Background image credit: Illustris-TNG collaboration

LoCuSS: The splashback radius of massive galaxy clusters and its dependence on cluster merger history

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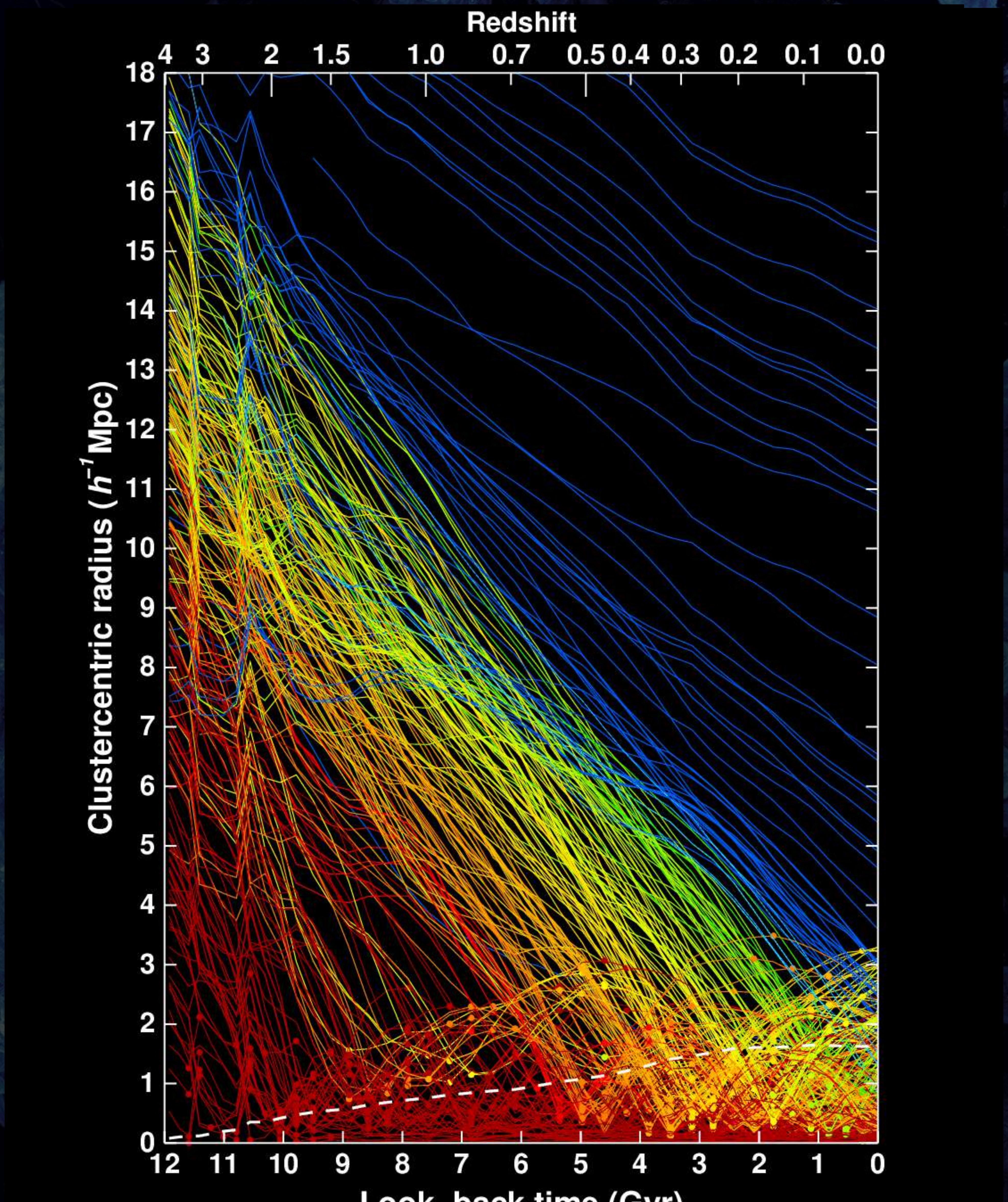
MB+21, ApJ 911, 136B(Arxiv:2010.05920)
Galaxy Cluster Formation II, June 15th

Cluster in-formation

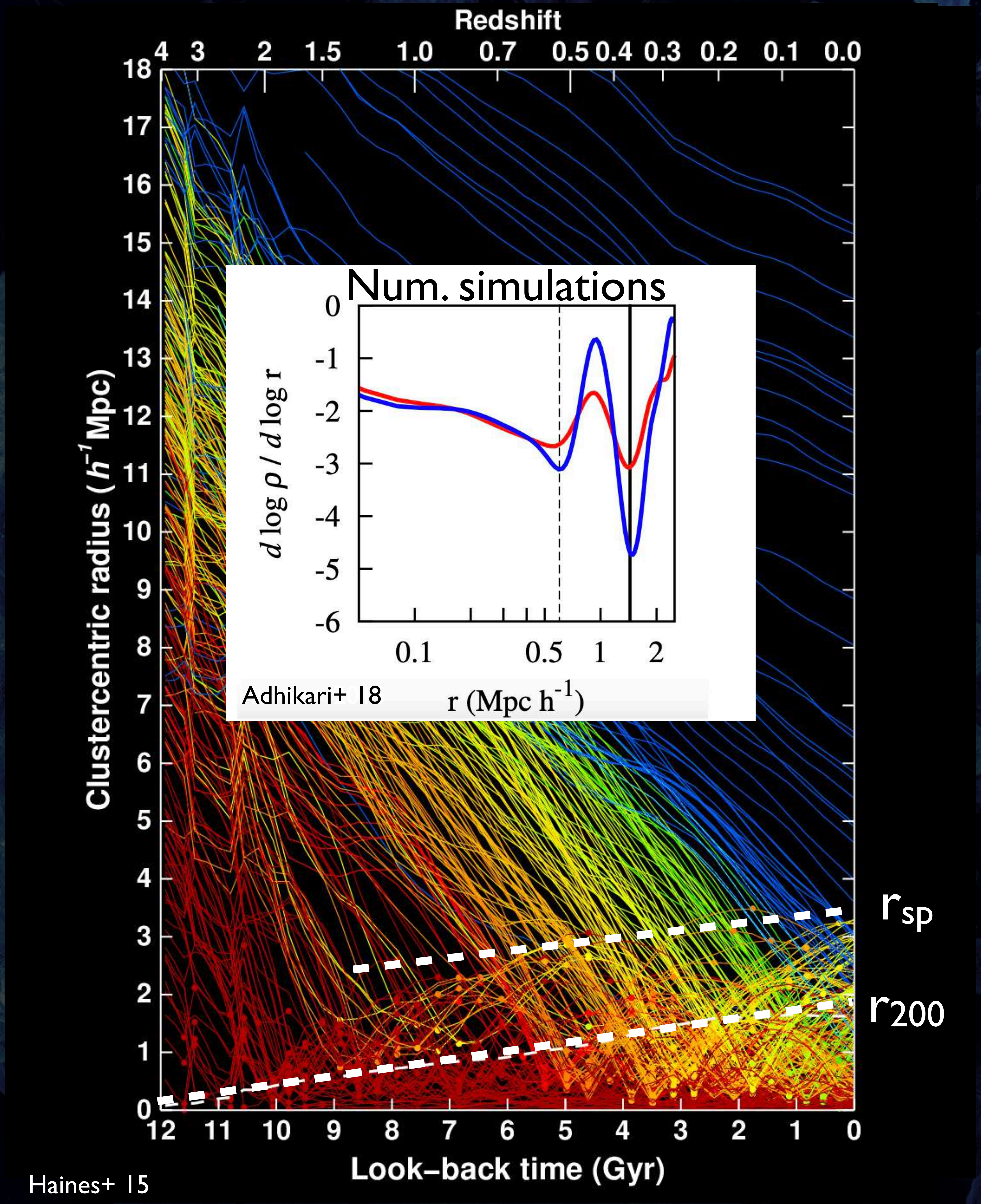


Haines+ 15

Cluster in-formation

Theory

Filmore & Goldreich 84
Bertschinger 85
Diemer & Kravtsov 14
Adhikari+ 14, 18
Shi+ 16a,b
Diemer+ 17
Banerjee+ 20
Mansfield & Kravtsov 20
Sugiura+ 20
Deason+ 20, 21
Diemer 20, 21
Contigiani+ 21
Zhang+ 21
…



Observations

Tully 15
Patej & Loeb 16
More+ 16
Adhikari+ 16
Umetsu & Diemer 17
Baxter+ 17
Busch & White 17
Nishizawa+ 18
Chang+ 18
Zuercher & More 19
Shin+ 19
Murata+ 20
Adhikari+ 21
…

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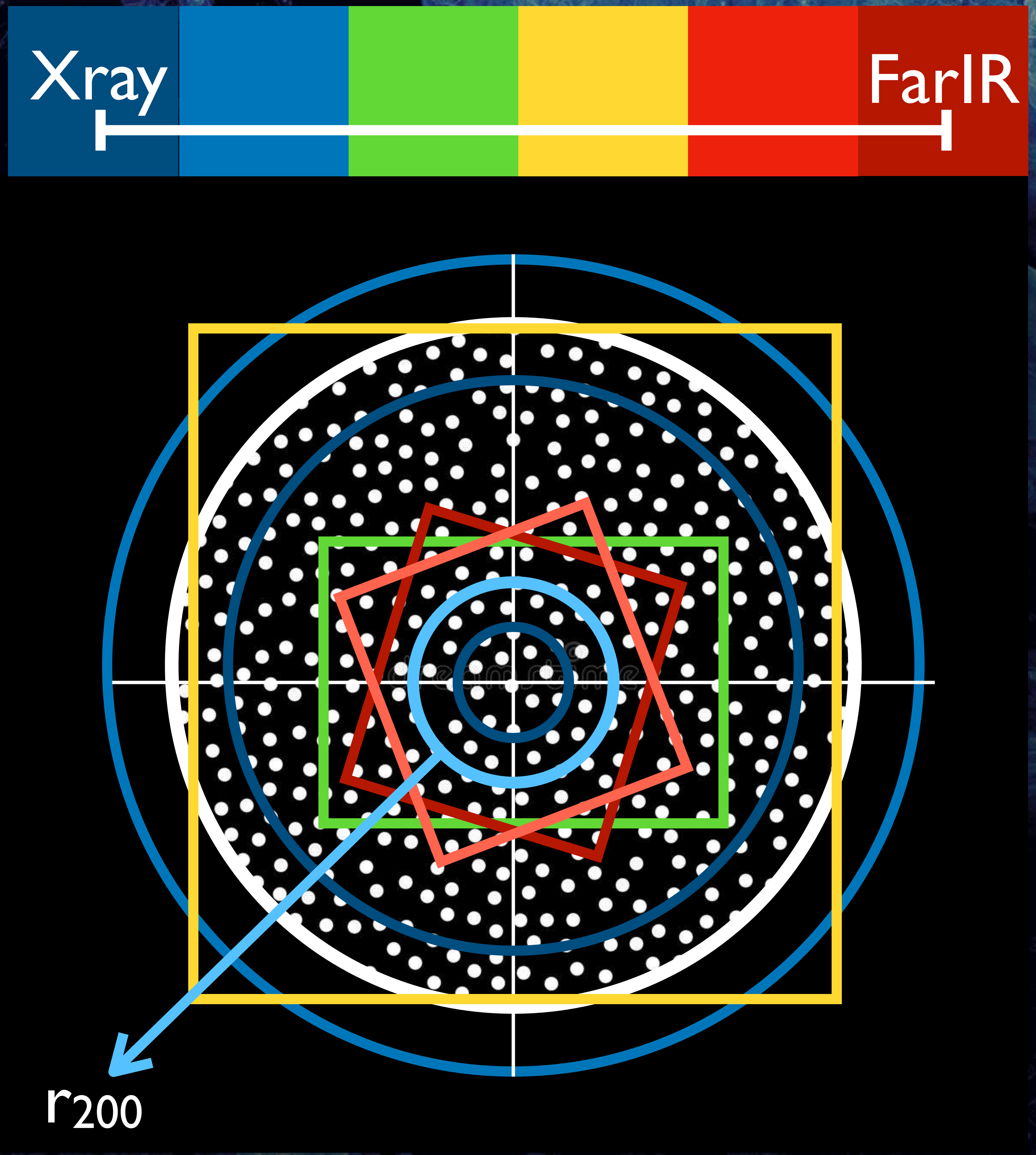
Towards the unification of clusters' physics
across all scales

LoCuSS survey

- Multi-wavelength survey of 30 X-ray luminous clusters at $0.15<z<0.30$
- 10^4 spectr. confirmed cluster members up to $\sim 3r_{200}$ and down to $M_* \approx 2\times10^{10}\,M_\odot$ (80 % completeness)
- No morphological bias, weak dependence on SFR and SFH thanks to mid-IR colour selection of spectr. targets



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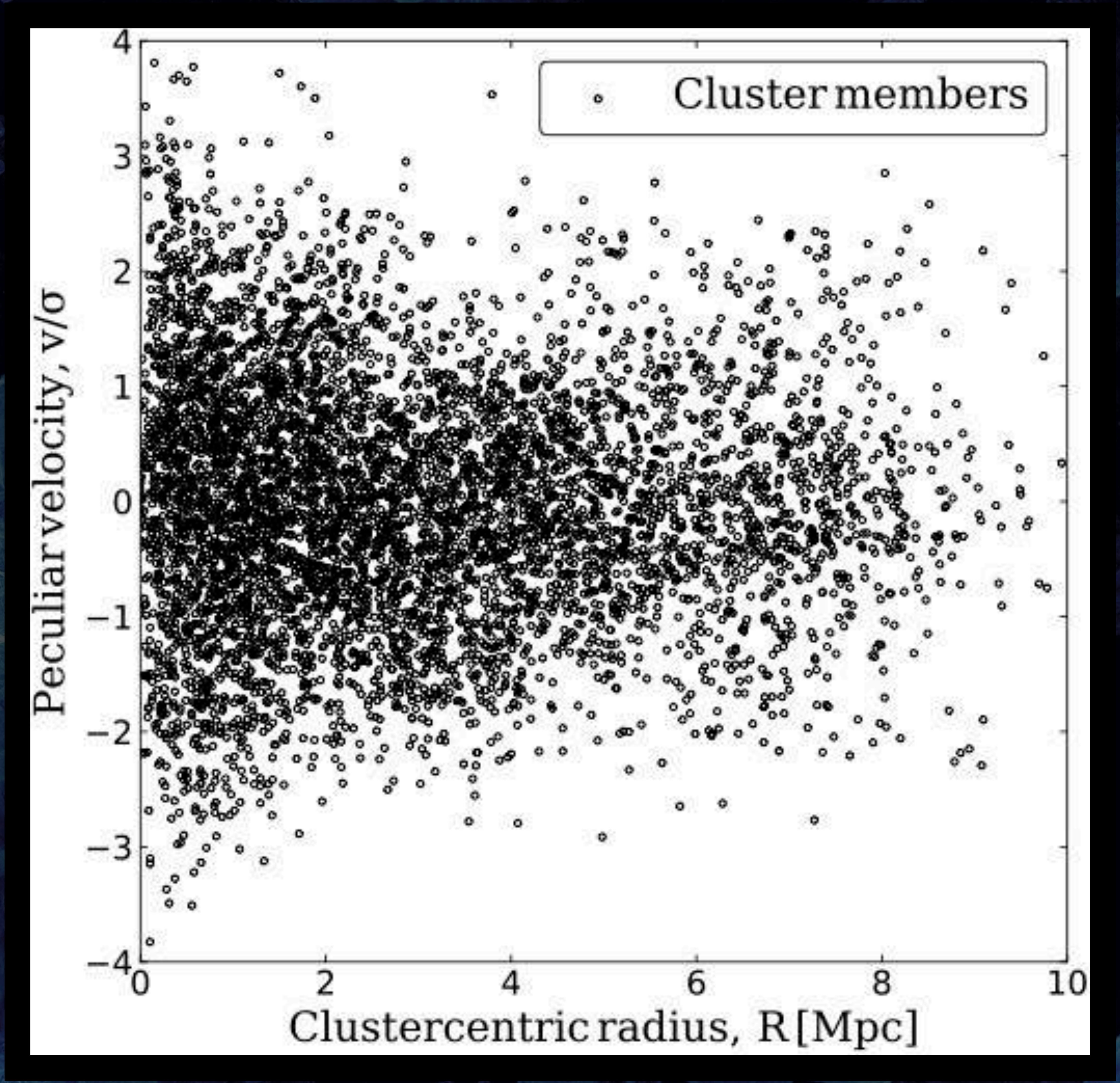
LoCuSS survey



- Armitage+ 18: stellar mass-limited galaxy sample is good tracer of the cluster gravitational potential
- Shirasaki+ 21: LoCuSS galaxy velocity dispersion is consistent with ΛCDM out to ~ 8 Mpc

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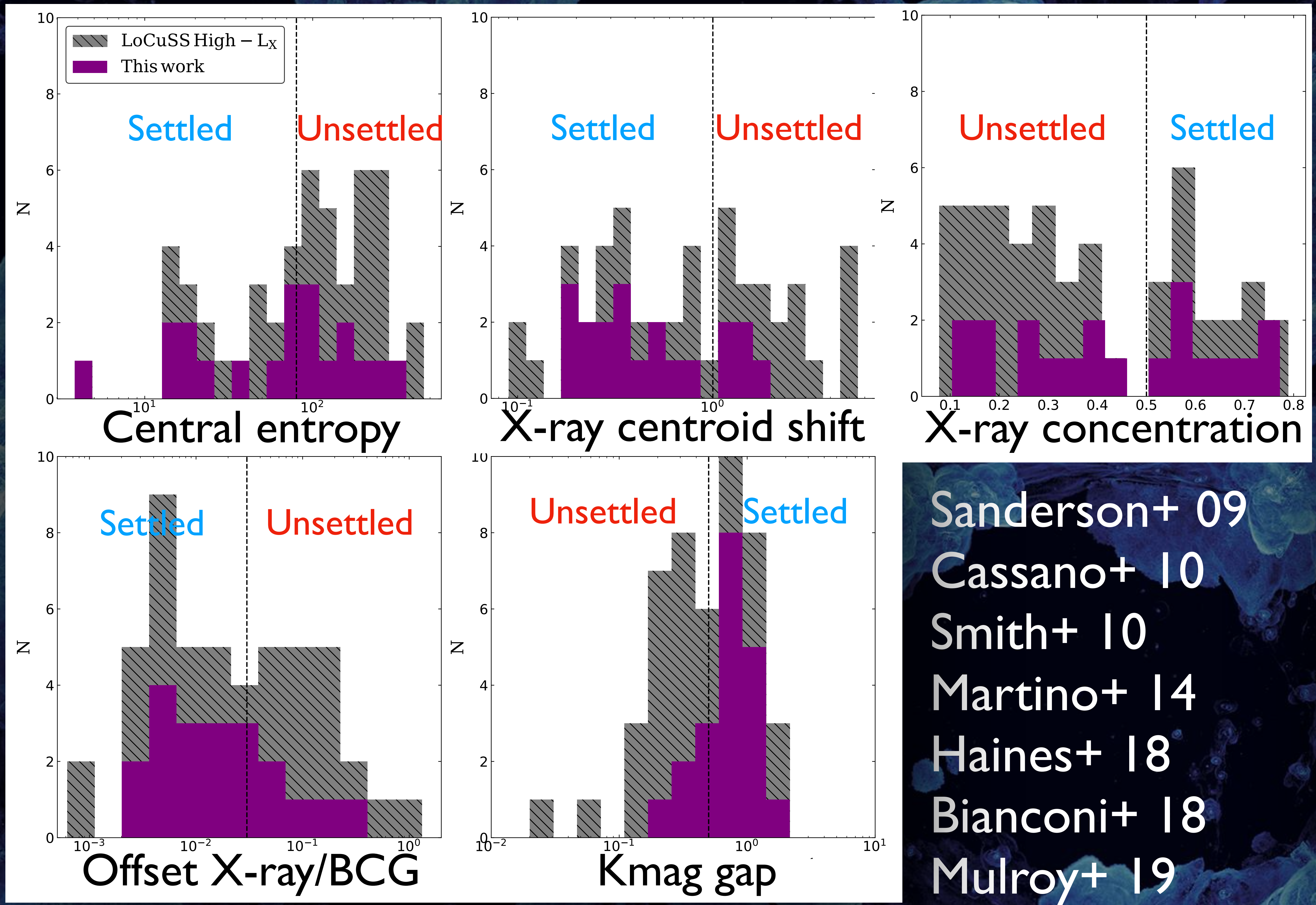
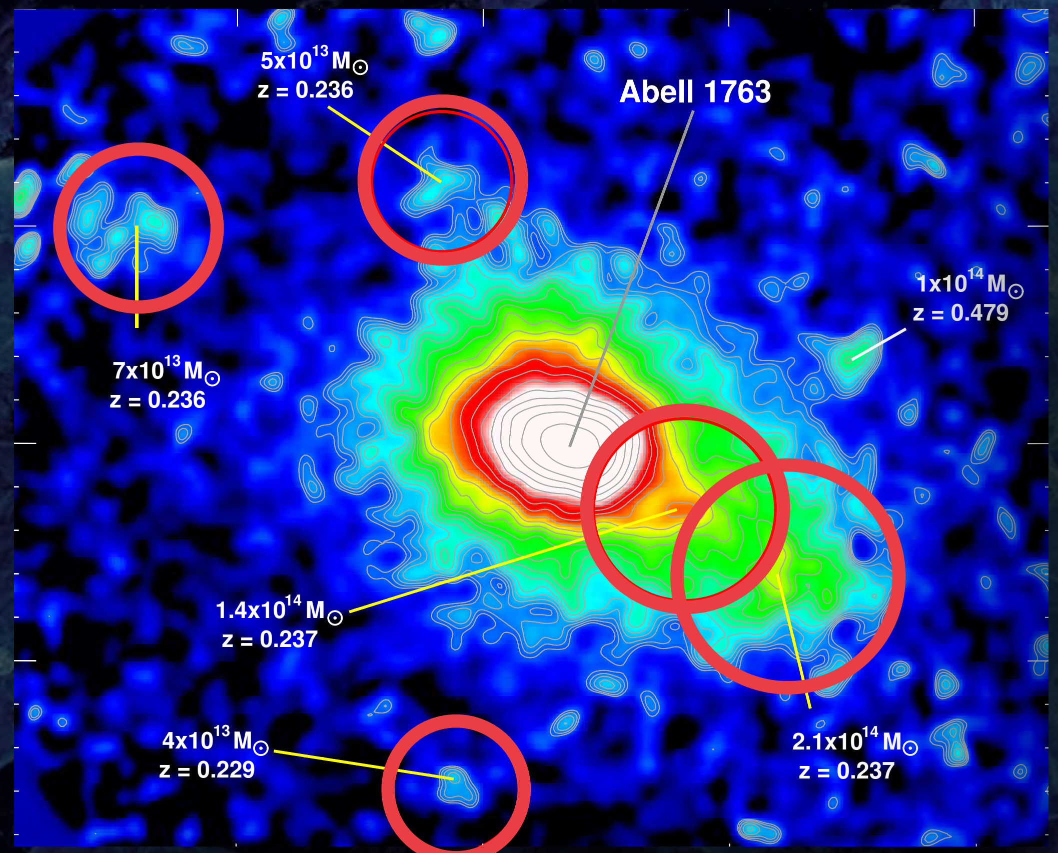
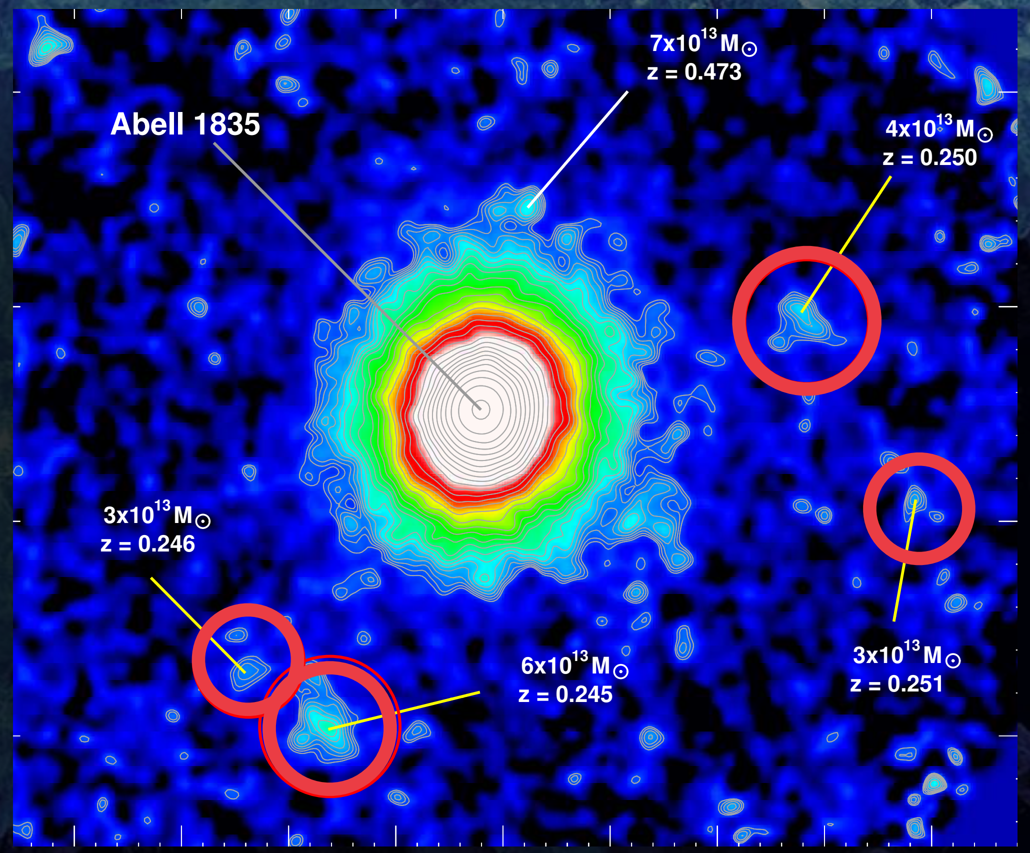
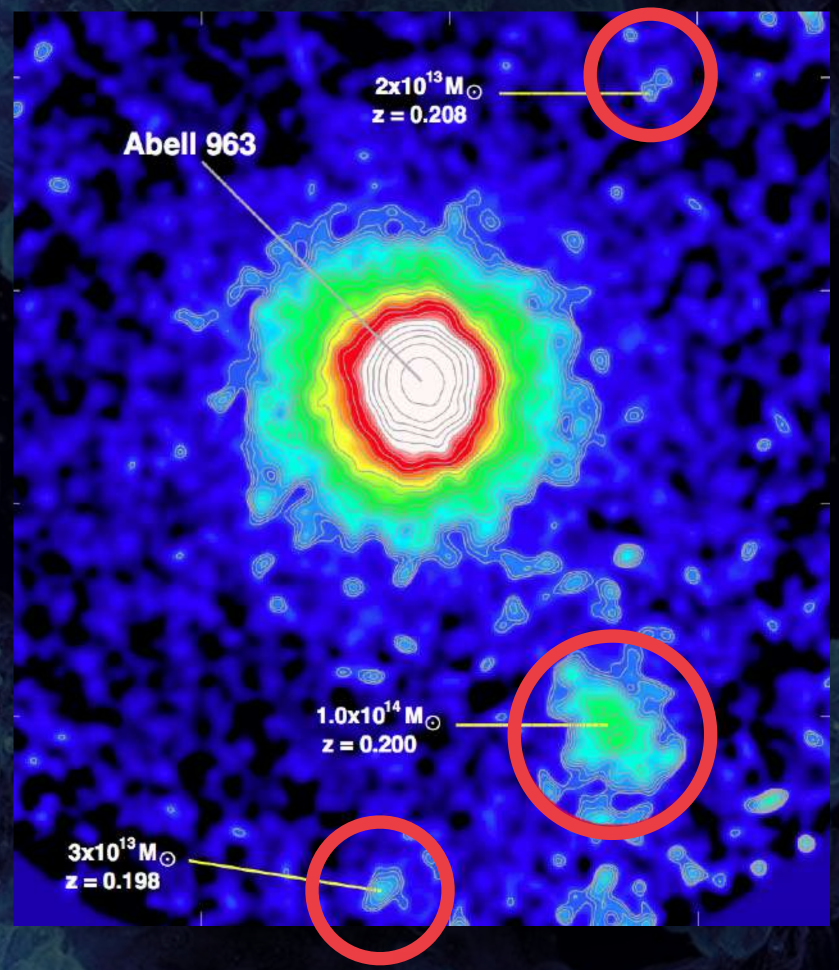
LoCuSS survey



Sanderson+ 09
Cassano+ 10
Smith+ 10
Martino+ 14
Haines+ 18
Bianconi+ 18
Mulroy+ 19







Infalling
X-ray groups
surronding
clusters

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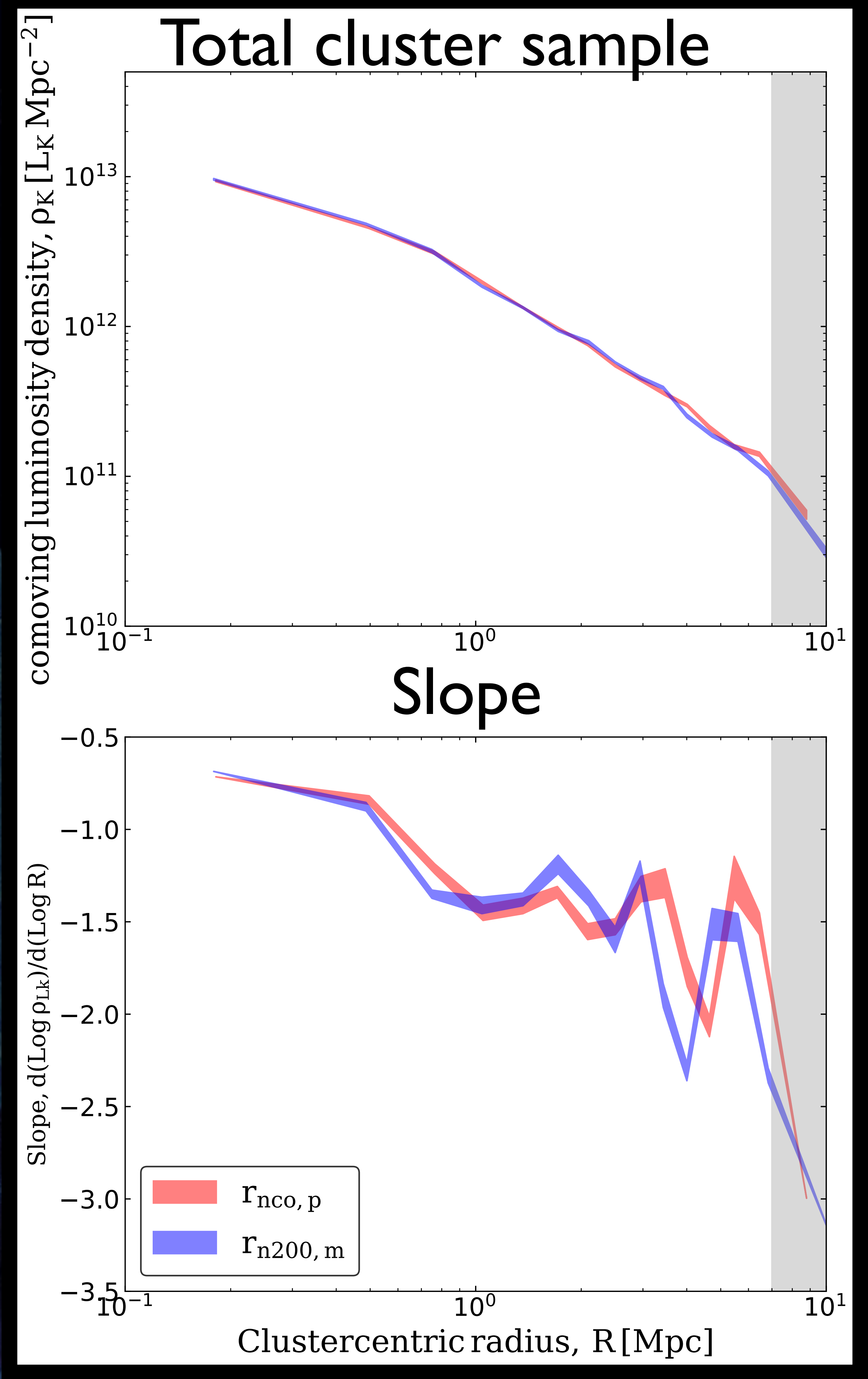
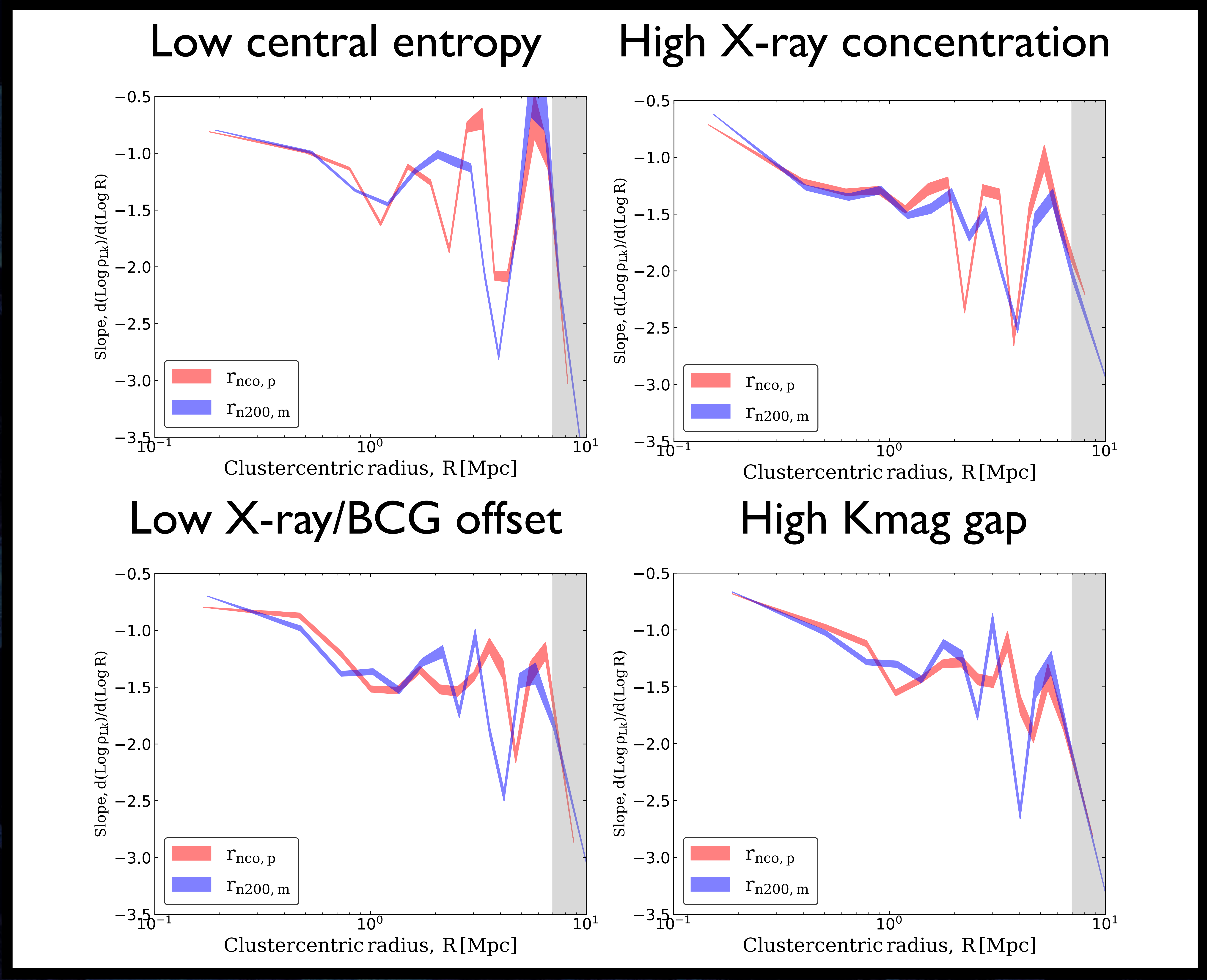
Results: empirical detection





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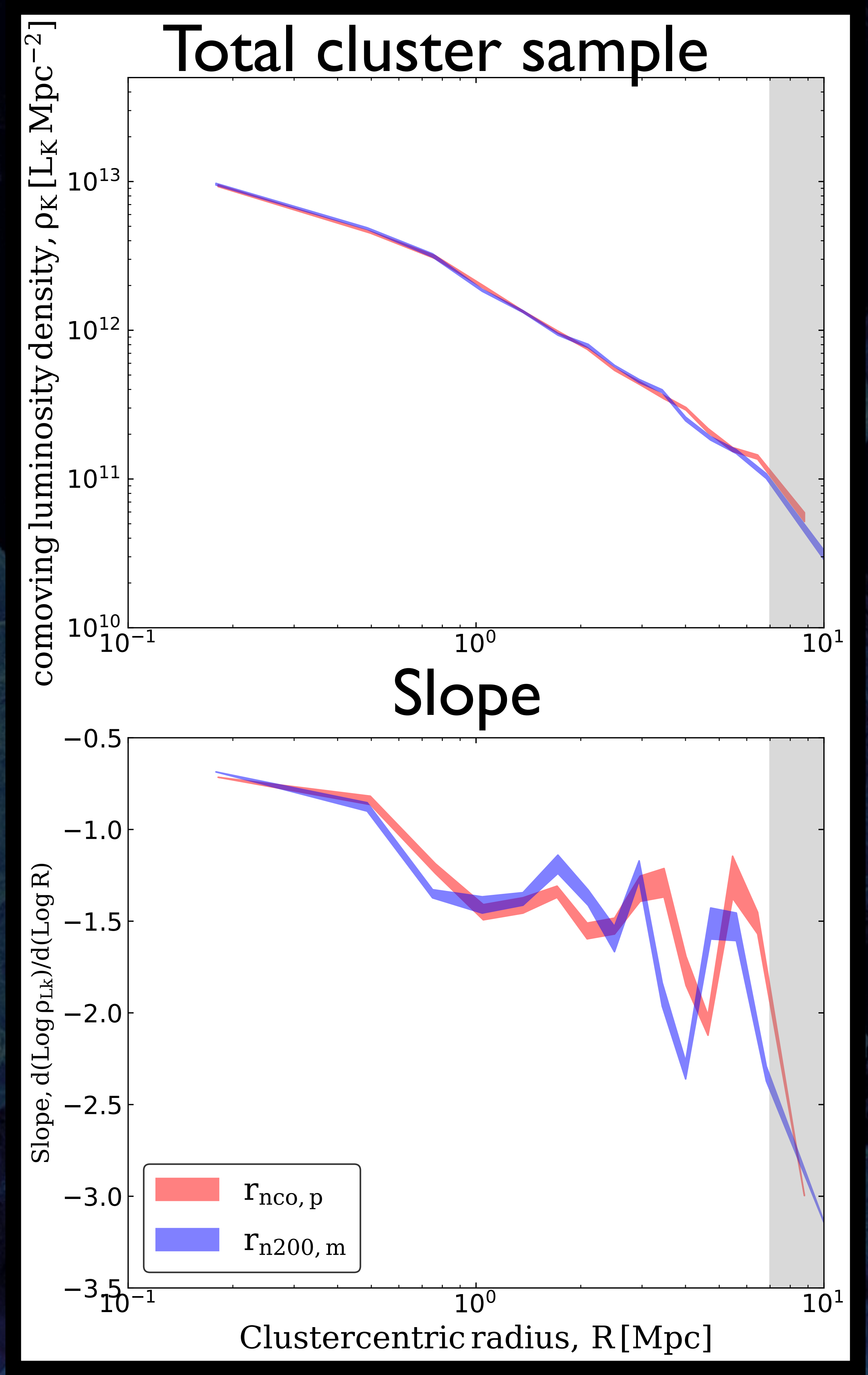
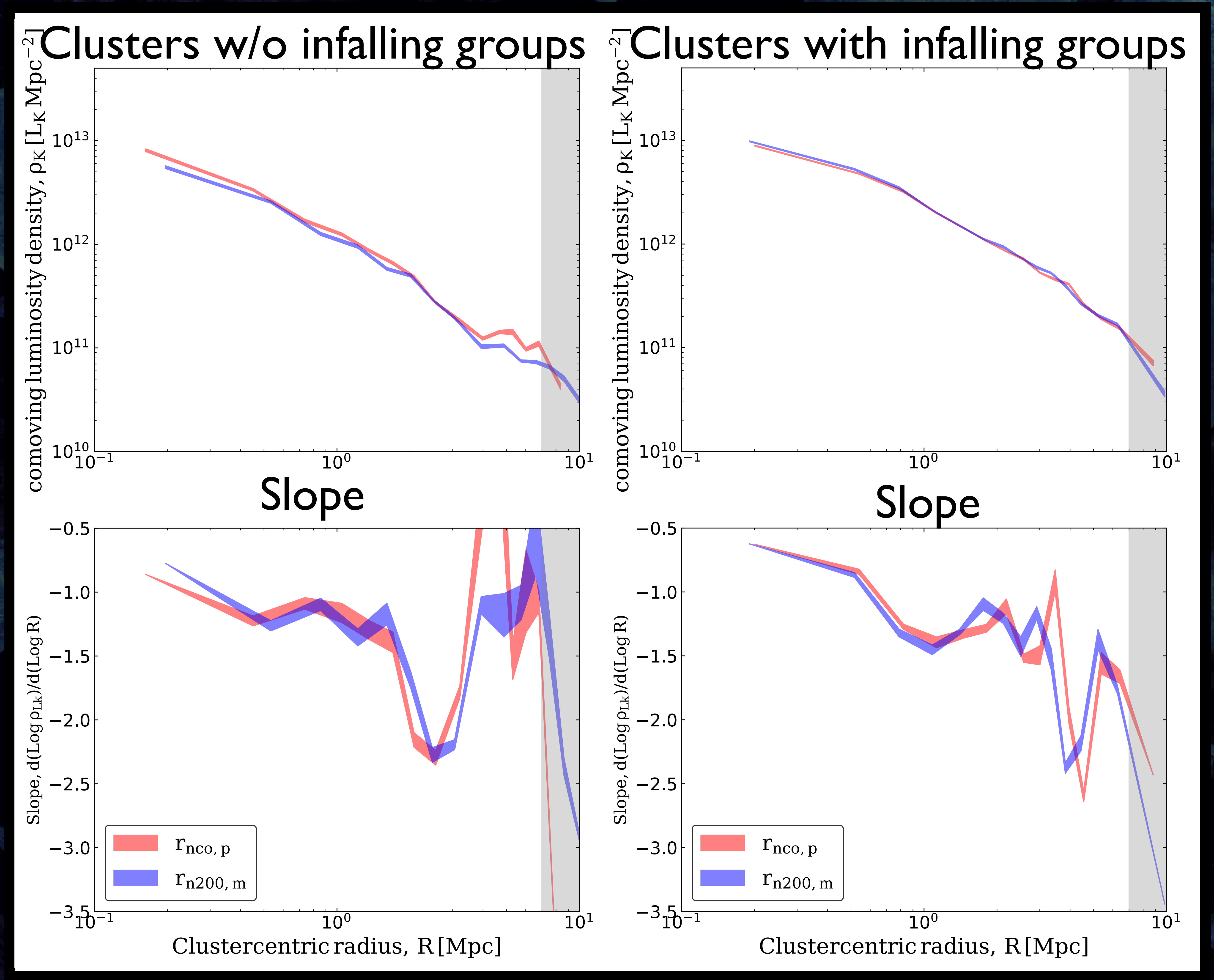
Results: empirical detection





Results: model confirmation

$$\rho(r) = \rho_{\rm Ein}(r) \times f_{\rm trans}(r) + \rho_{\rm infall}(r),$$

$$\rho_{\rm Ein}(r) = \rho_s \exp\left\{-\frac{2}{\alpha}\left[\left(\frac{r}{r_s}\right)^{\alpha} - 1\right]\right\},$$

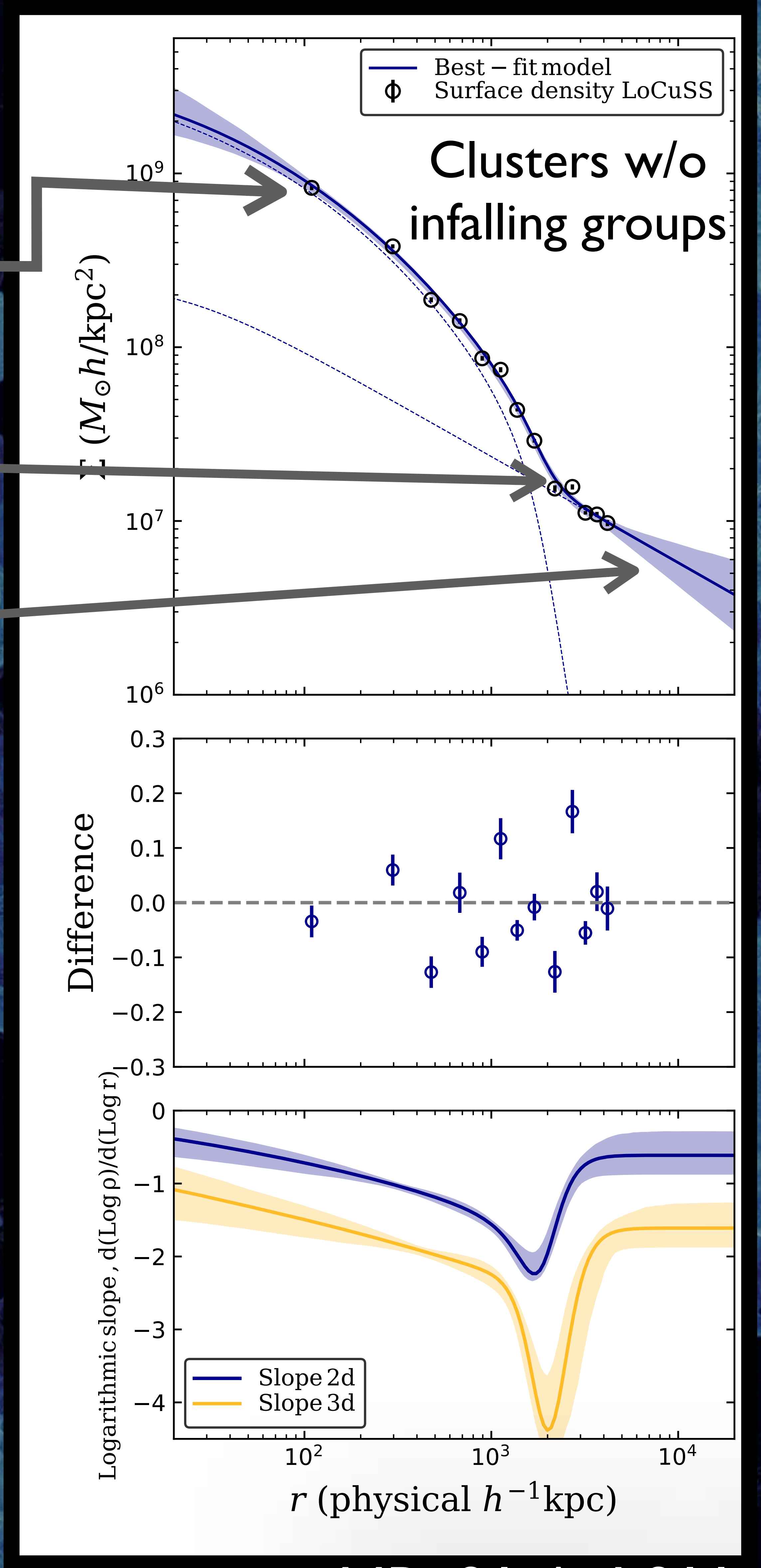
$$f_{\rm trans}(r) = \left[1 + \left(\frac{r}{r_t}\right)^{\beta}\right]^{-\gamma/\beta},$$

$$\rho_{\rm infall}(r) = \frac{\rho_0}{1/\Delta + (r/r_{\rm pivot})^{s_e}}$$

Collapsed

Splashback

Infall



- Model (Diemer+ 14) fit+validation from Bayesian evidence using nested sampling algorithm CPNest (Veitch+ 2017)

- Splashback model more descriptive of data than model without transition

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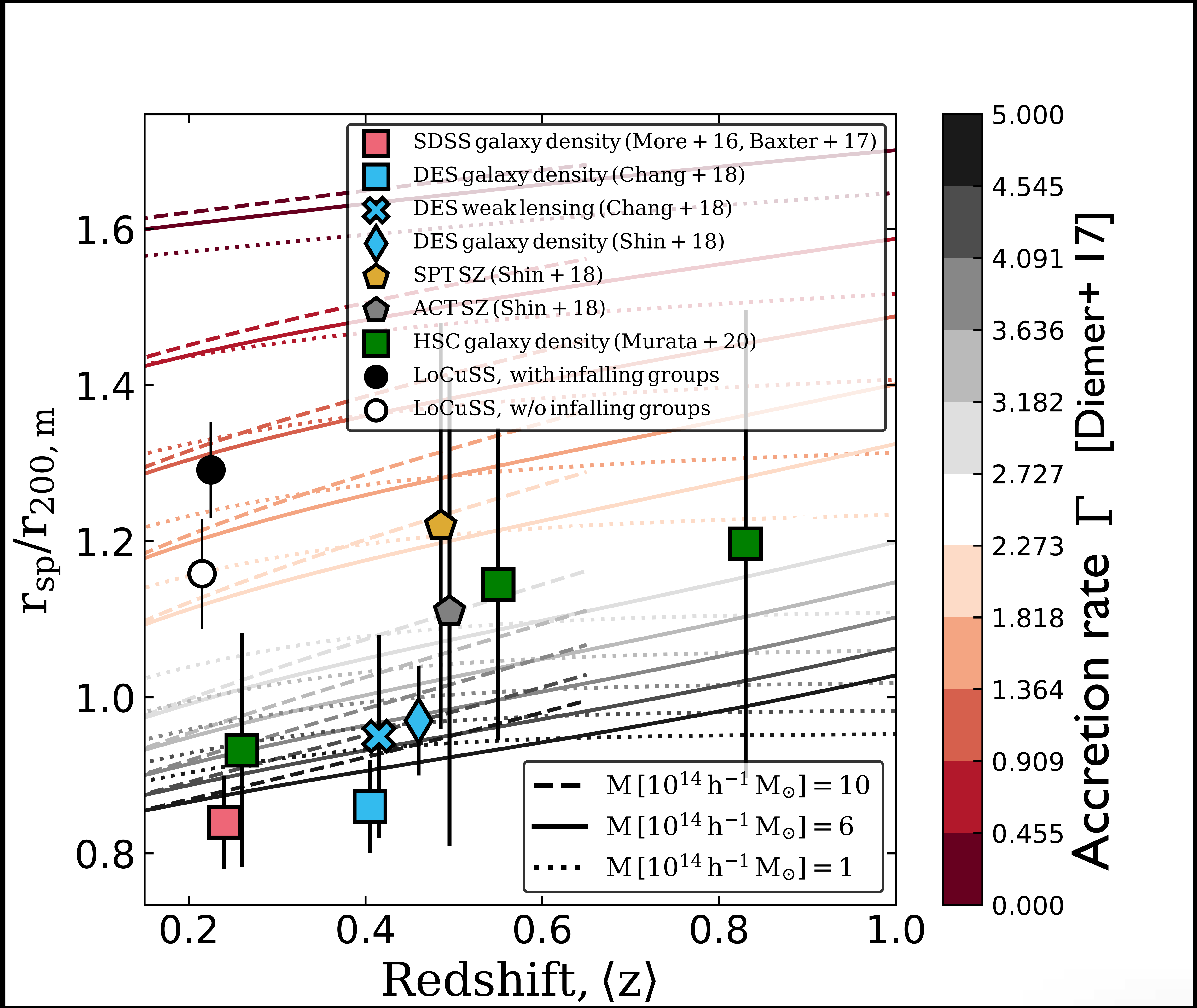
Results: detection comparison



Discussion on systematics in splashback observations:
Busch & White 2017
Sunayama & More 2019
Murata+ 20

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Conclusions

- Extensive multi-wavelength spectroscopical campaign precursor of next-generation cluster science
- First detection of the splashback feature (above 5σ) using spectroscopically confirmed cluster members
- Clusters classified as old/dynamically inactive show stronger splashback feature
- Evidence of dynamical state and accretion history affecting location and depth of the splashback feature
- Fundamental dynamical properties of clusters reverberate across vastly different physical scales

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Thank you