

SMURF 2019

How to define a relaxed galaxy cluster?

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Outline

1. Introduction
2. Distribution of relaxation parameters
3. Correlation between relaxation parameters
4. Other topics, conclusion and future work

1. Introduction: cosmology with relaxed galaxy clusters

Wiser selection
of relaxed galaxy clusters

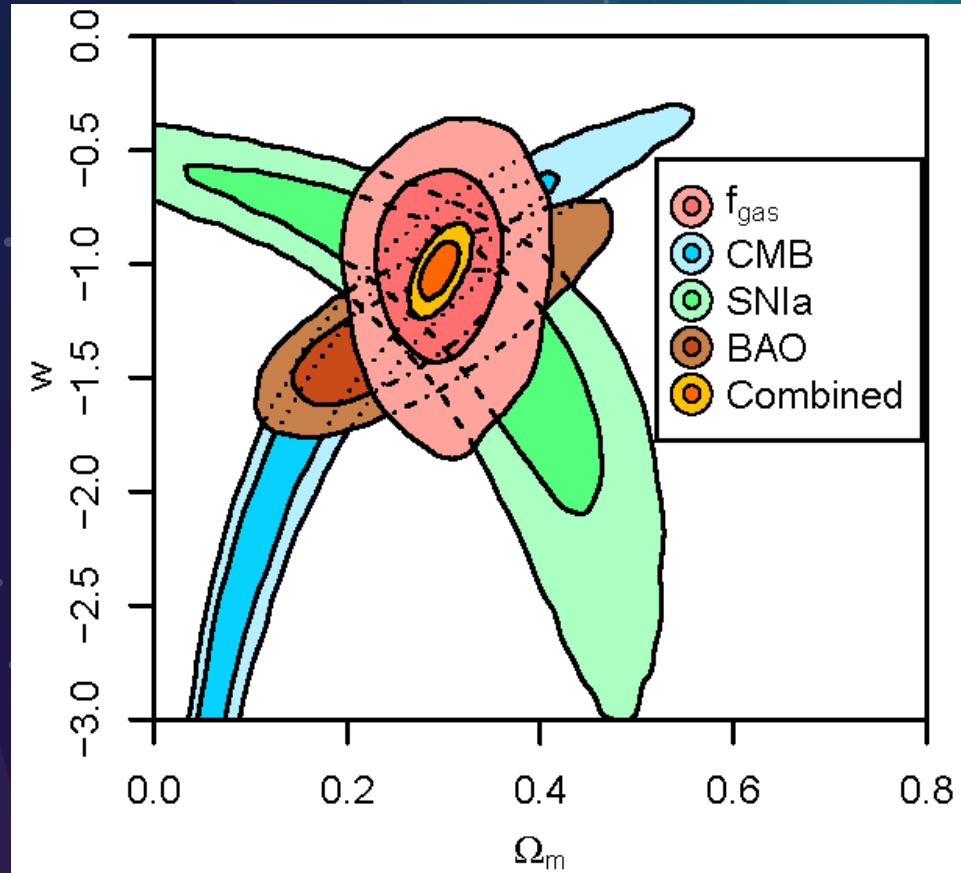


Lesser scatter
in halo mass estimation



Stronger constraints
for cosmological parameters

Taken from Mantz+ 2014 →



1. Introduction: simulations and relaxation parameters

Sims studied in this work:

1. **BAHAMAS**: **B**aryons and **H**aloes of **MA**ssive **S**ystems

Ref.: McCarthy+ 2017

2. **MACSIS**: **MA**ssive **C**lusters and **I**ntercluster **S**tructures

Ref: Barnes+ 2017

3. **IllustrisTNG300**: Illustris The **N**ext **G**eneration, **300** Mpc

Ref: Naïman+, Marinacci+, Springel+, Nelson+, Pillepich+ 2018

RLX params from **simulation**:

X_{off} : Centre of mass placement

f_{sub} : Substructure mass fraction

$E_{\text{kin}} / E_{\text{therm}}$ or E_{rat} : Energy ratio

RLX params from **observation**:

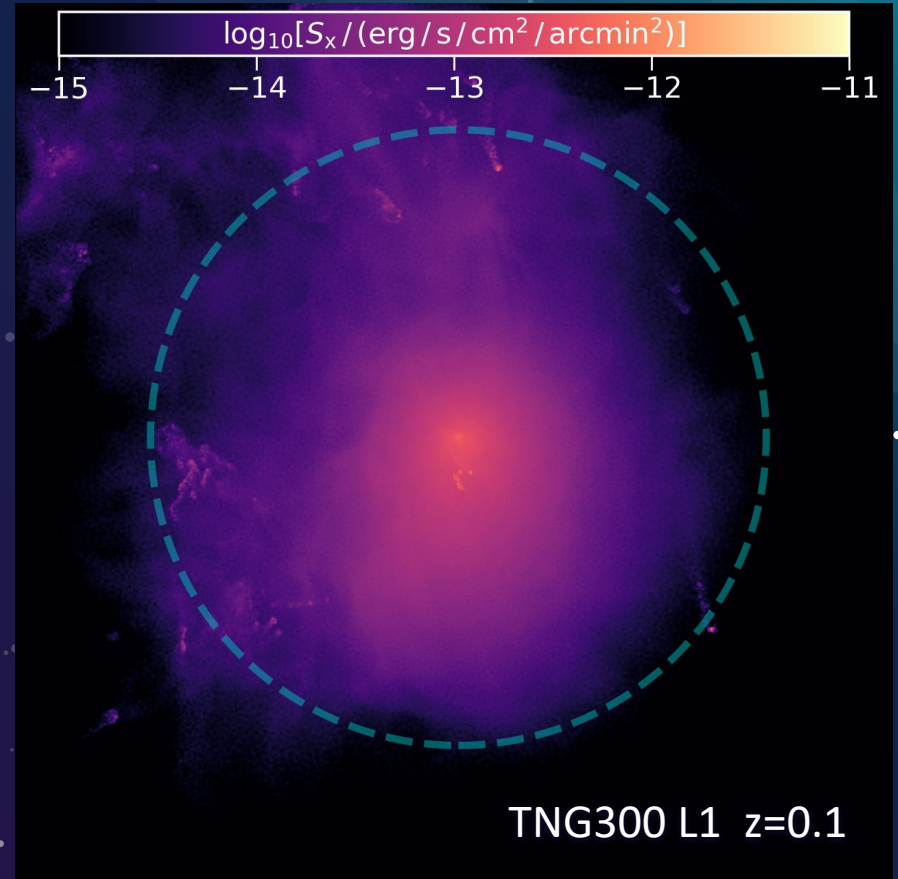
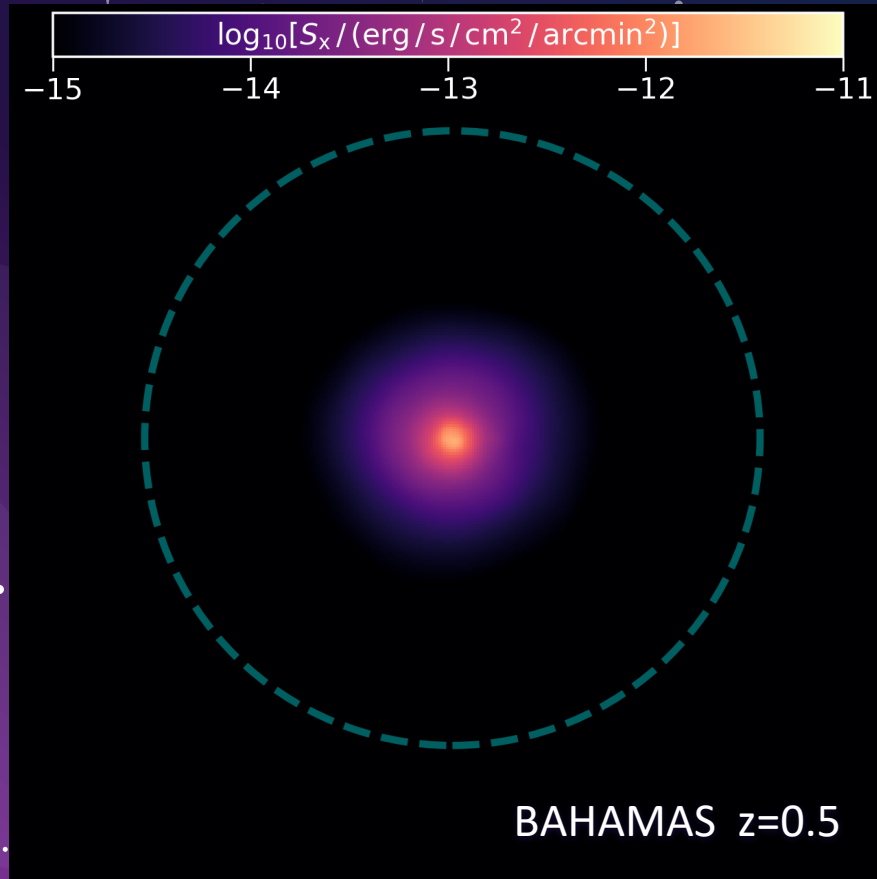
$\langle w \rangle$: Centroid shift

p : Surface brightness peakiness

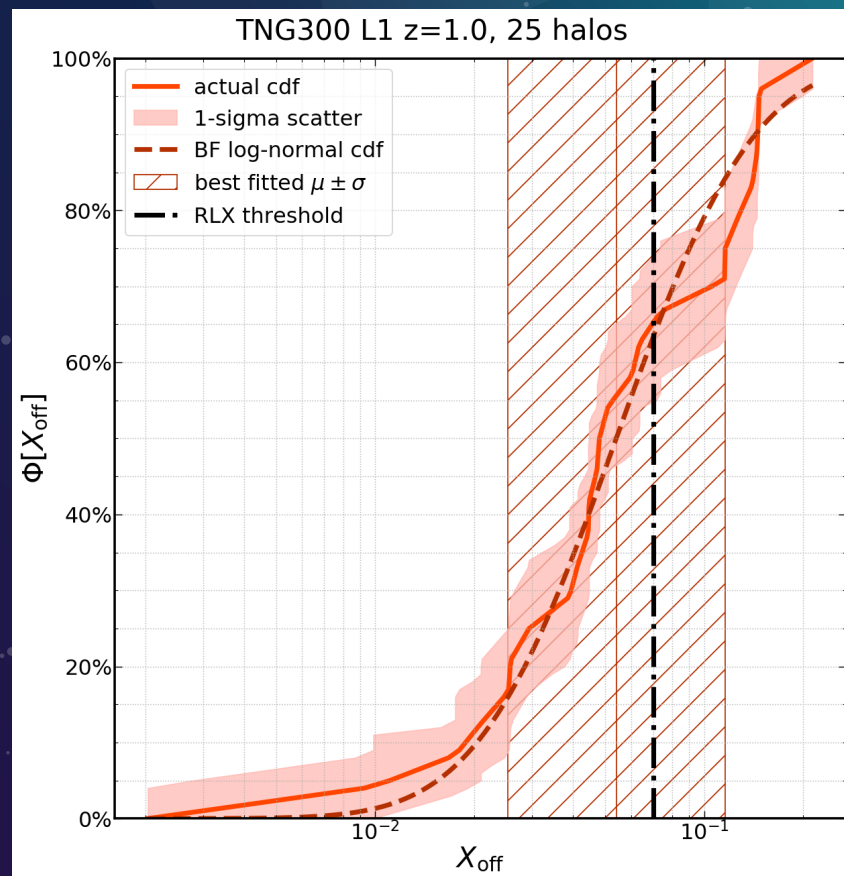
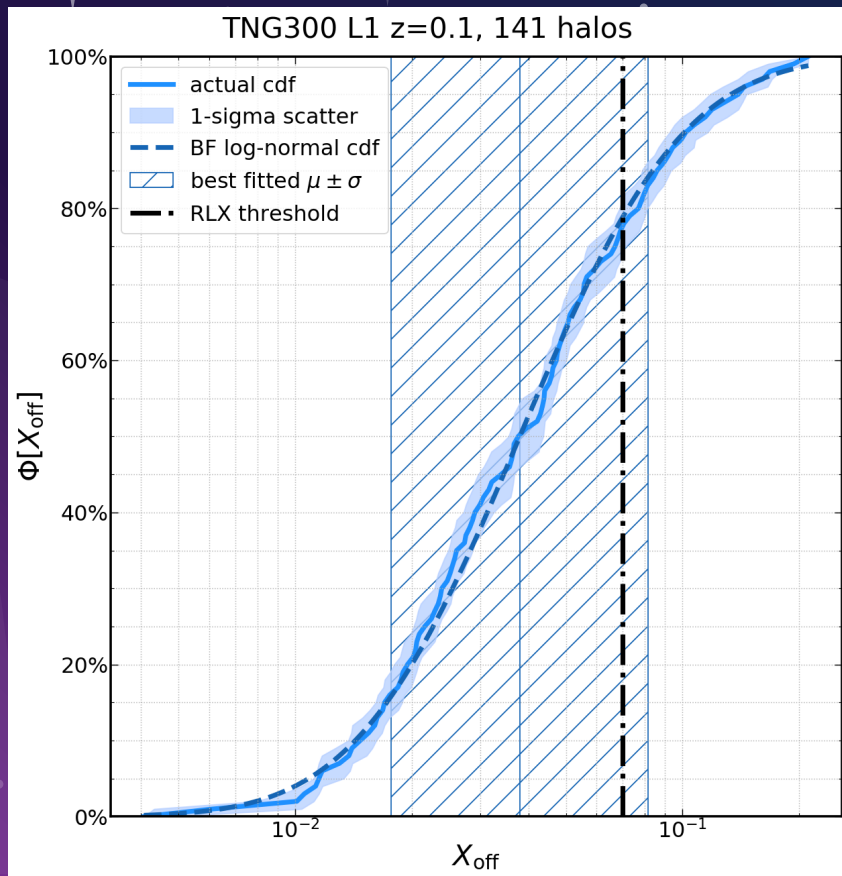
s : Symmetry statistic

a : Alignment statistic

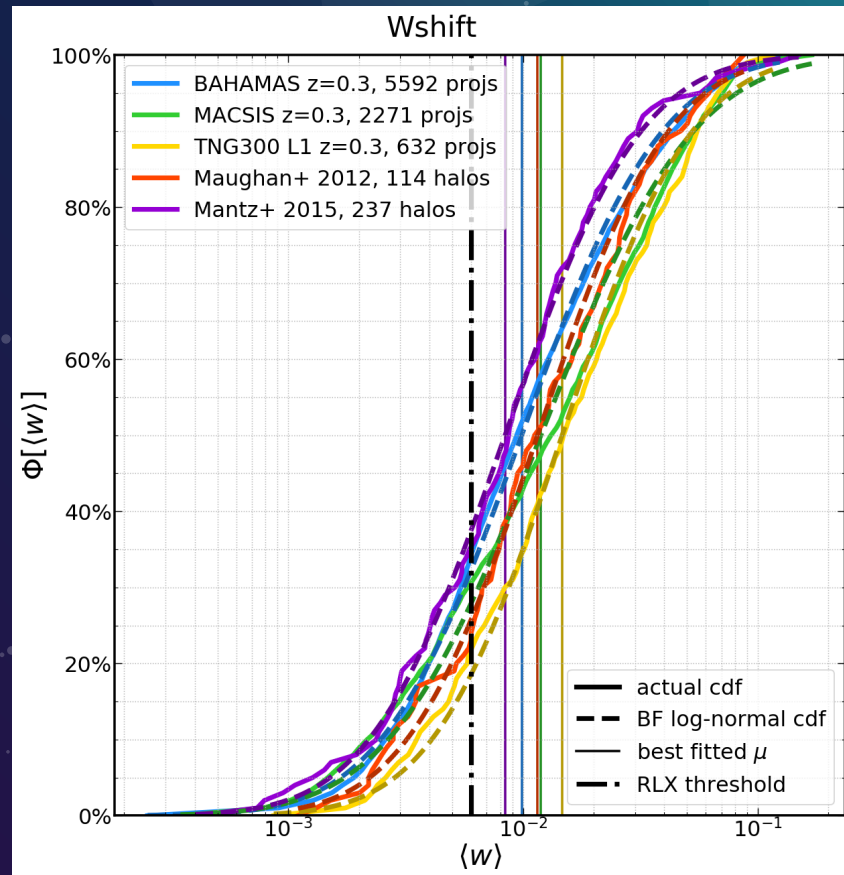
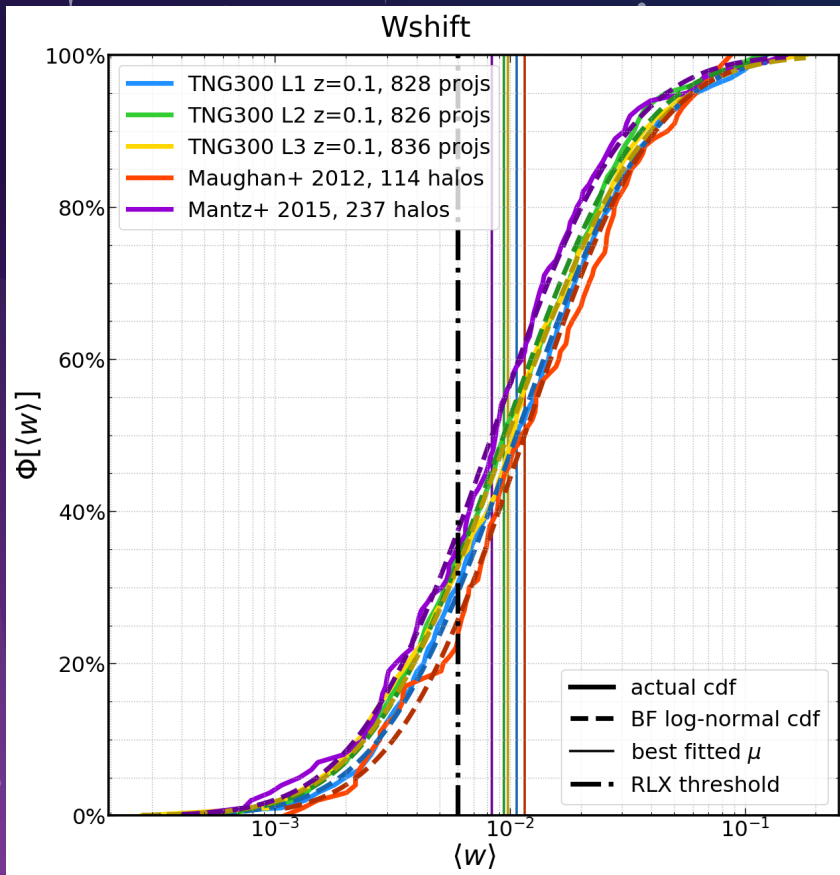
1. Introduction: relaxed vs. unrelaxed galaxy cluster



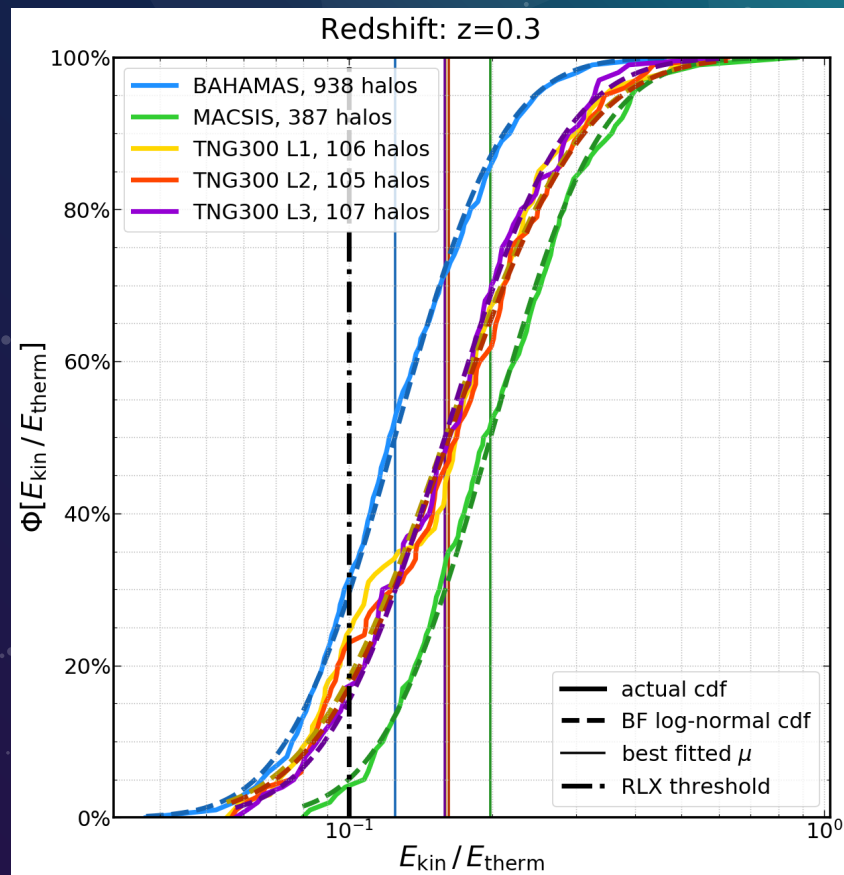
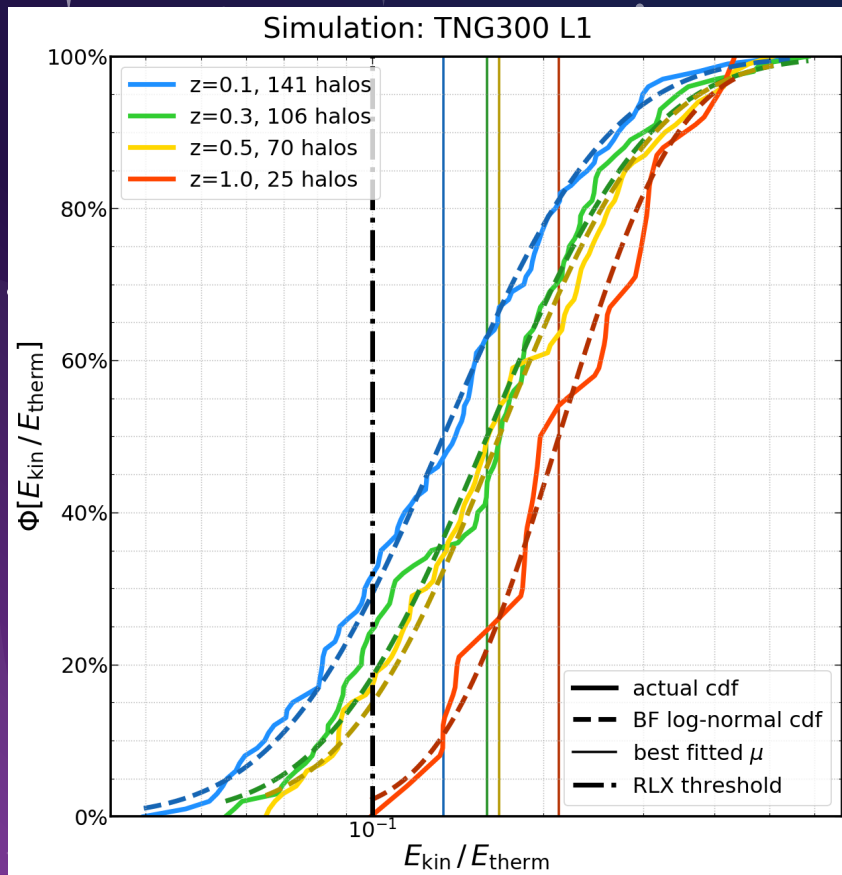
2. Distribution: details in the percentile – cdf plots



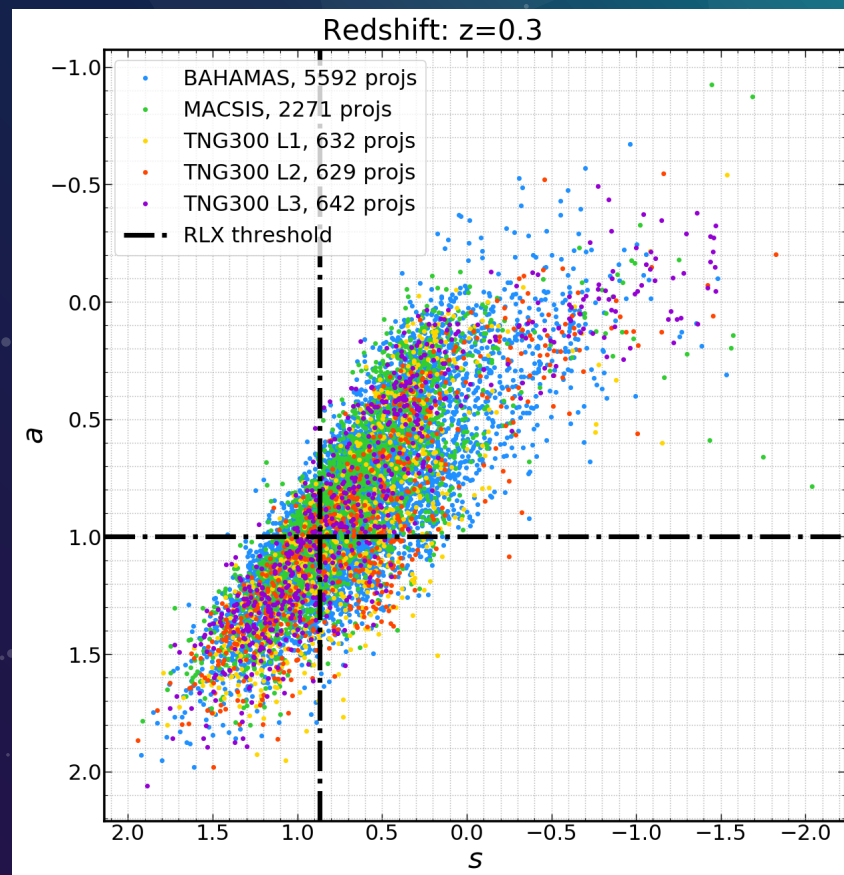
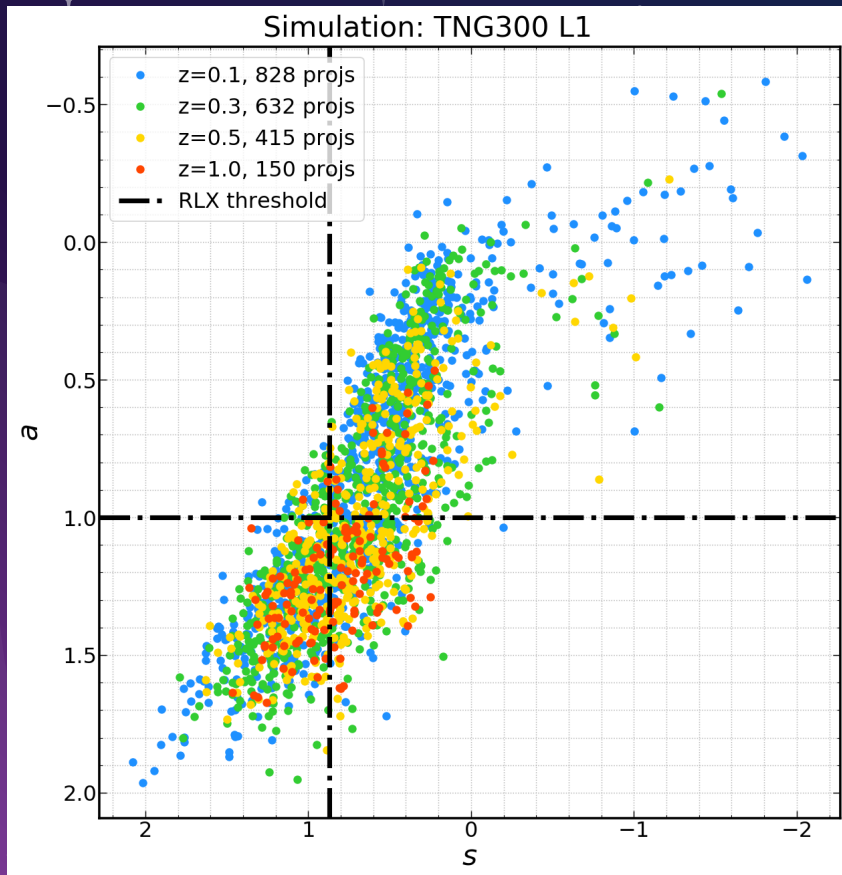
2. Distribution: observation – simulation comparison



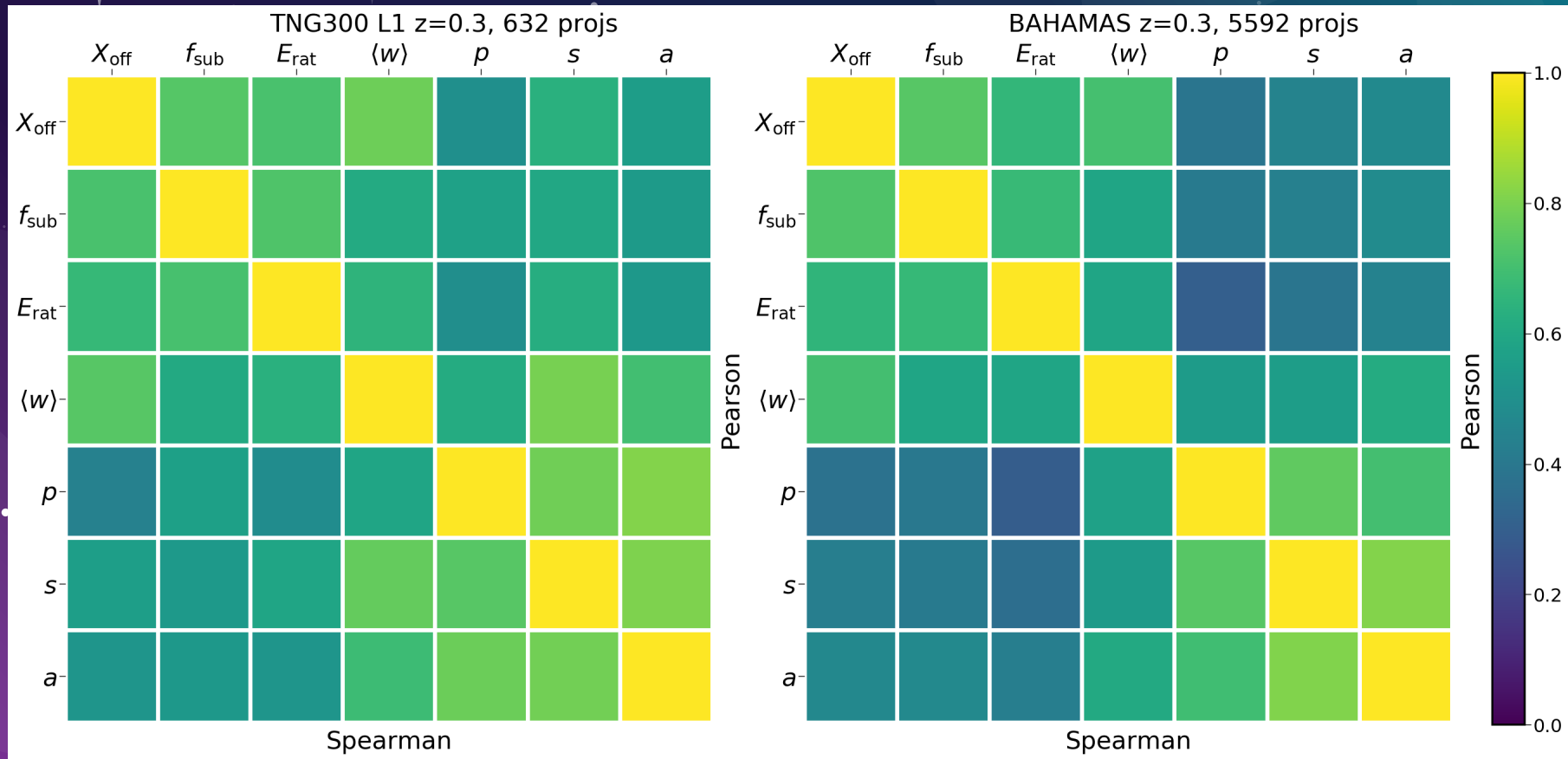
2. Distribution: different redshifts, different simulations



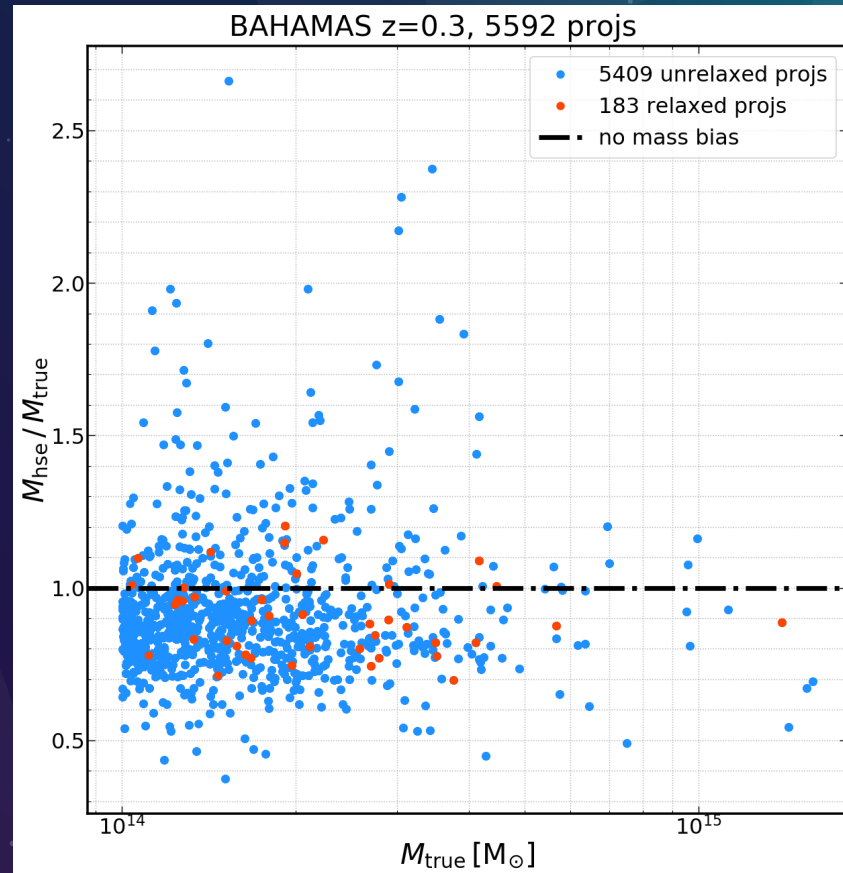
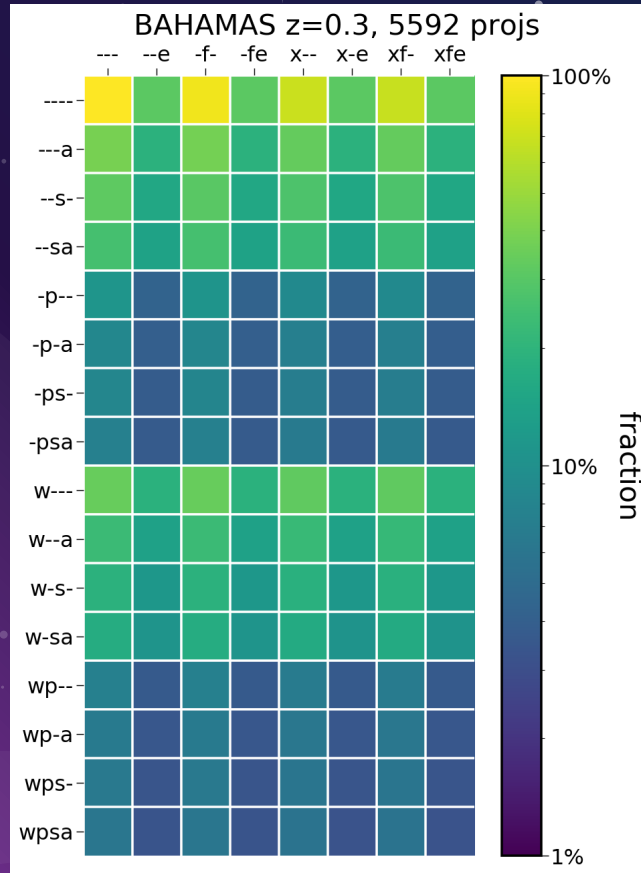
3. Correlation: different redshifts, different simulations



3. Correlation: heatmaps for Spearman / Pearson coefs



4. Other topics: fraction and behavior of relaxed halos



4. Conclusion and future work

Conclusion:

1. The relaxation parameters of simulated galaxy clusters are (log-) normal distributed and correlated to each other.
2. Redshift evolution of distributions / correlations and nuances between simulations with different sub-grid physics are observed.
3. Low-redshift simulation results (for relaxation parameters from observation) are in good agreement with observational data.

Future work:

1. Application of machine learning techniques
2. Alternative thresholds for relaxation parameters
3. To consider selection bias and detector performance