

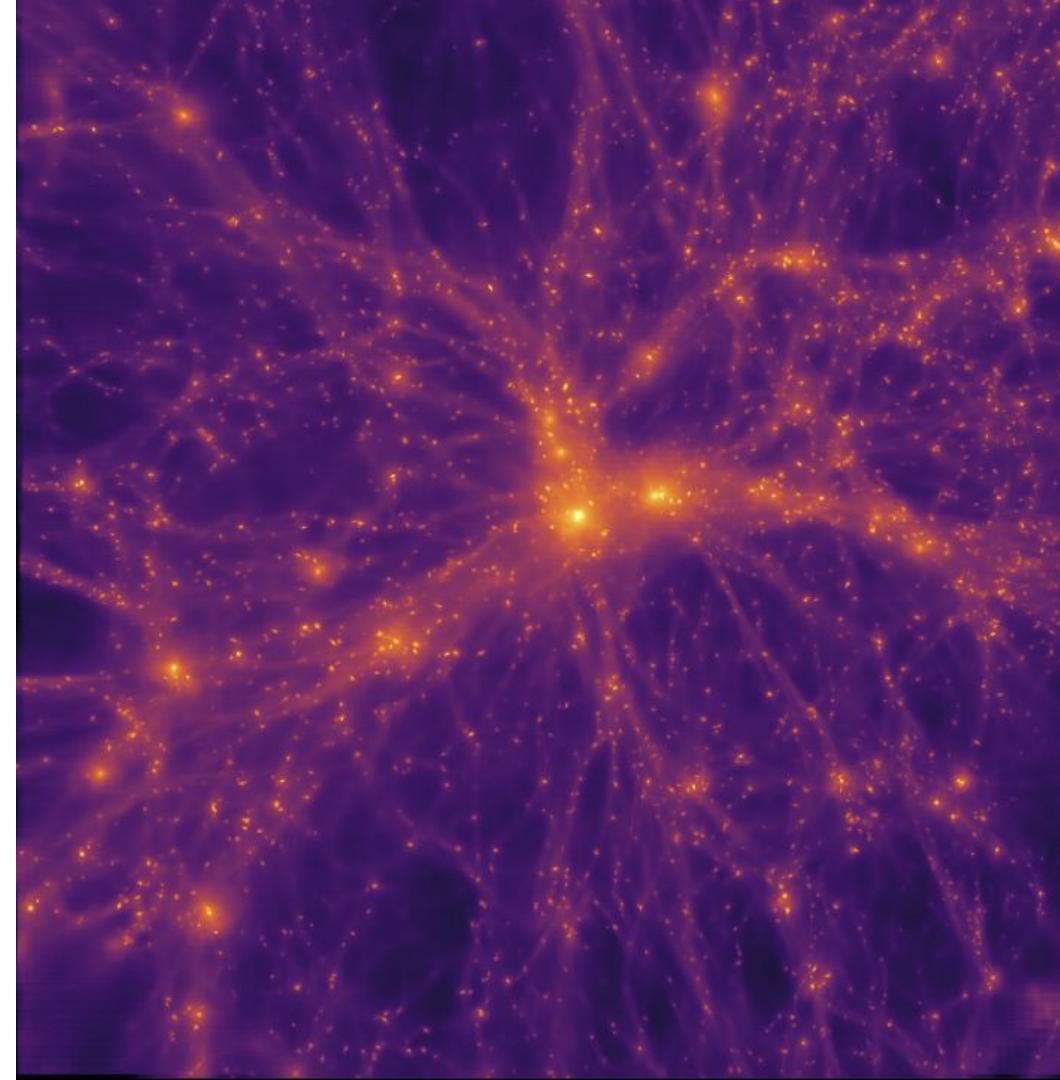
Simulations of galaxy clusters in evolving dark energy models

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With **Amandine Le Brun &**
Pier Stefano Corasaniti

RAMSES SNO days 2025



A new suite of galaxy cluster zoom-in simulation with RAMSES

Goal:

Study the combined effect of AGN feedback and evolving dark energy in the internal properties of galaxy clusters

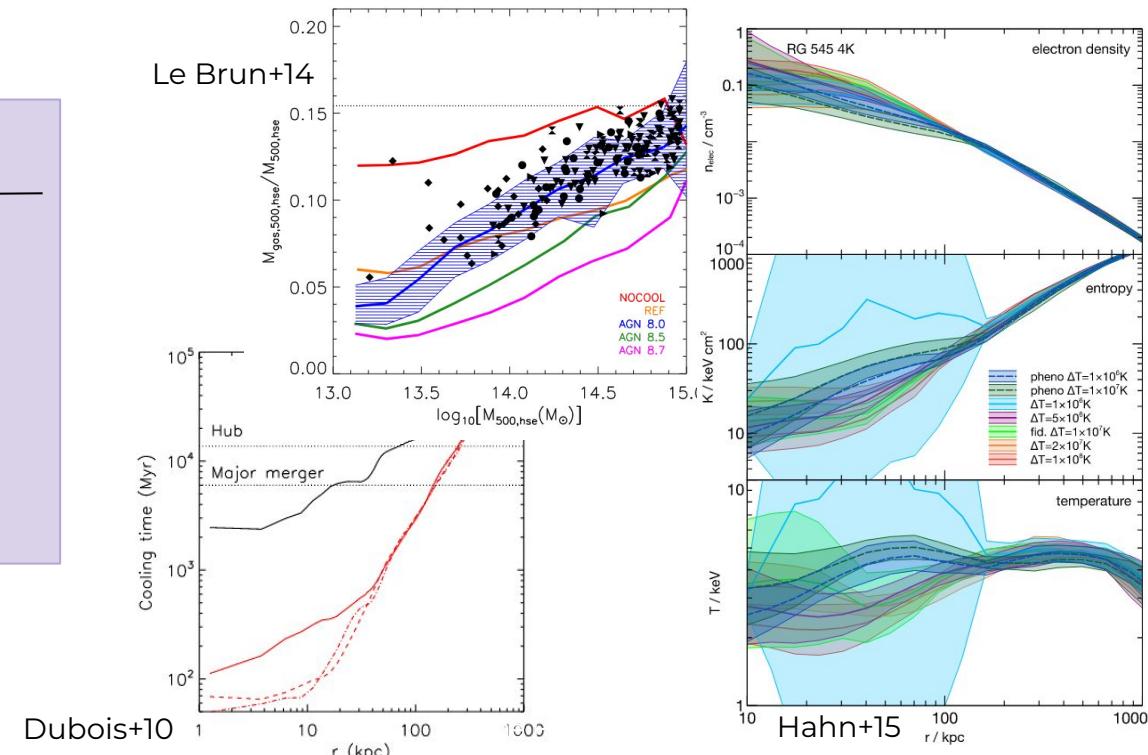
A new suite of galaxy cluster zoom-in simulation with RAMSES

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Study the combined effect of AGN feedback and evolving dark energy in the internal properties of galaxy clusters

The Literature:

- A lot of studies of the **impact of AGN feedback in clusters**
- Regulate cooling catastrophe
- Lower central densities
- Lower $M_{\text{gas}} / M_{\text{halo}}$ & M_{*} / M_{halo}



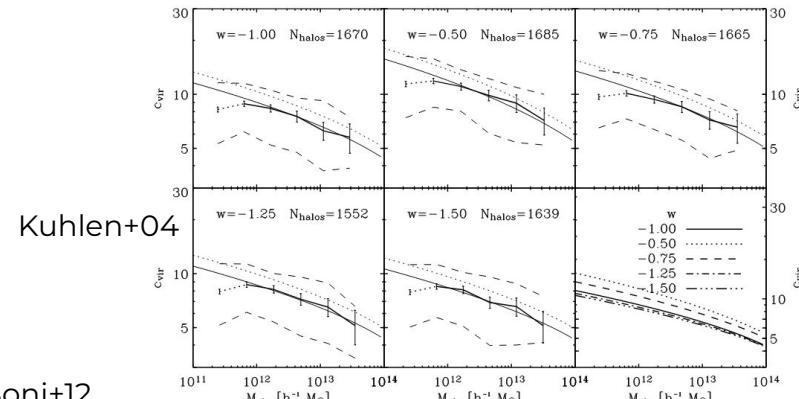
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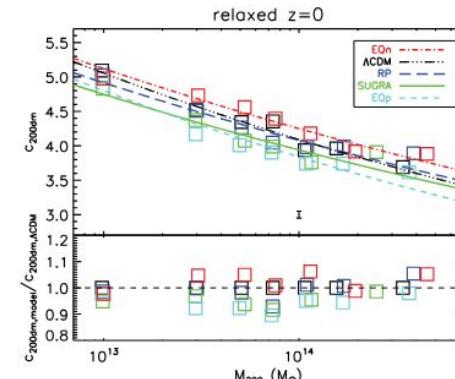
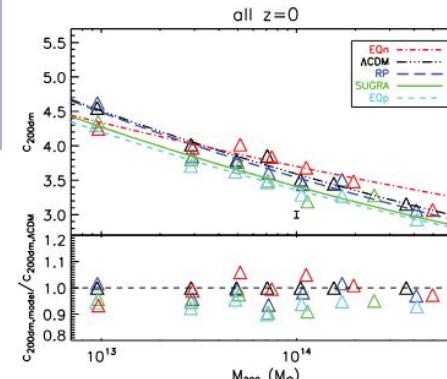
The Literature:

- Studies of the **impact of evolving dark energy** (although not with zoom-in simulations)
- Lower / increase halo concentration
- **No study of the combined impact!**



Kuhlen+04

De Boni+12



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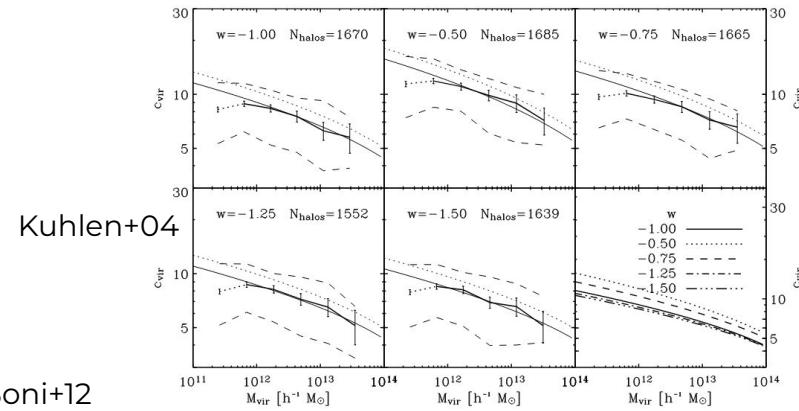
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Degeneracies not understood

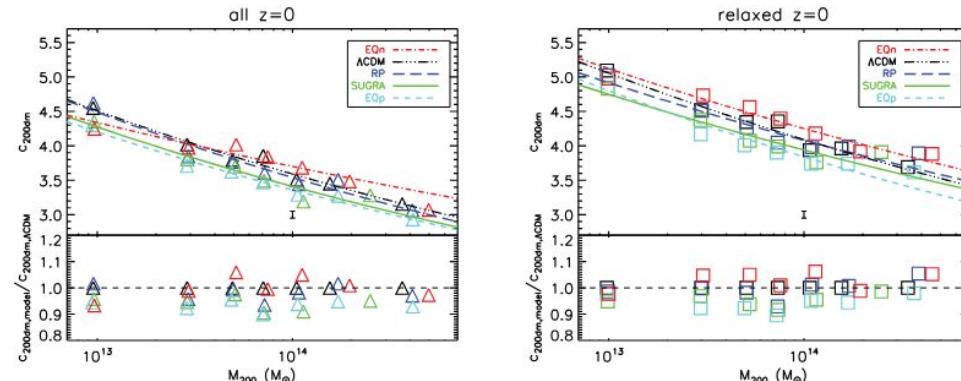
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Biases in the cosmological inference



Kuhlen+04

De Boni+12



The project

12 massive systems from a Dark Matter Only 1 Gpc box:

- **2 evolving DE cosmologies:** w CDM models, $w = -0.8, w = -1.2$
- 1 Λ CDM cosmology:** $w = -1$

The project

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DM resolution: $\sim 2 \times 10^8 M_\odot$ (coarse level = 13)

Grid resolution: $\sim 1 \text{ kpc comoving}$ at all redshift (level 20)

Baryonic physics: Horizon-AGN prescriptions (Dubois+11, +14, +16)

- Quasar mode (thermal feedback)
- Radio mode (kinetic feedback)

16 Million cpuh allocation on Adastra/Jean-Zay computer

The project

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→ **2 evolving DE cosmologies:** wCDM models, $w = -0.8, w = -1.2$

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DM resolution: $\sim 2 \times 10^8 M_\odot$ (coarse level = 13)

~ 240k cph per run

Grid resolution: $\sim 1 \text{ kpc comoving}$ at all redshift (level 20)

- Use of the new
LASSO halo finder

Baryonic physics: Horizon-AGN prescriptions (Dubois+11, +14, +16)

- Quasar mode (thermal feedback)
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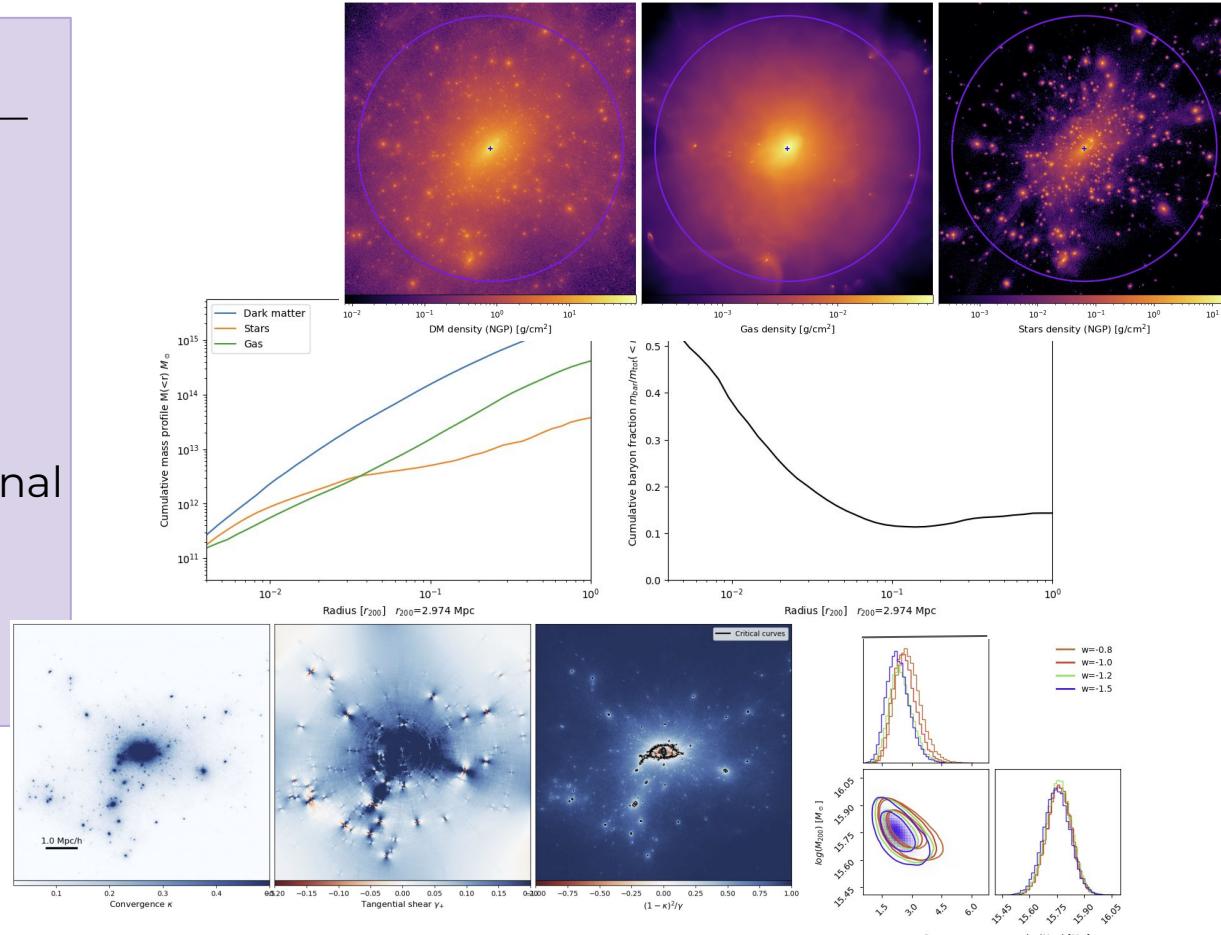
**Production
has started!**

What to do with the simulations ?

(stay tuned!)

A lot to study:

- Mass profiles and sparsities
- Gas and star profiles
- Galaxy morphology
- Shear signal, X maps, SZ signal
- CMB induced polarization
- Merger history



If you have ideas / want to collaborate, I would be very happy to discuss with you!