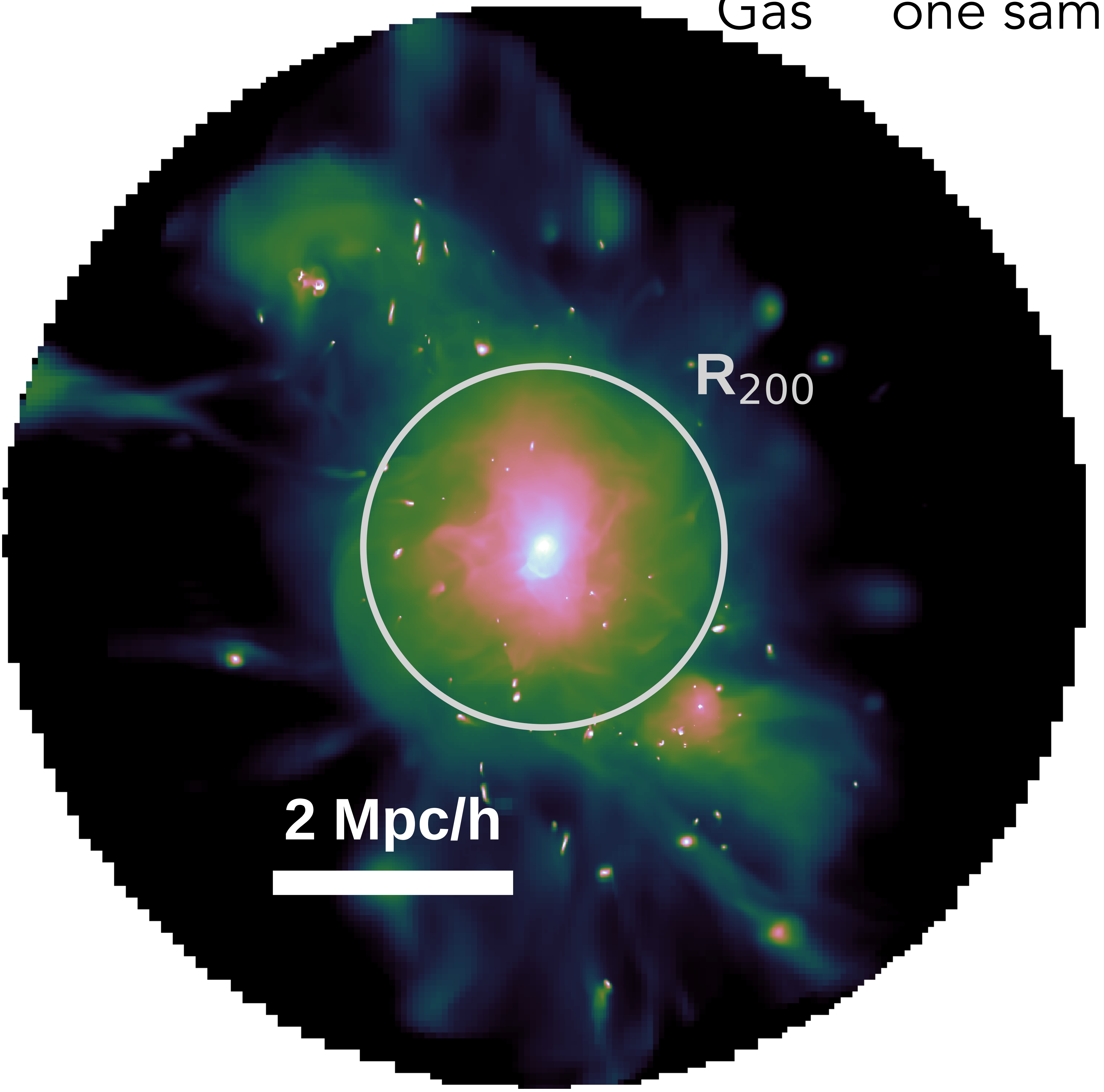
YZiCS papers

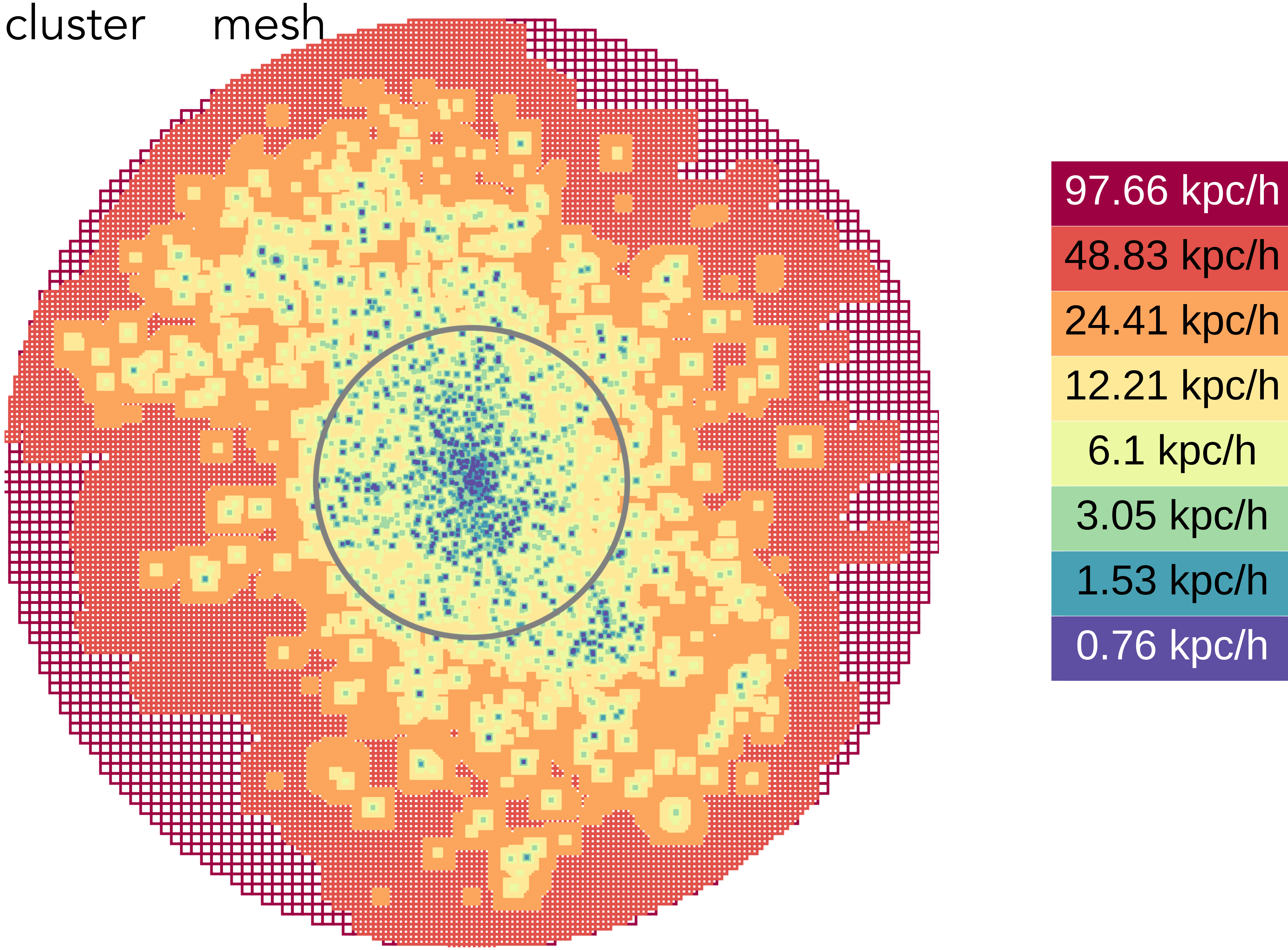
- Smith et al. 2016, ApJ, 833, 109 "Tidal stripping of DM and stars in galaxies"
- Choi & Yi 2017, ApJ, 837, 68 "Galaxy spin evolution in clusters"
- Rhee et al. 2017, ApJ, 843, 128 "Phase space analysis: Time since infall"
- Lee et al. 2018, ApJ, 864, 69 "Wobbling galaxy spin axes in dense environments"
- Jung et al. 2018, ApJ, in press "SF quenching of cluster galaxies":astro-ph/1809.01684
- Han et al. 2018, ApJ, in press "Preprocessing of dark haloes":astro-ph/1809.02763
- Rhee et al. 2018 ApJ, in prep "SF quenching of cluster galaxies using phase space analysis"

Jung et al. 2018, ApJ, in press: arXiv:1809.01684

Resolution

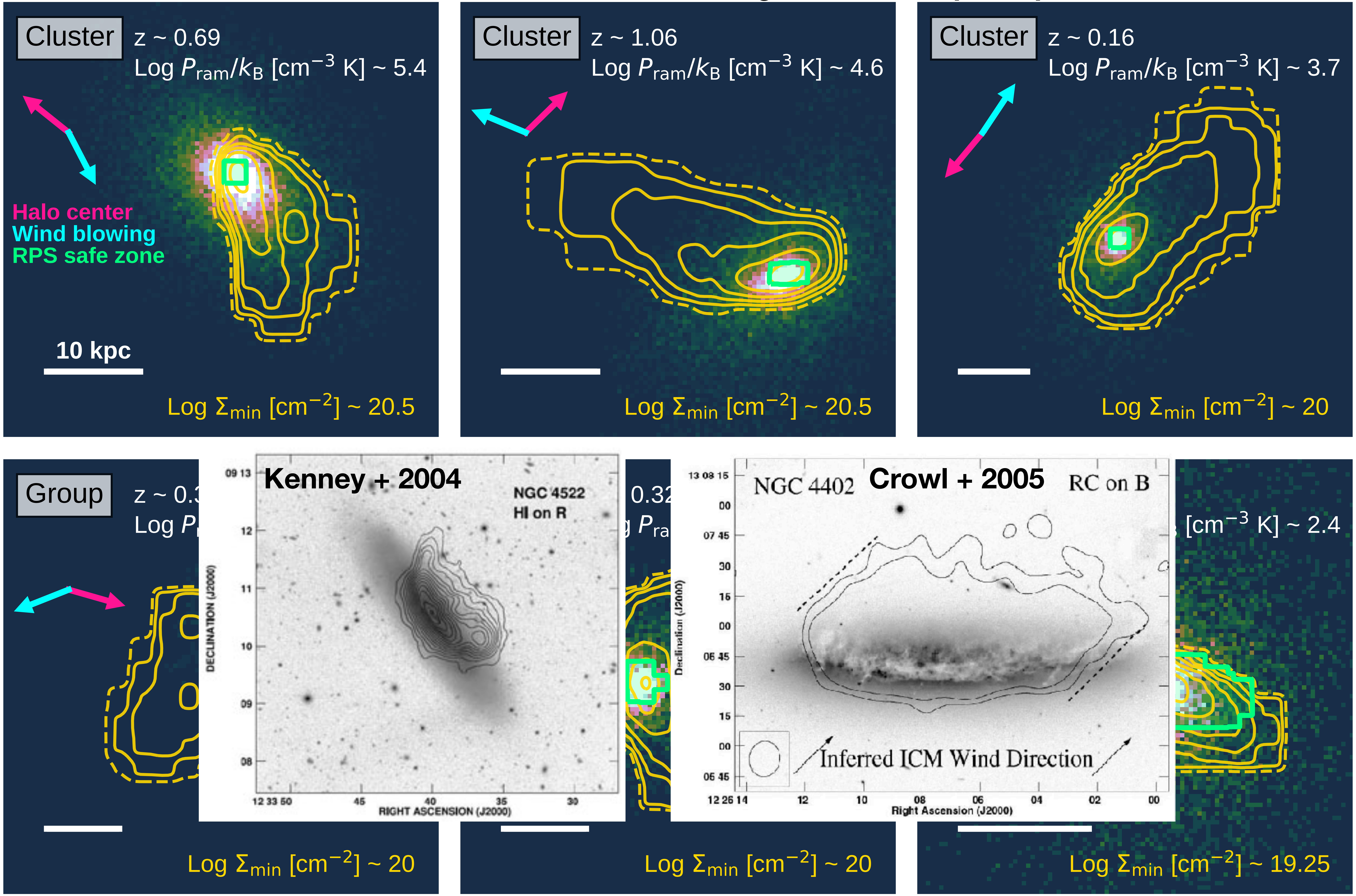
Gas one sample cluster mesh





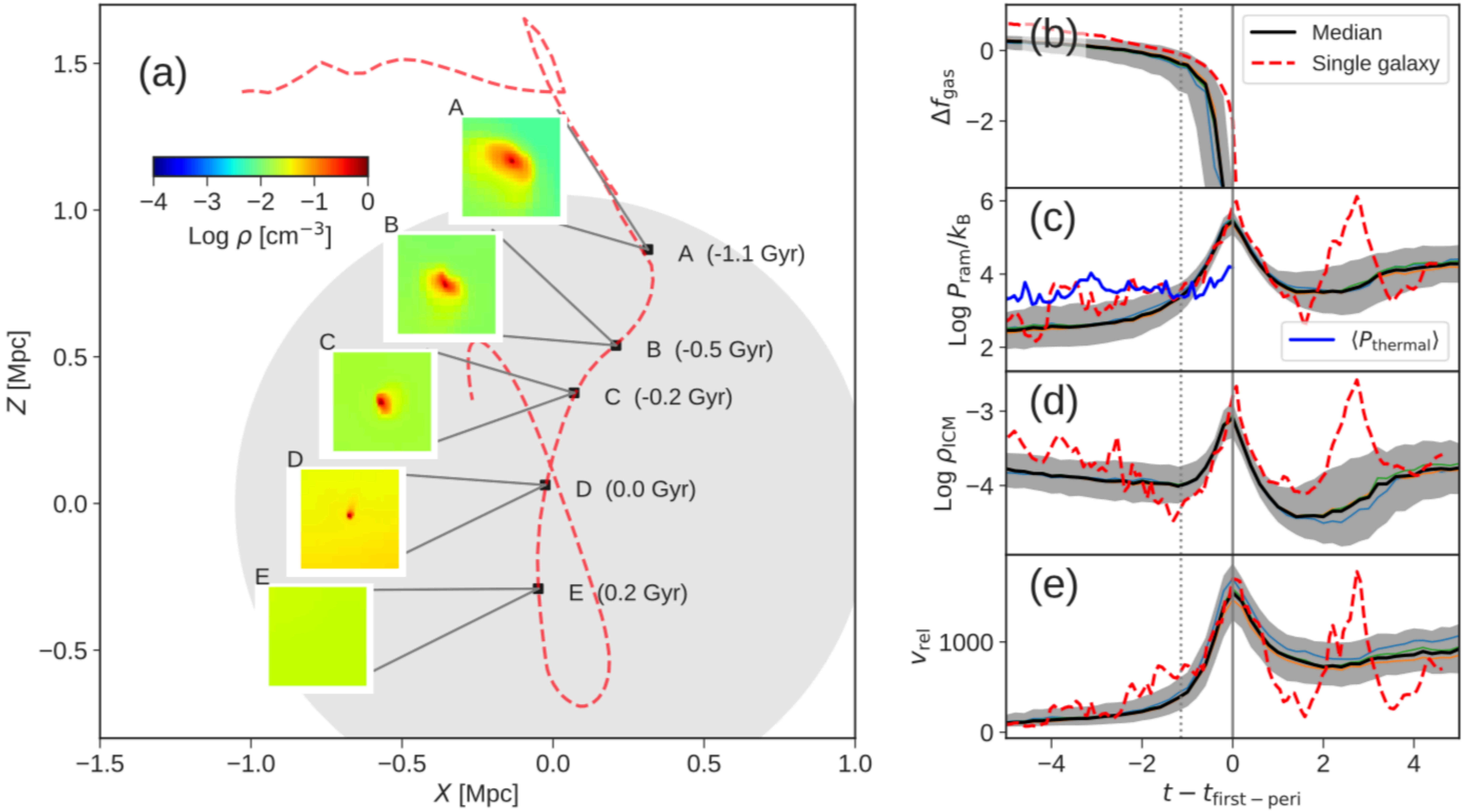
Ram pressure stripping

Jung et al. 2018, ApJ, in press: arXiv:1809.01684



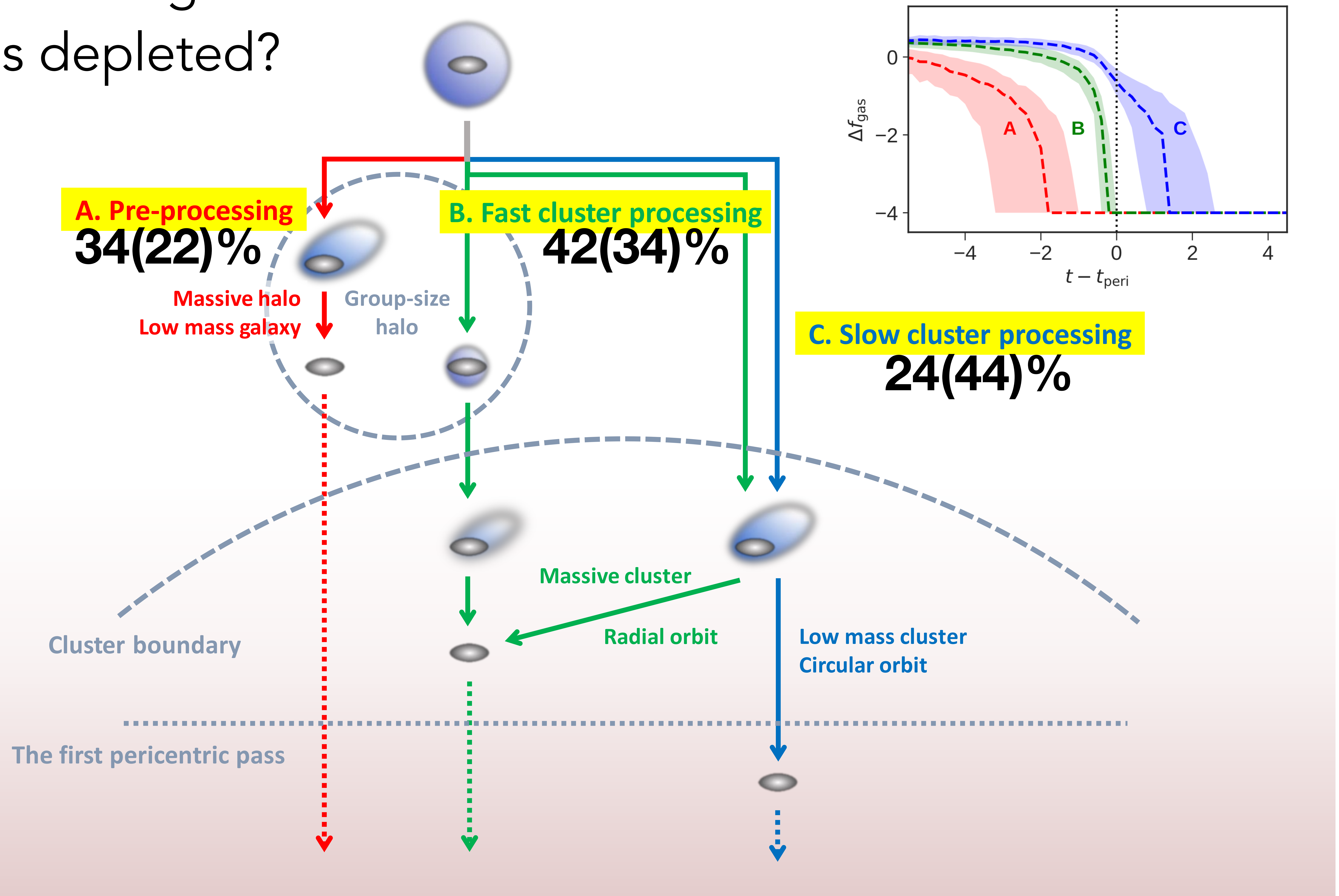
Jung et al. 2018, ApJ, in press: arXiv:1809.01684

Ram pressure stripping



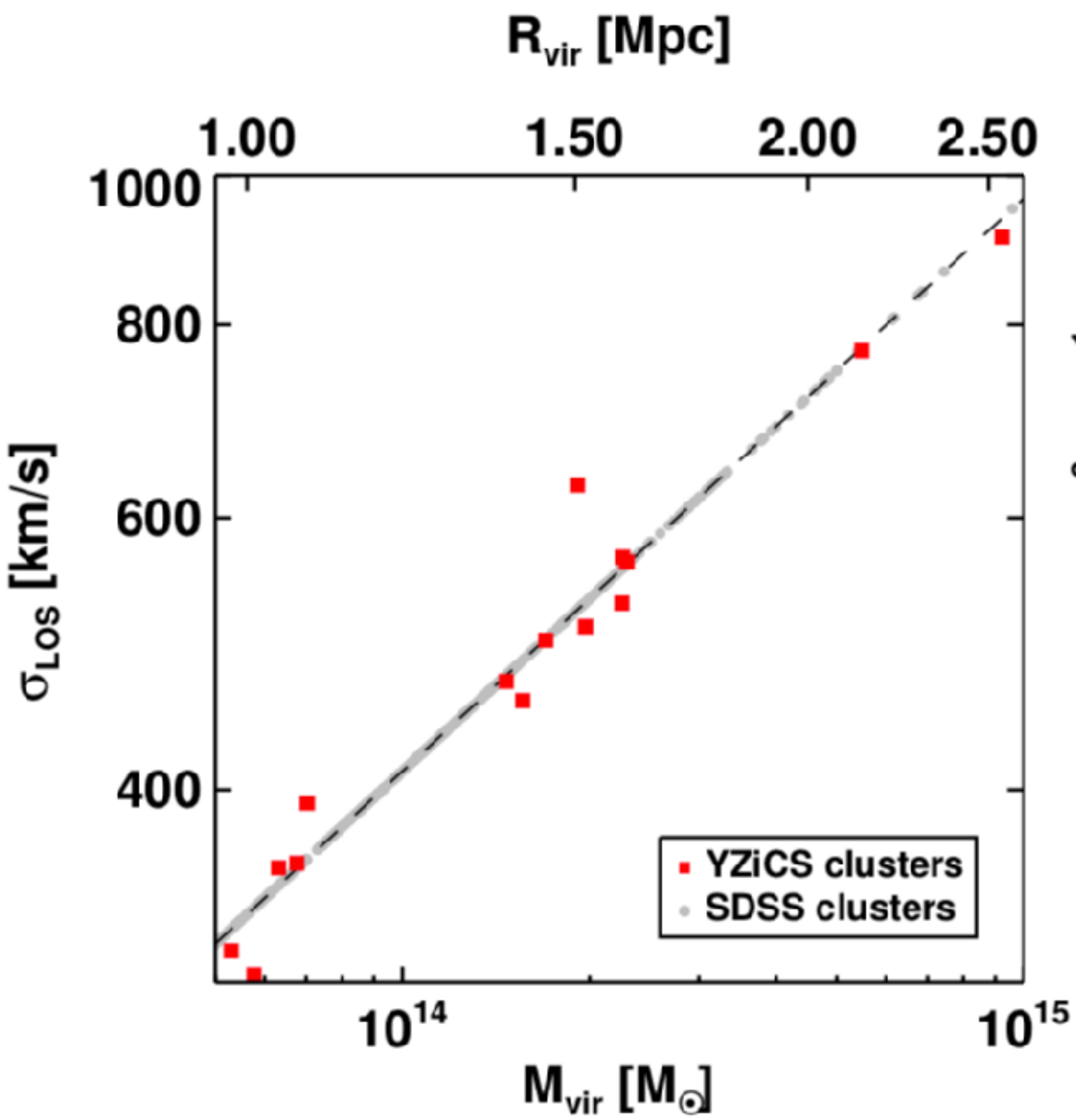
When/where do galaxies get gas depleted?

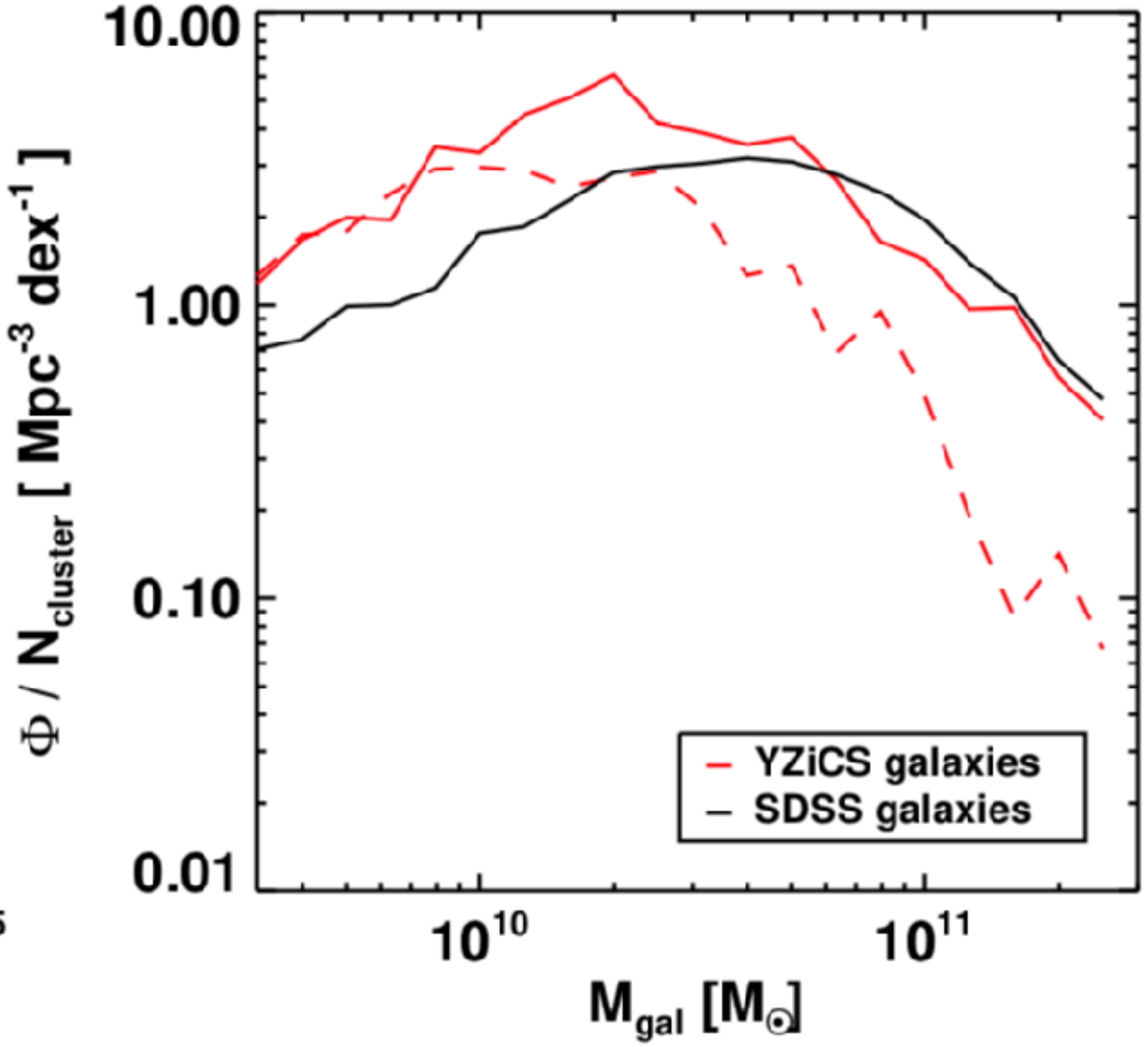
Jung et al. 2018, ApJ, in press: arXiv:1809.01684



YZiCS clusters

YZiCS clusters are overly SF-quenched, ET, slow-rating: resolution, AGN, ?

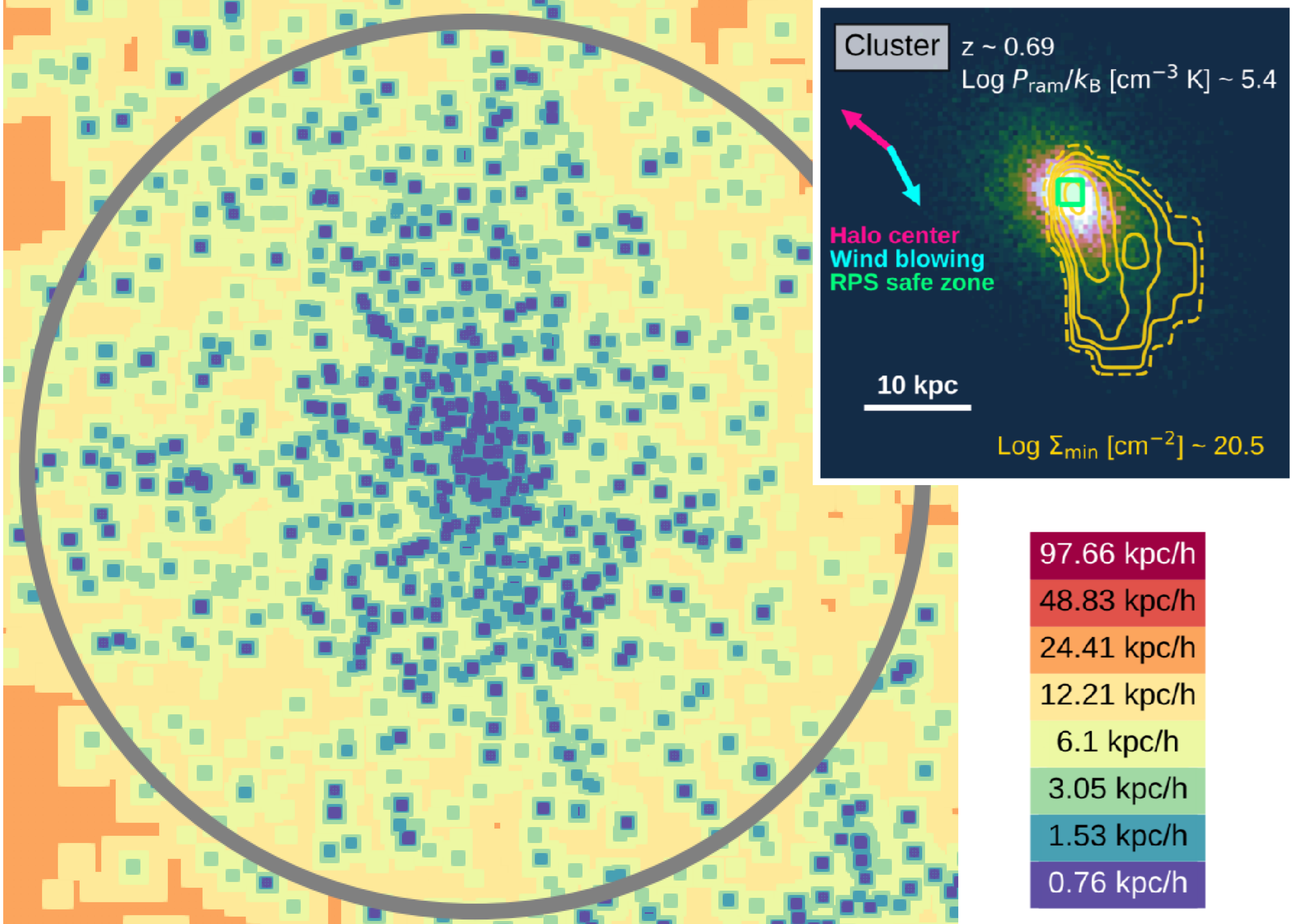




Rhee, SKY et al. in prep

C.f. C-Eagle (Barnes et al. 2017)
With AGN
galaxies are overly gas rich

YZiCS resolution



Proposal for High-resolution cluster zoom-in simulation

- high res cluster simulation with NewHorizon specifications
- Tracer particles
- Alternative input ingredients (AGN, CR?)

KISTI Nurion (2018)

x85 more capability?

	GEN4	GEN5, Phi	GEN5, CPU
Processor	Xeon X5570 2.93GHz	KNL7250 1.4GHz	Xeon SKL6148 2.4GHz
Cores / Memory	8cores / 24GB	**68cores / 96GB**	40cores / 192GB
Node	3176	8305	132
Throughput	0.3PF (25,408 cores)	25.3PF (564,740 cores)	0.4PF (**5,280** cores)
Total Memory	74TB	778TB	25TB
Interconnection	QDR(40Gbps)	OPI(100Gbps)	OPI(100Gbps)
Feature	SSE	AVX512 (8x)	AVX512 (8x)

“Super-challenge” with Nurion

- >5PF
- Xeon Phi processor, 68core/node ~ 3TF
- 5PF ~ 1700 nodes ~ 115,600 cores ~ 1700 x 96GB ~ 162TB ~ 7 x mem(NH)*

* mem(NH)=24TB

Ramses and Nurion

- “redundancy problem” of AMR
- “load balancing problem” of Ramses
- Ramses run on Nurion seems inefficient.
- mini Ramses?

Test run of mini-Ramses

by San Han

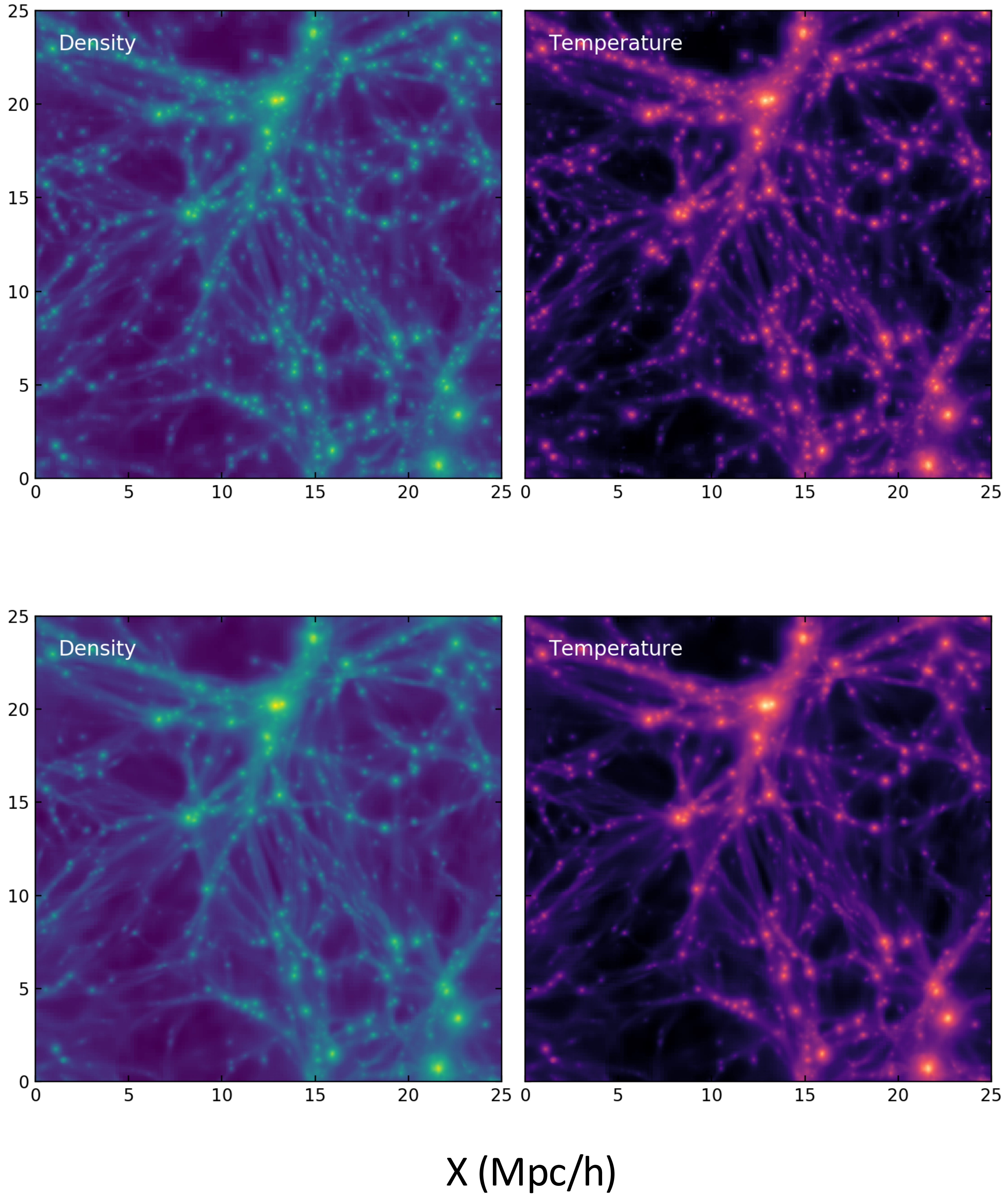
- Performance test:
  - 25Mpc volume box, 128^3 DM particles, levelmin=7
  - 40 cores, Intel(R) Xeon(R) CPU 3.00GHz
  - Mini-RAMSES forces equipartition of AMR grids

	RAMSES	Mini-RAMSES
Run time	104m 59s	184m 34s
Max. CPU grid	84942 (~0.12GB)	45038 (~0.06GB)

Ramses:
DM and hydro only

(No stars, No cooling)

mini-Ramses:



- Detailed halo structure is different.
- Two codes may have different hydrodynamics scheme

Prospect on mini Ramses

- Is mini-Ramses superior in dealing with load balancing and redundancy?
- We are considering adding astrophysical prescriptions (cooling, SF, BH, FB, chemical enrichment, etc.) into mini-Ramses. Any duplicated effort?
- Is this doable?