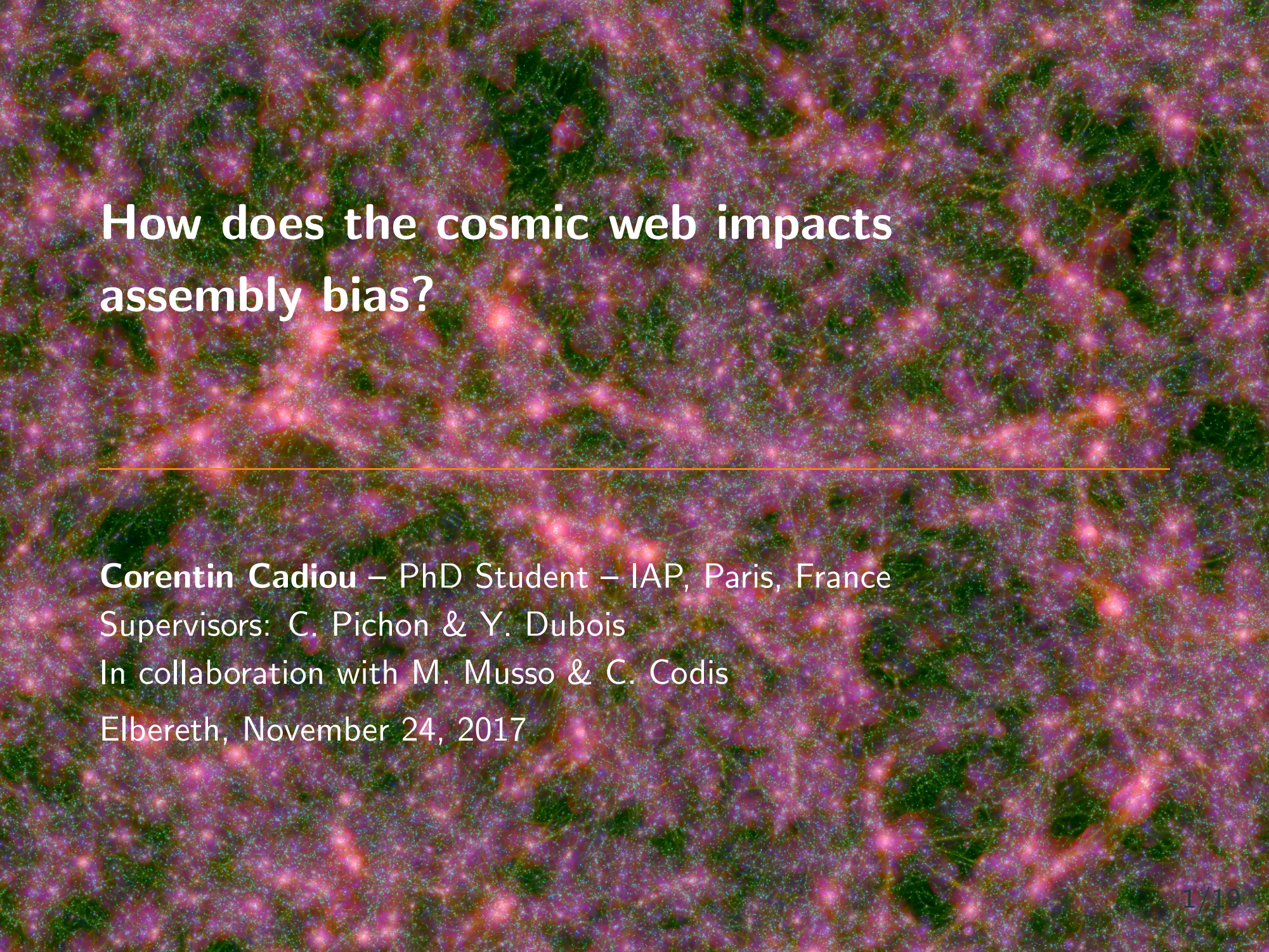

How does the cosmic web impacts assembly bias?

Corentin Cadiou – PhD Student – IAP, Paris, France
Supervisors: C. Pichon & Y. Dubois
In collaboration with M. Musso & C. Codis

Elbereth, November 24, 2017

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"Grandir dans une téci vs. le 16e vs. Niederschaeffolsheim"

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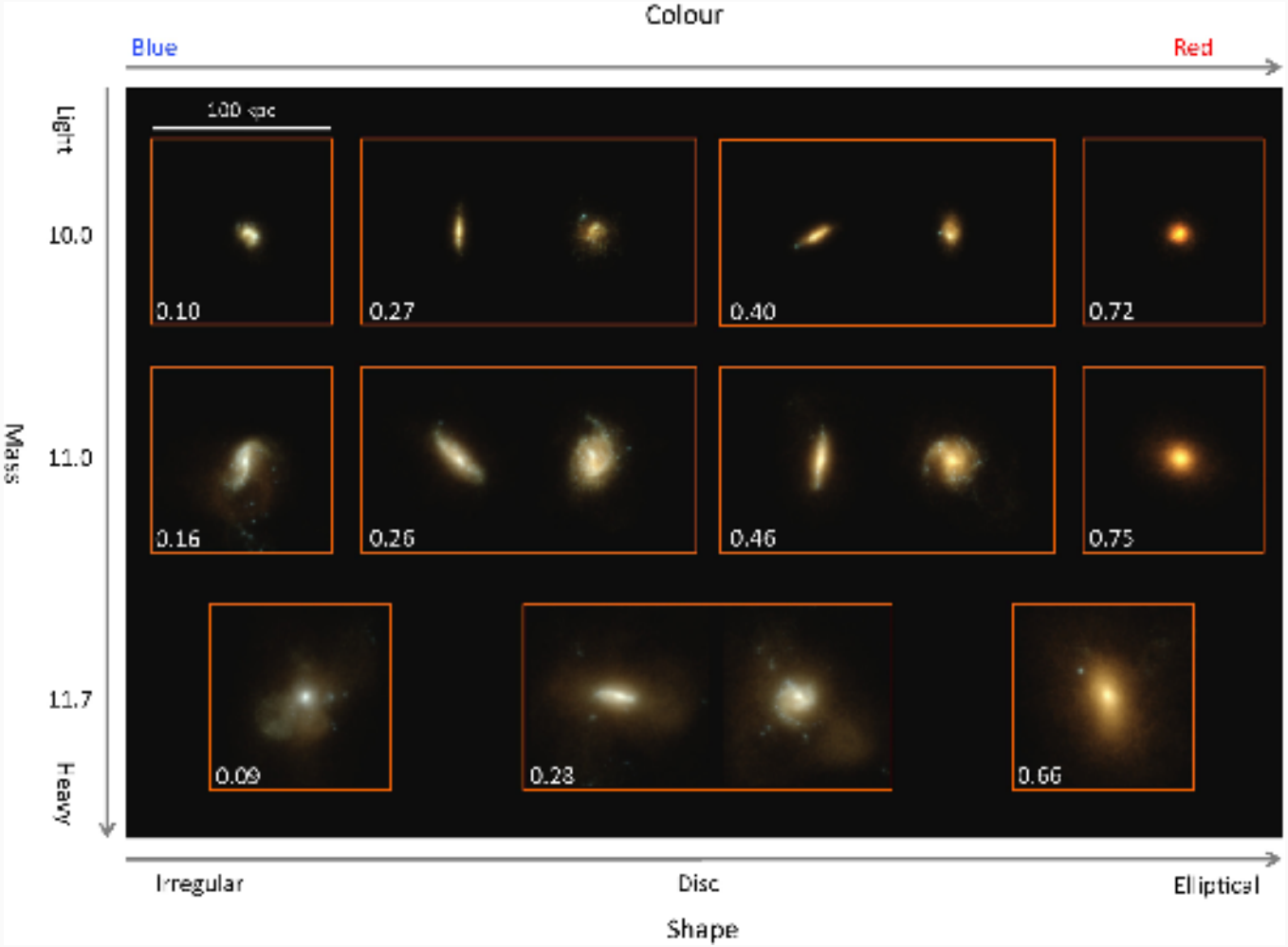
Introduction

The influence of mass

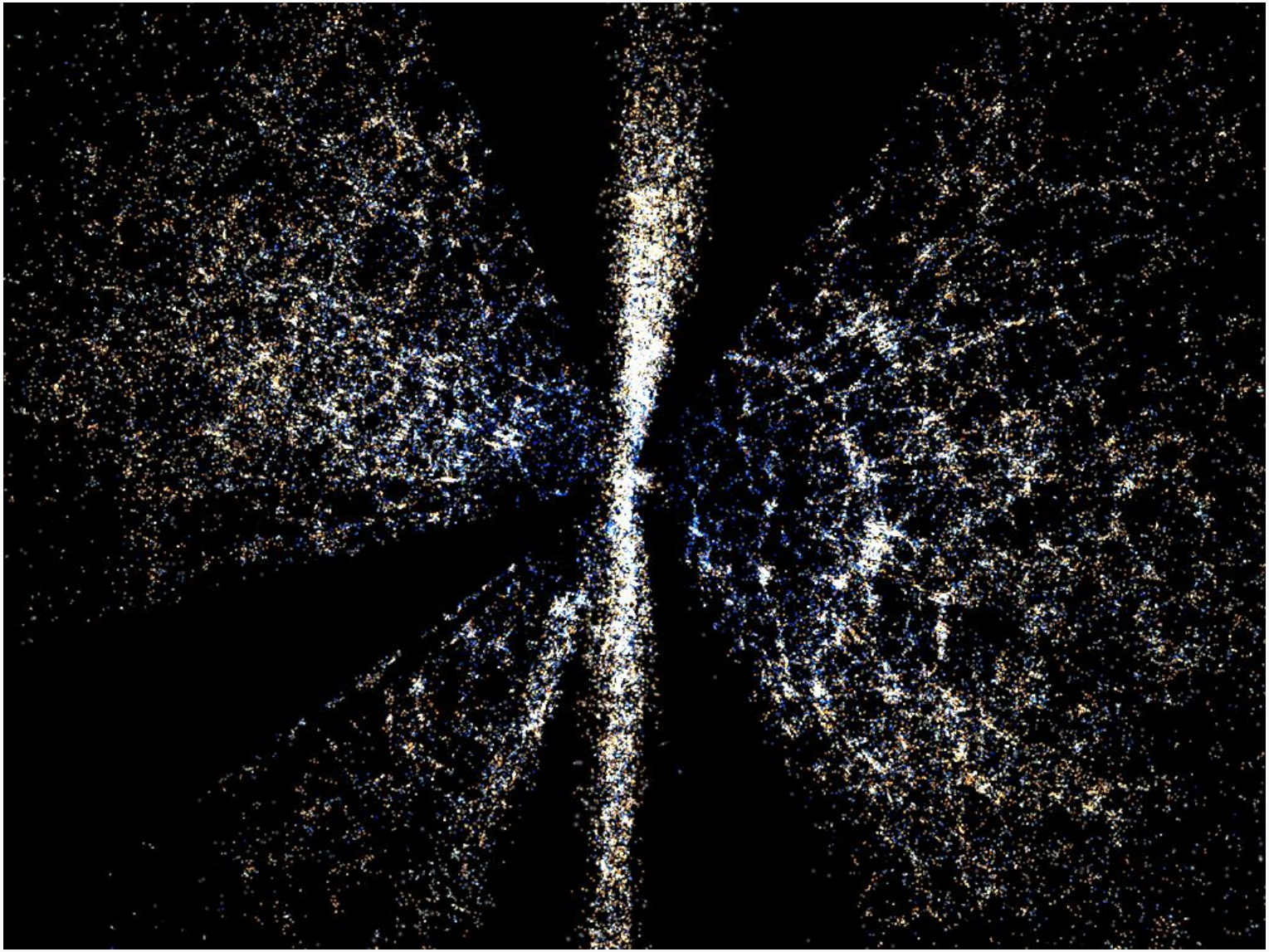


Horizon-AGN Dubois+14

Fact 1: Galaxies are greedy

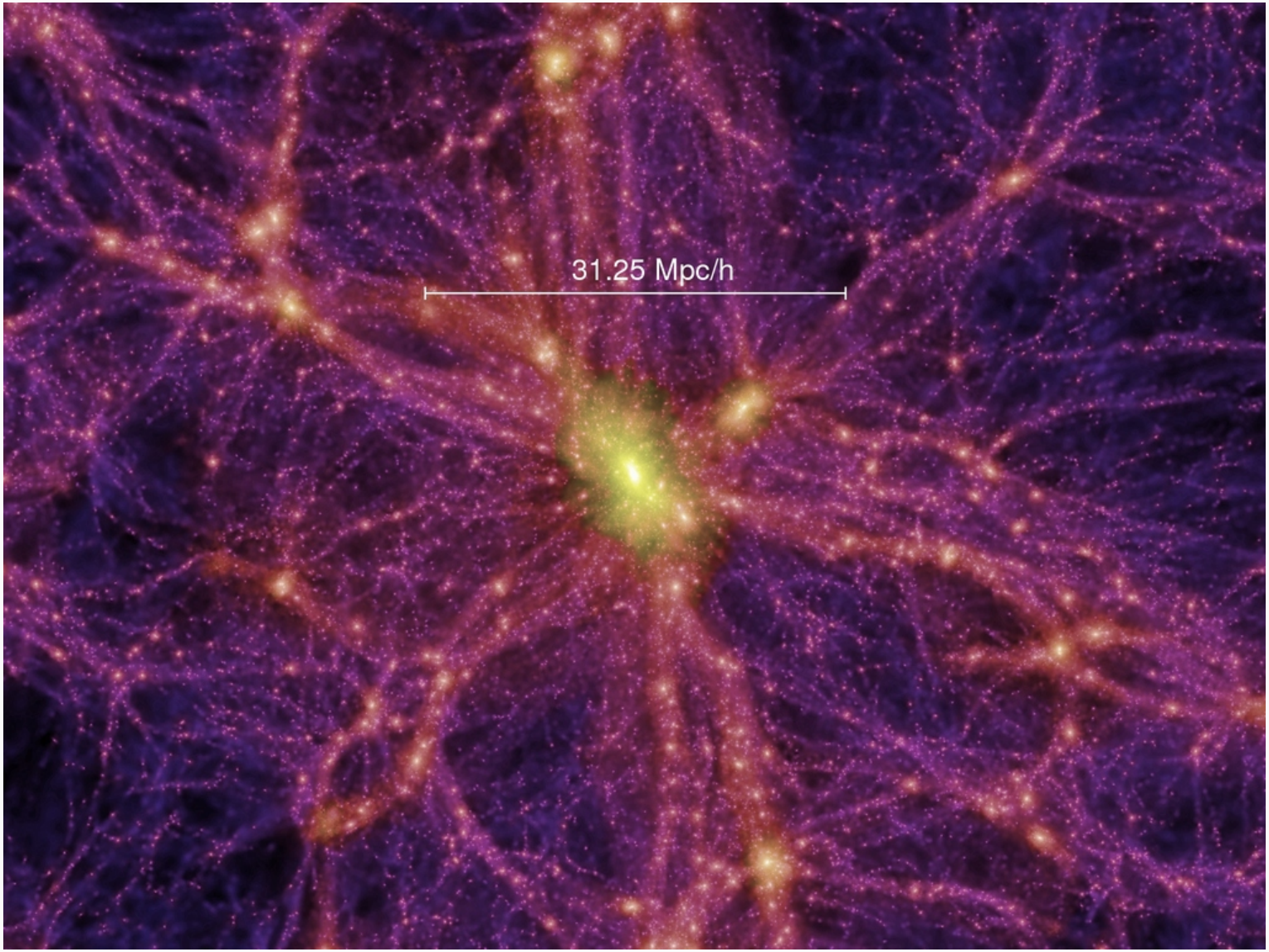
Galactic properties are driven by galactic mass

Who said “Cosmic Web”?



SDSS

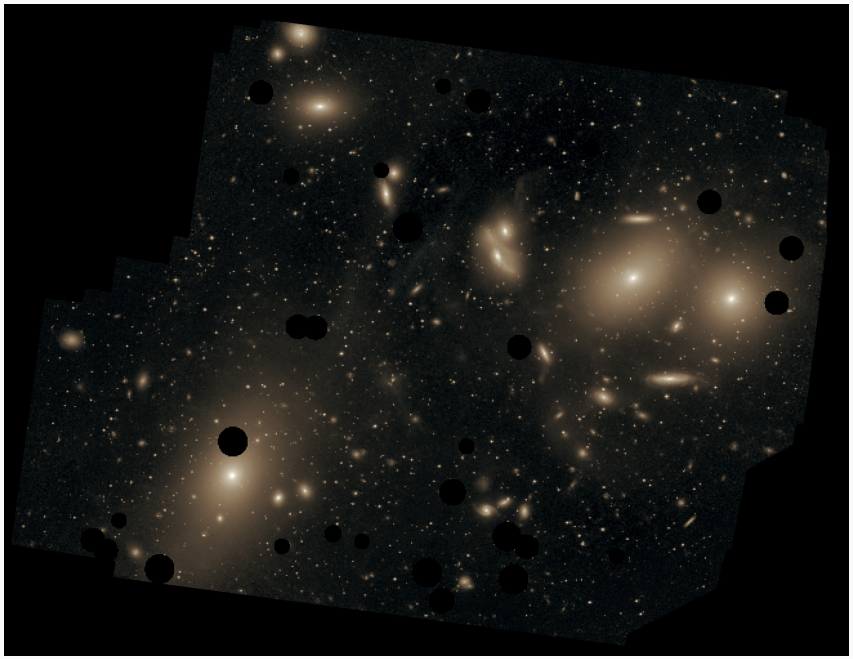
Who said “Cosmic Web”?



Fact 2: Galaxies are social beings

Galactic properties are driven by the local density

OK... but you also said "Assembly Bias"?



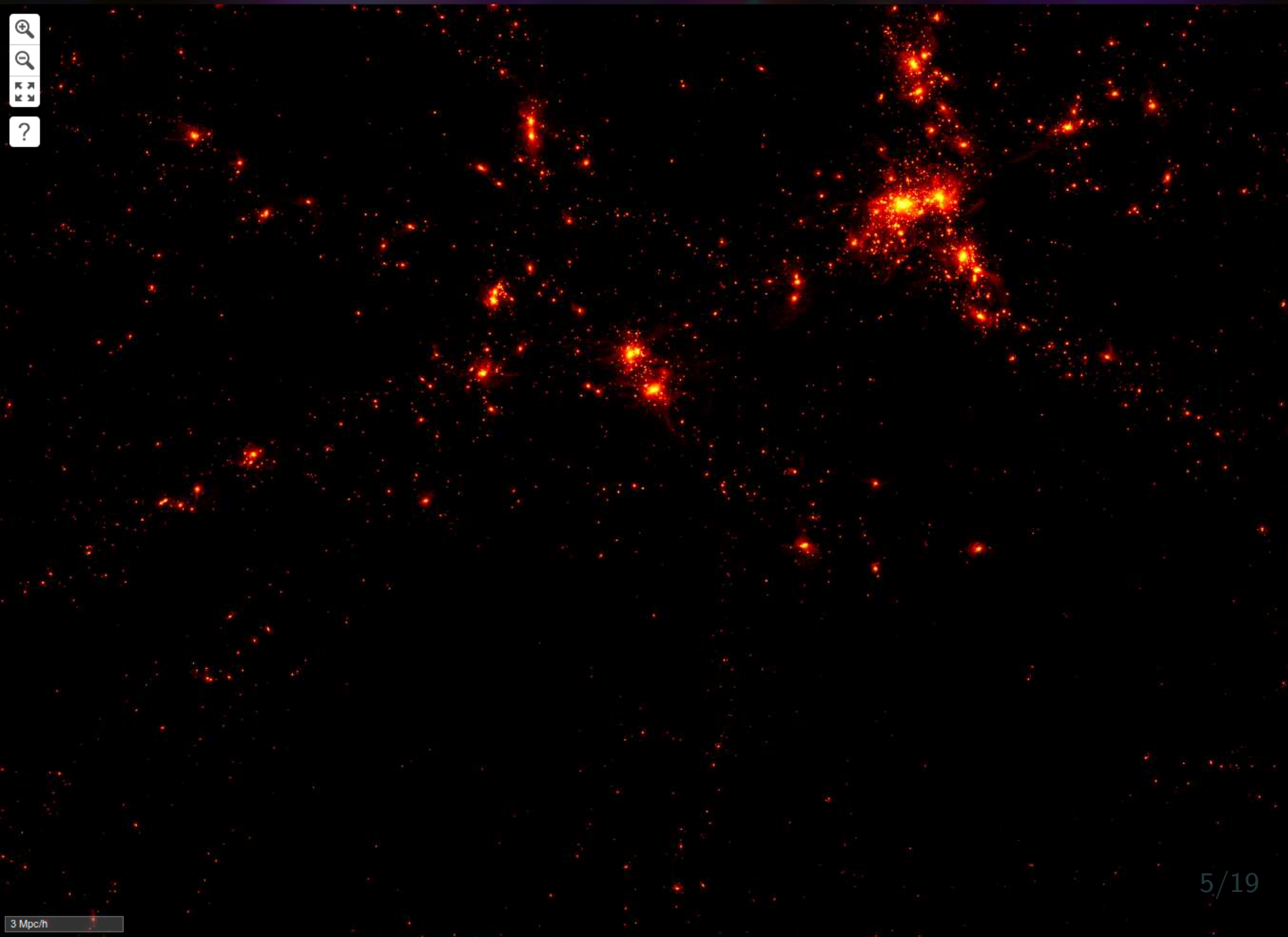
A central galaxy – M87, Virgo Cluster, ESO

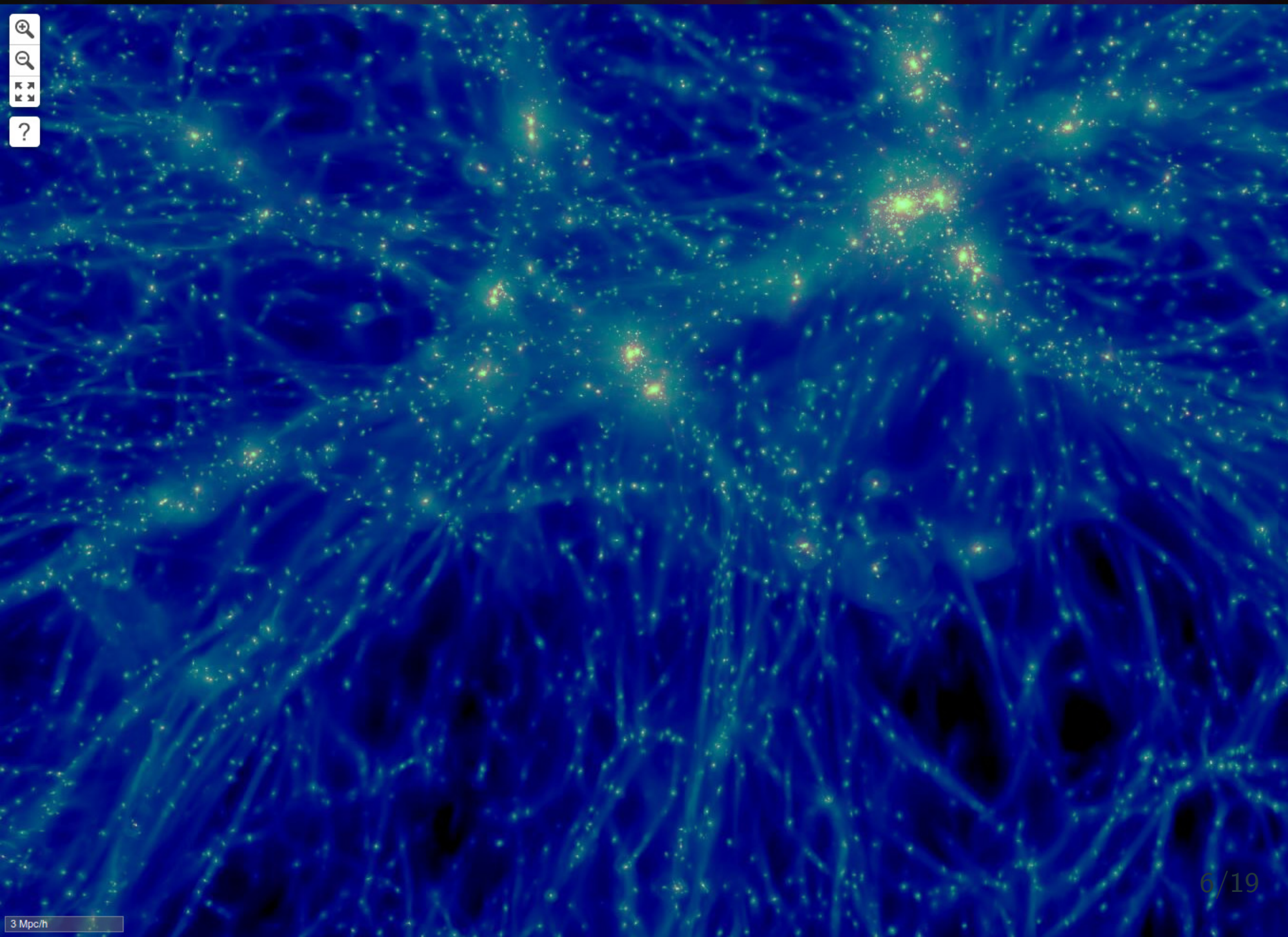
A less central galaxy – M101, HST

Different **environments** $\rightarrow$ different **morphological distribution**

Fact 3: Galaxies have different social backgrounds

Galactic properties are influenced by the large-scale structure


3 Mpc/h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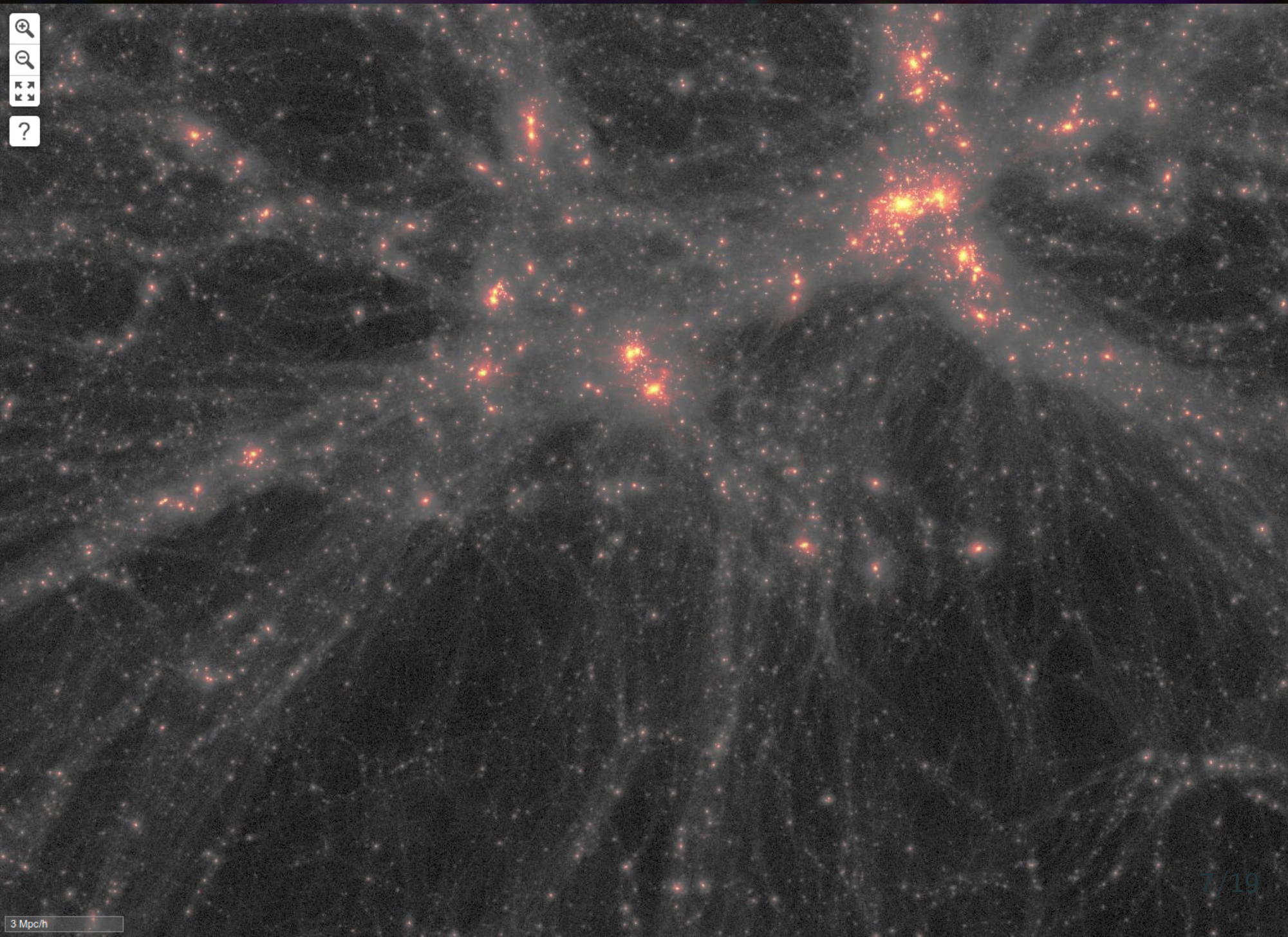


3 Mpc/h

Fact 4: Galaxies ♡ DM halo

Galactic properties are correlated with DM halos'

Partial conclusion + TODO list

We've seen that galactic properties are influenced by

1. their mass
2. their local density
3. their large-scale environment?

Partial conclusion + TODO list

We've seen that galactic properties are influenced by

1. their mass ✓
2. their local density
3. their large-scale environment?

Partial conclusion + TODO list

We've seen that galactic properties are influenced by

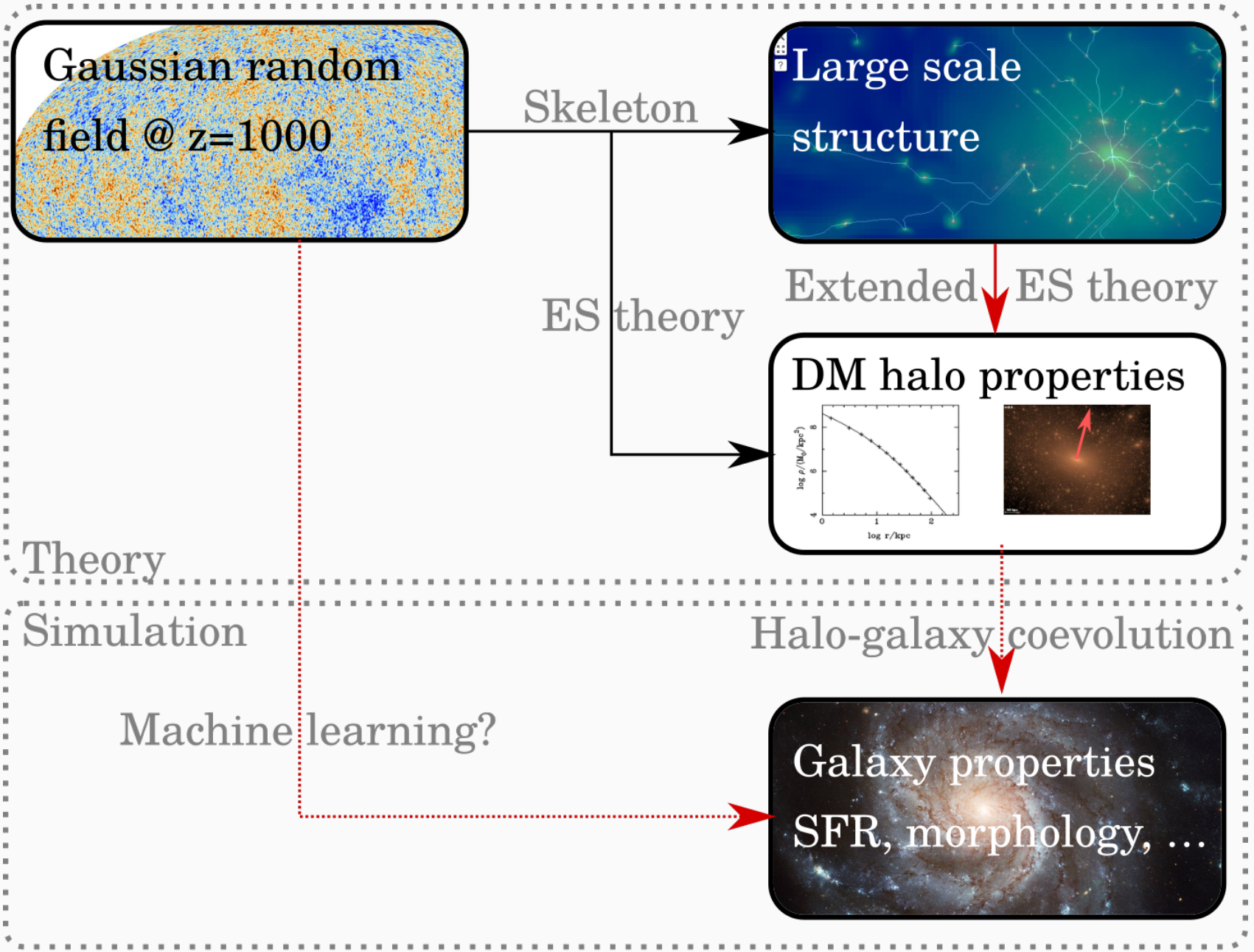
1. their mass ✓
2. their local density ✓
3. their large-scale environment?

Partial conclusion + TODO list

We've seen that galactic properties are influenced by

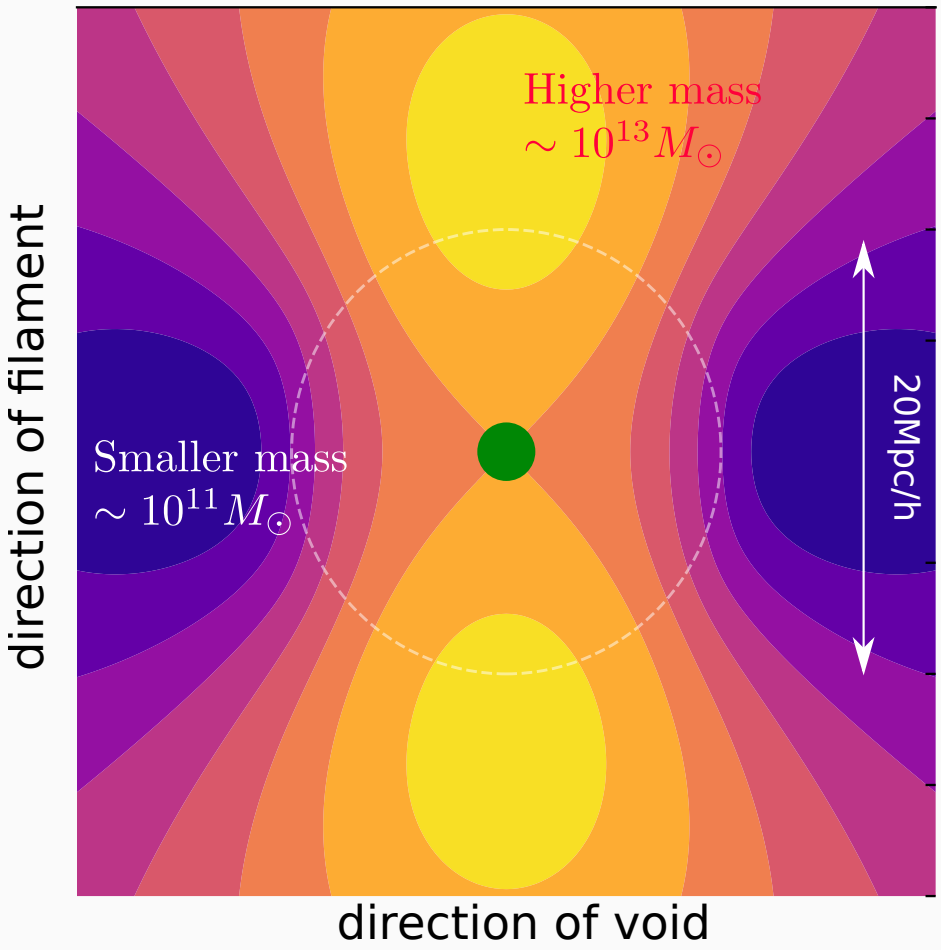
1. their mass ✓
2. their local density ✓
3. their large-scale environment? To what extent? Can we quantity it?

What's the plan?



Effect on assembly history

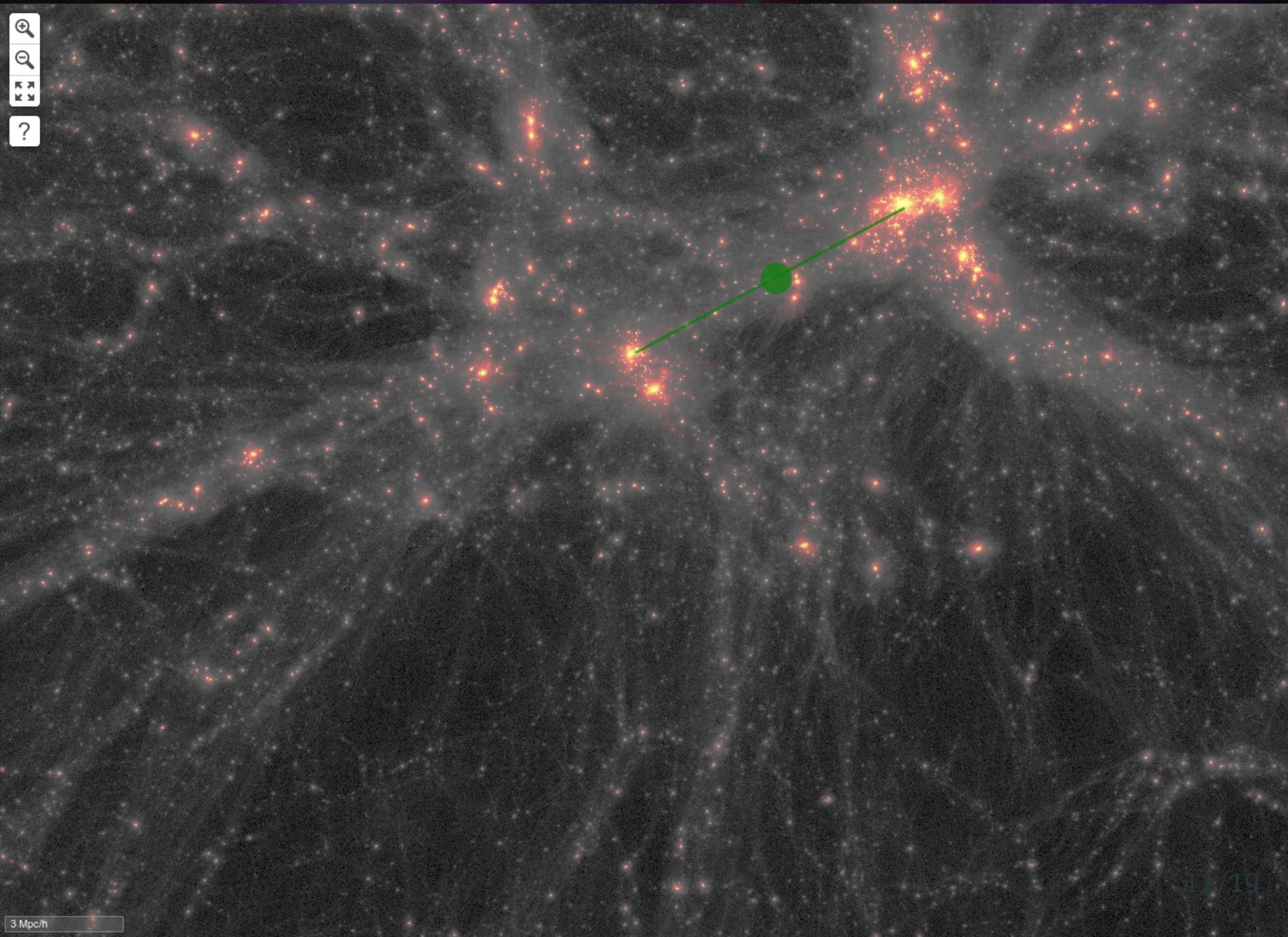
Typical mass



$$\Delta M_\star(\mathbf{r}) \propto \delta_S \xi_{20}(r) \mathcal{Q}$$

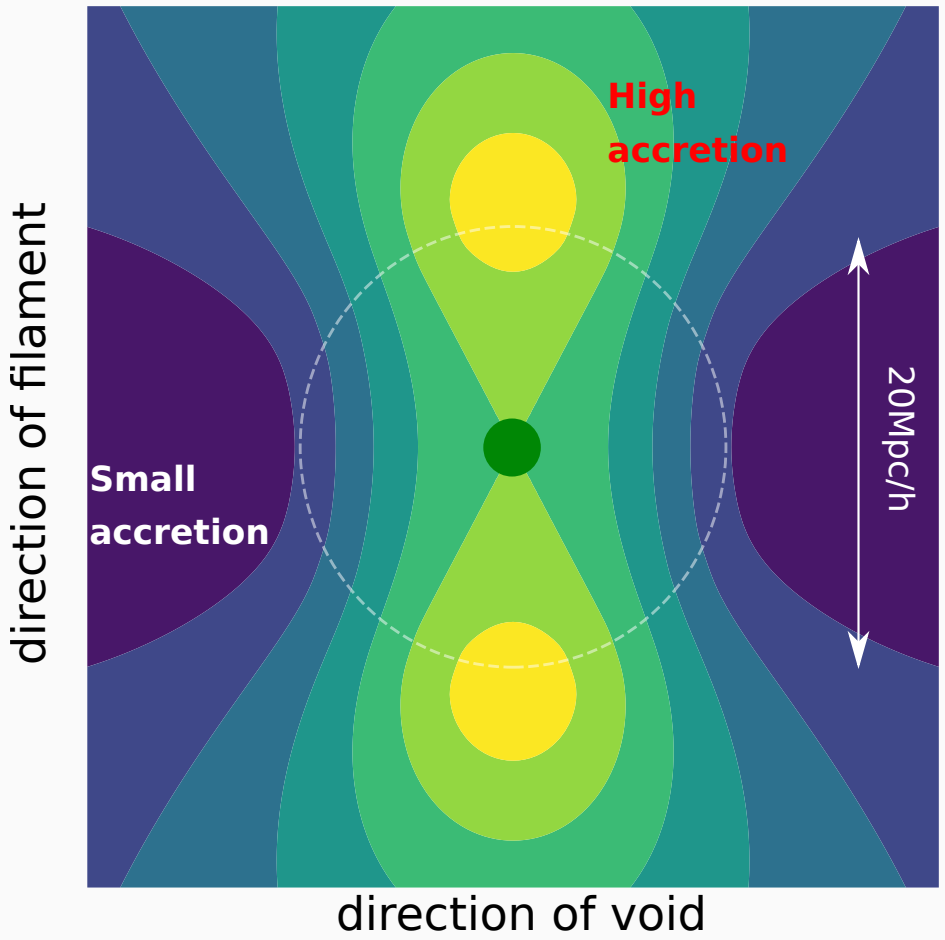
ξ_{20}: corr. density-tide + density

M. Musso, C. Cadiou *et al.*, MNRAS



3 Mpc/h

Accretion rate @ $\approx 3 \times 10^{11}\,\mathrm{M}_\odot$ & $z = 0$

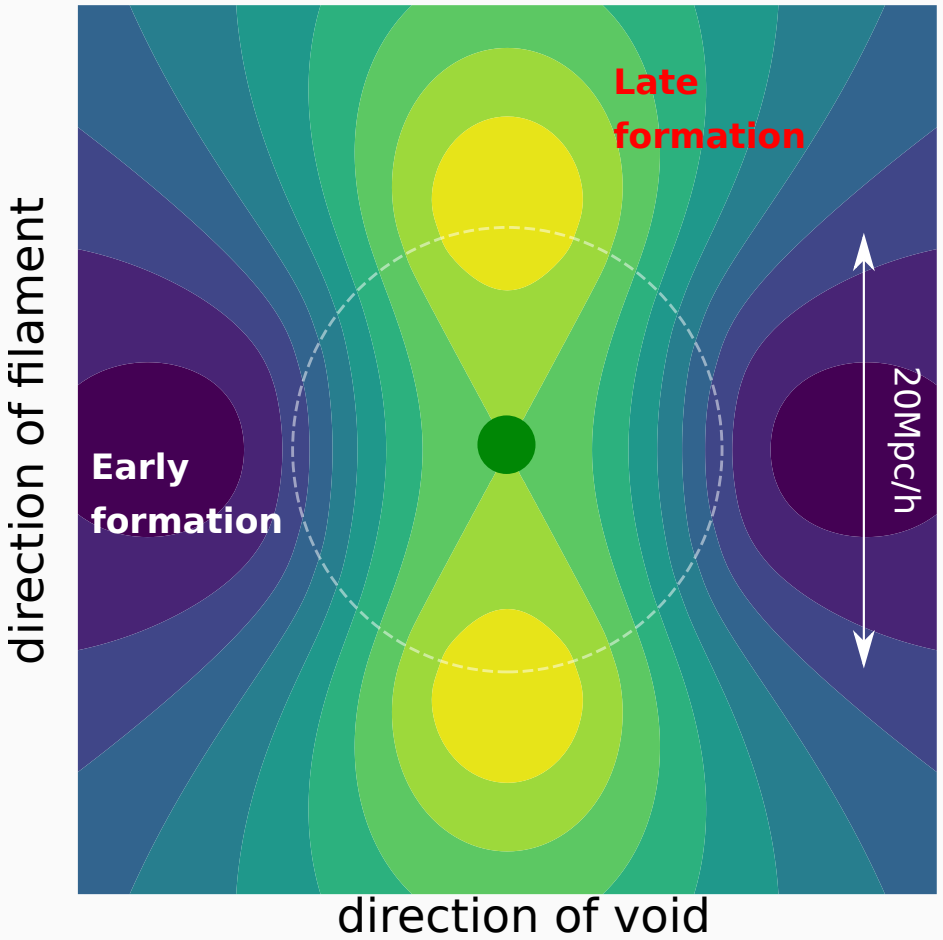


$$\Delta\dot{M}(\mathbf{r}) \propto \left[\xi'_{20} - \frac{\sigma - \xi'_1\xi_1}{\sigma^2 - \xi^2}\xi_{20}\right]\mathcal{Q}$$

ξ'_{20}: corr. slope-tide + variance of field

M. Musso, C. Cadiou *et al.*, MNRAS

Formation time @ $\approx 3 \times 10^{11}\,\mathrm{M}_\odot$ & $z = 0$



$$\Delta z_\star(\mathbf{r}) \propto M \xi_{20}(r) \mathcal{Q}$$

higher mass: later formation time

M. Musso, C. Cadiou *et al.*, MNRAS

Tension with observations?

Theory
Predict higher + late formation:

blue central galaxy?

Observations
Massive red central galaxies

Tension with observations?

Theory
Predict higher + late formation:

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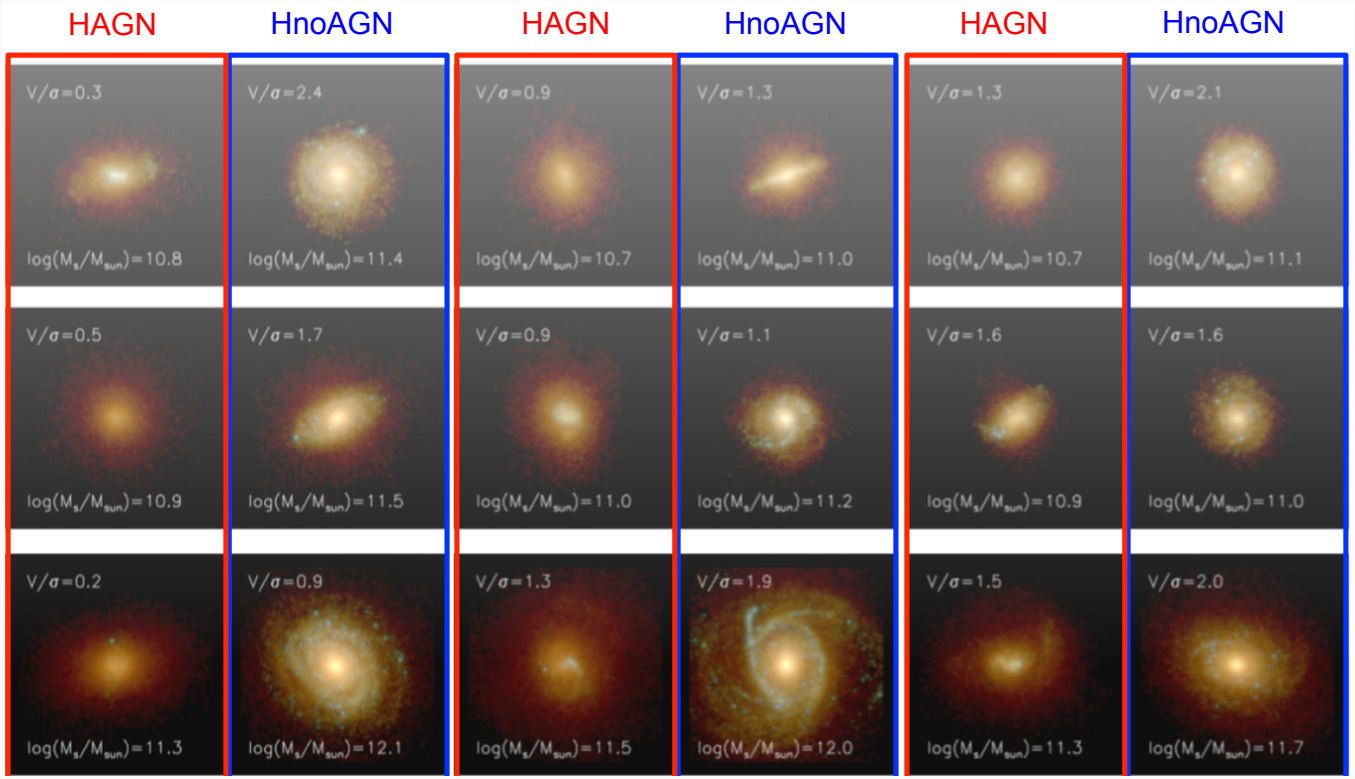
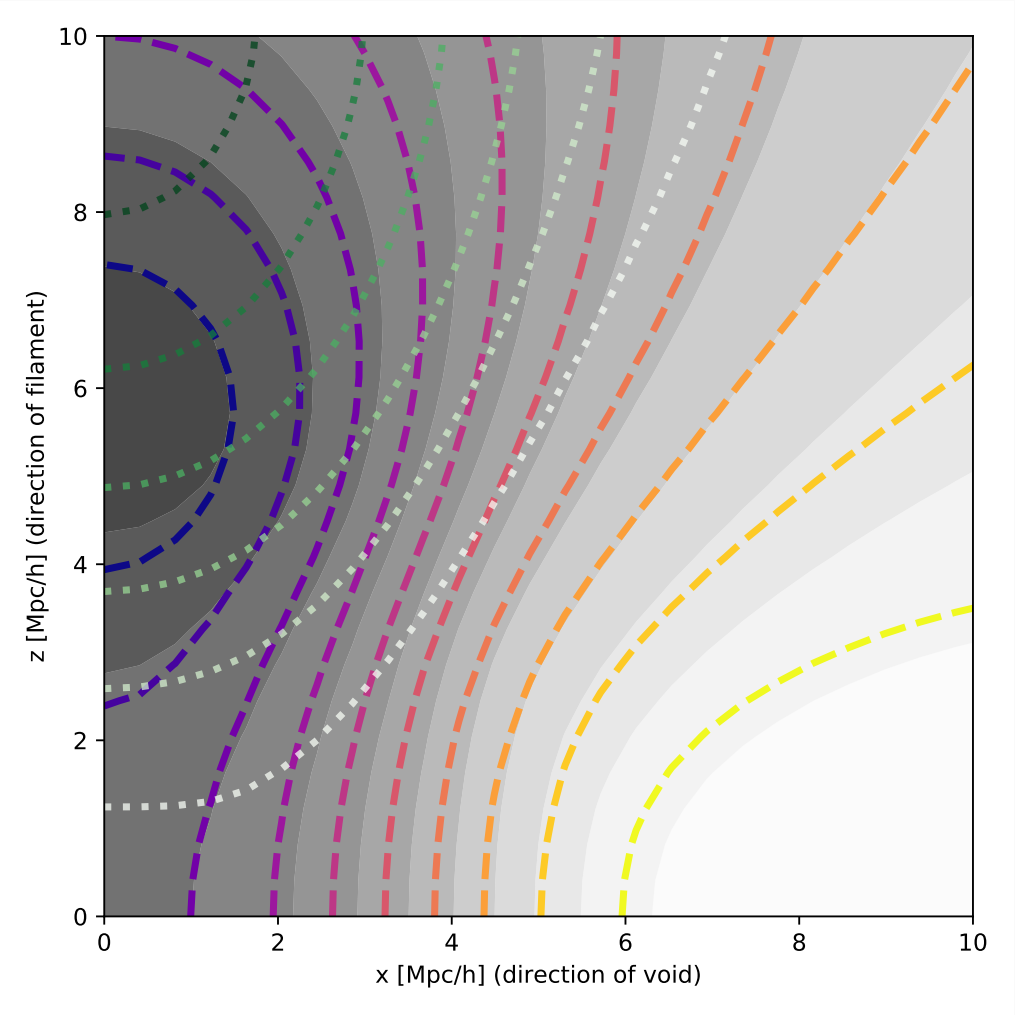
Observations
Massive red central galaxies



Dubois+16

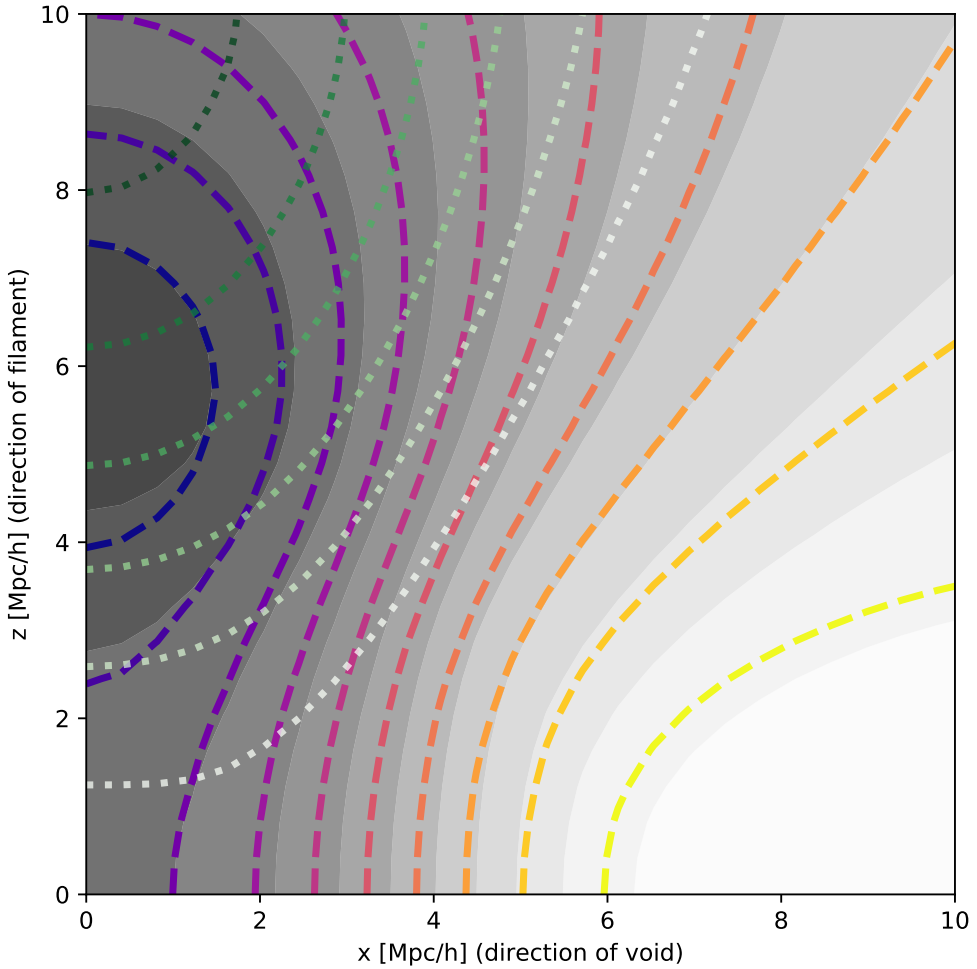
Gradient alignment



- background: ρ
- dotted M
- dashed $\dot{M}$

K. Kraljic, S. Arnouts, C. Pichon, C. Laigle, S. de la Torre, D.Vibert, C. Cadiou et al., MNRAS

Gradient alignment



- background: ρ
- dotted M
- dashed $\dot{M}$

$\Rightarrow$ different gradients

K. Kraljic, S. Arnouts, C. Pichon, C. Laigle, S. de la Torre, D.Vibert, C. Cadiou et al., MNRAS

(Temporary) conclusions

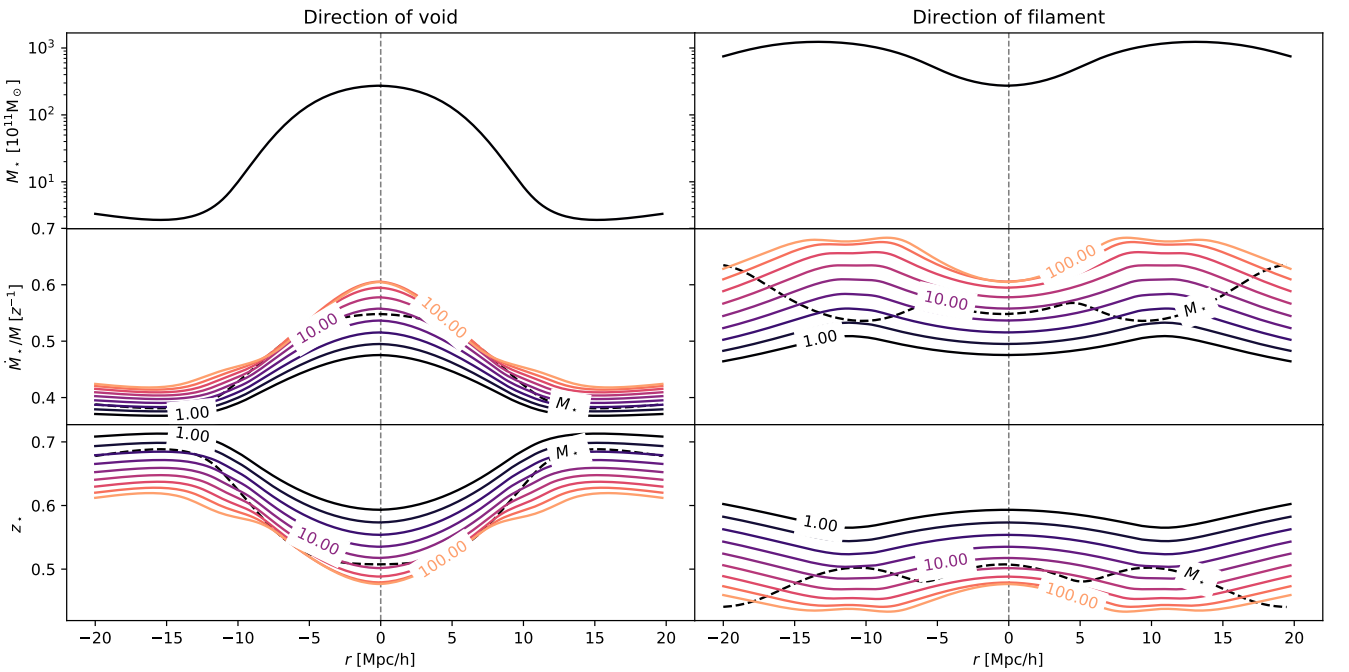
Halos in nodes . . .

- form later,
- are accreting more,
- typically more massive,

compared to those in filaments (and same from voids to filaments).

In agreement with results from n-body simulations + hint for different assembly w.r.t. cosmic web.

Quantitative results



Voids to filaments

- $M \times 10^2$
- $\dot{M}/M + 30\%$
- $z_f - 15\%$

Filaments to nodes

- $M \times 5$
- $\dot{M}/M + 10\%$
- $z_f - 5\%$

Conclusion

Conclusion

Results

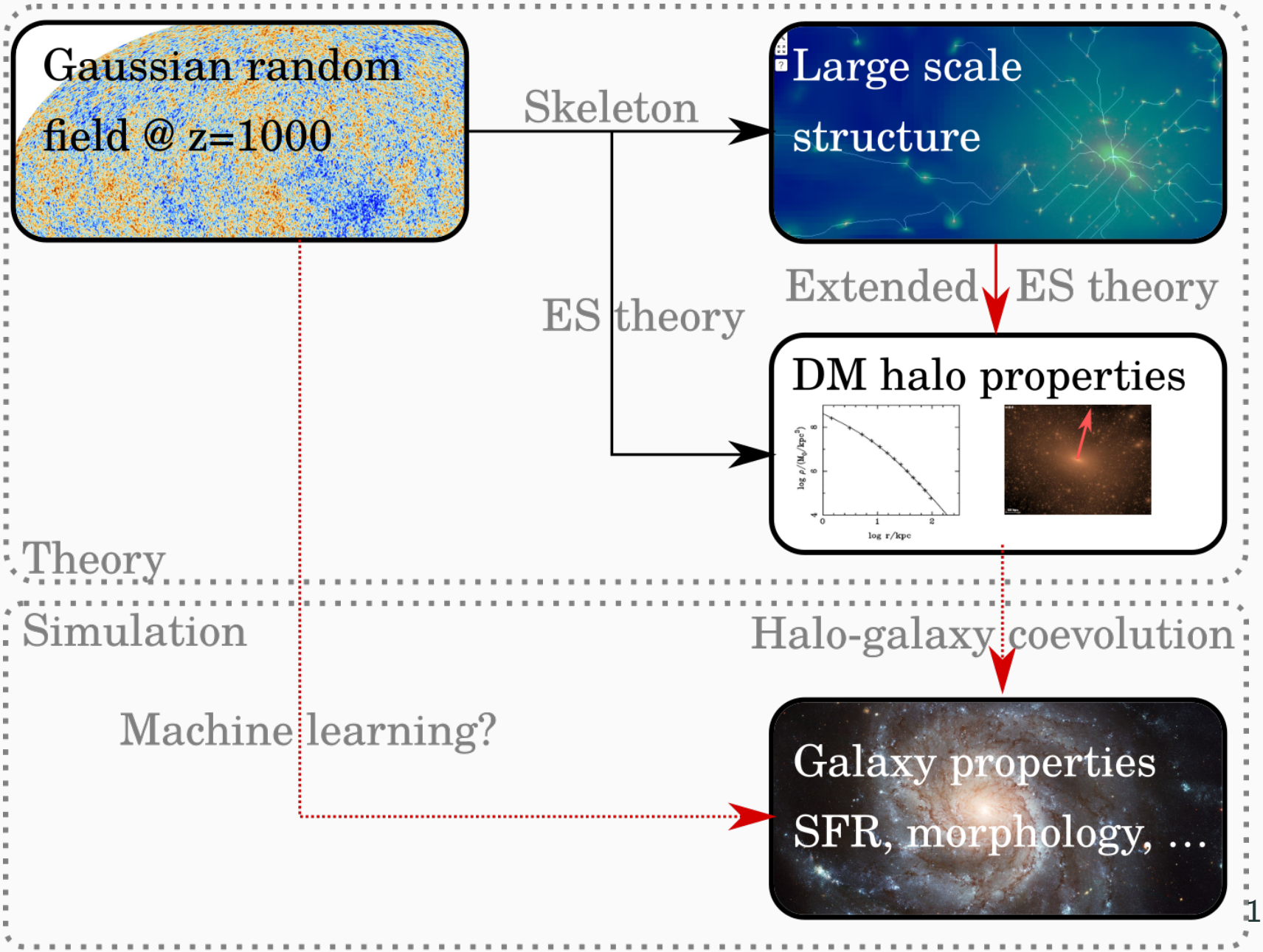
- Different gradients for different quantities
- Effects beyond mass & local density
- DM halo in nodes (resp. filaments)
  - form later
  - accrete more
  - are more massive

  than in filaments (resp. voids)

Open questions / WIP

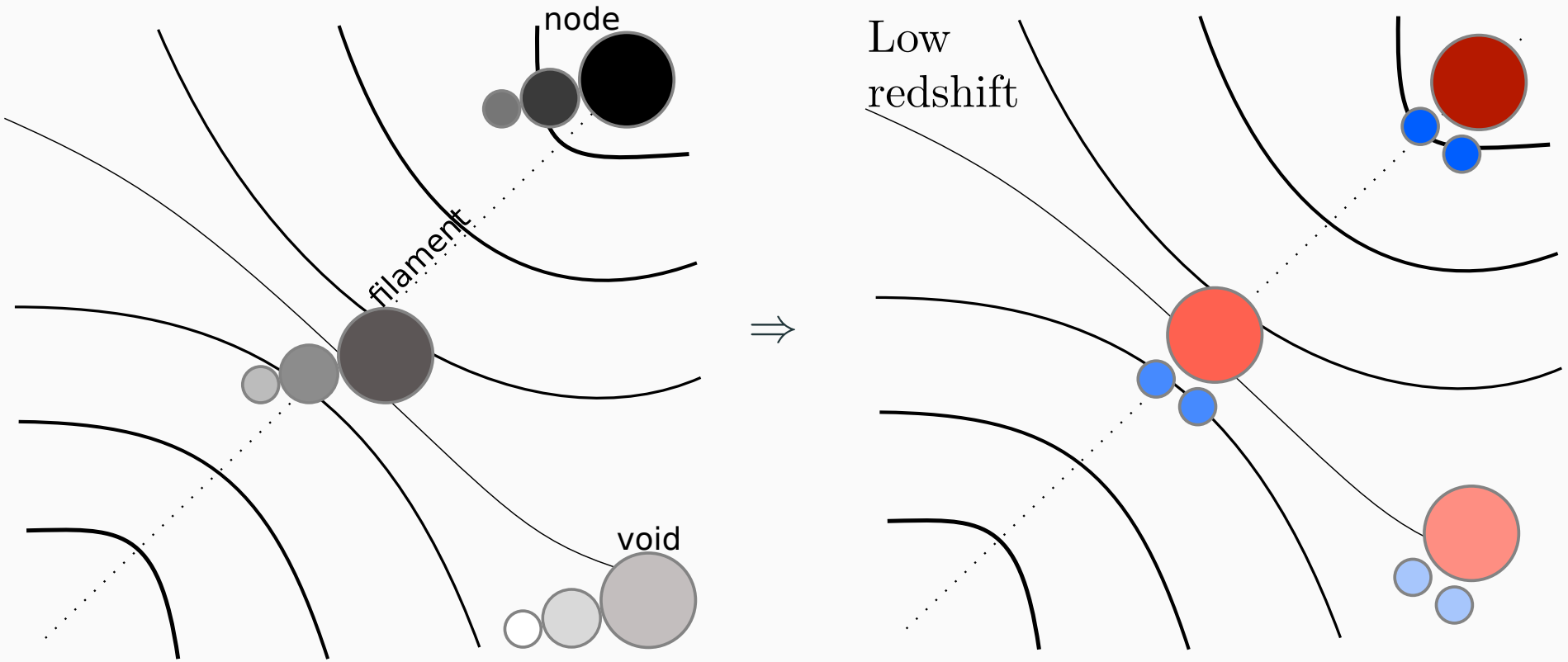
- Link DM halo to galaxy
- Take into account non-spherical collapse
- Build more proxies (e.g. merger rate)?

What's the plan?



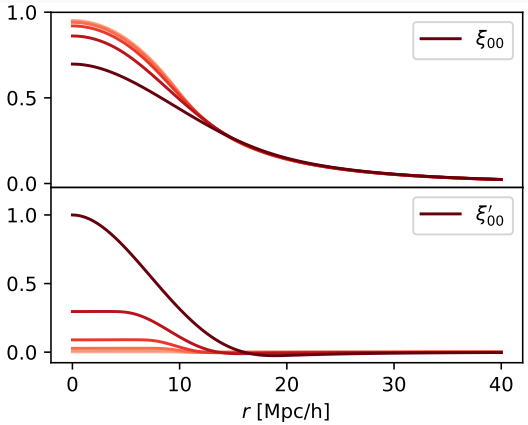
Thank you!

Effect of large scale

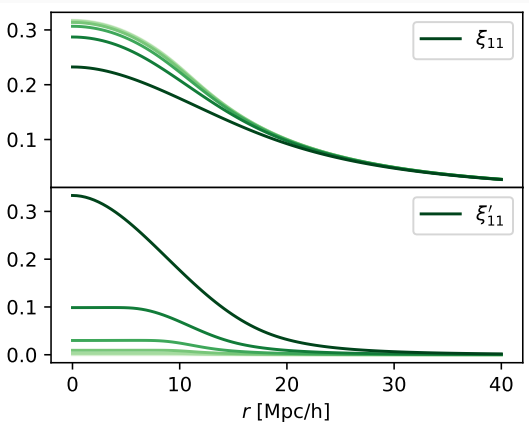


ξ functions

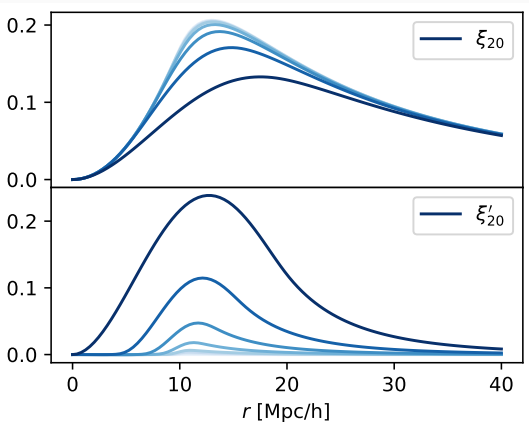
$\xi_{00} \propto \langle \delta \delta_{\mathcal{S}} \rangle$



$\xi_{11} \propto \langle \delta g_i \rangle$



$\xi_{20} \propto \langle \delta \bar{q}_{ij} \rangle$



$\xi'_{00} \propto \langle \delta' \delta_{\mathcal{S}} \rangle$

$\xi'_{11} \propto \langle \delta' g_i \rangle$

$\xi'_{20} \propto \langle \delta' \bar{q}_{ij} \rangle$