PROJECTION BIAS IN OPTICALLY SELECTED GALAXY CLUSTER FOR EUCLID SURVEY

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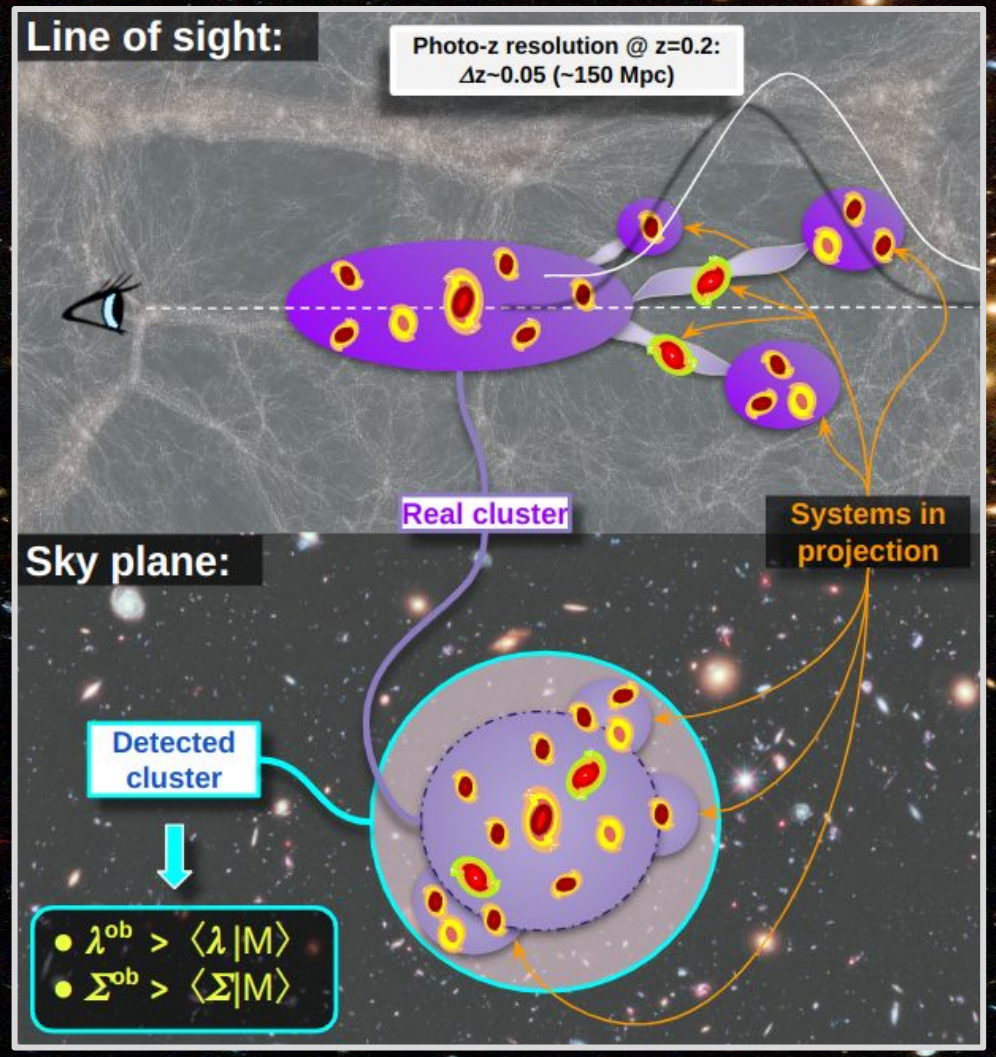
- STEFANO BORGANI
- MATTEO COSTANZI
- TIAGO CASTRO
- ALEXANDRO SARO

SELECTION EFFECTS IN OPTICAL CATALOGS



RICHNESS-MASS RELATION

$$\lambda^{ob} = \lambda^{true}(M) + \Delta\lambda(\lambda^{true}, \ldots)$$

$$\Sigma^{ob} = \Sigma(M) + \Delta\Sigma(\lambda^{ob}, \ldots)$$

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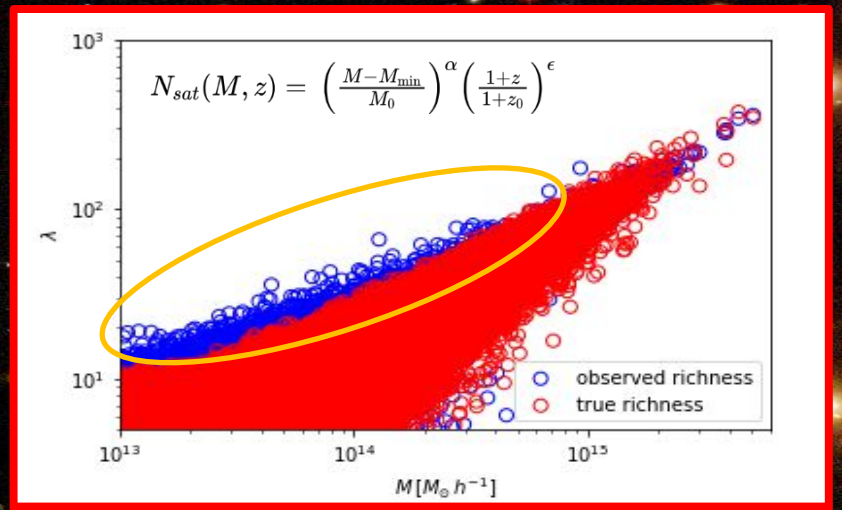

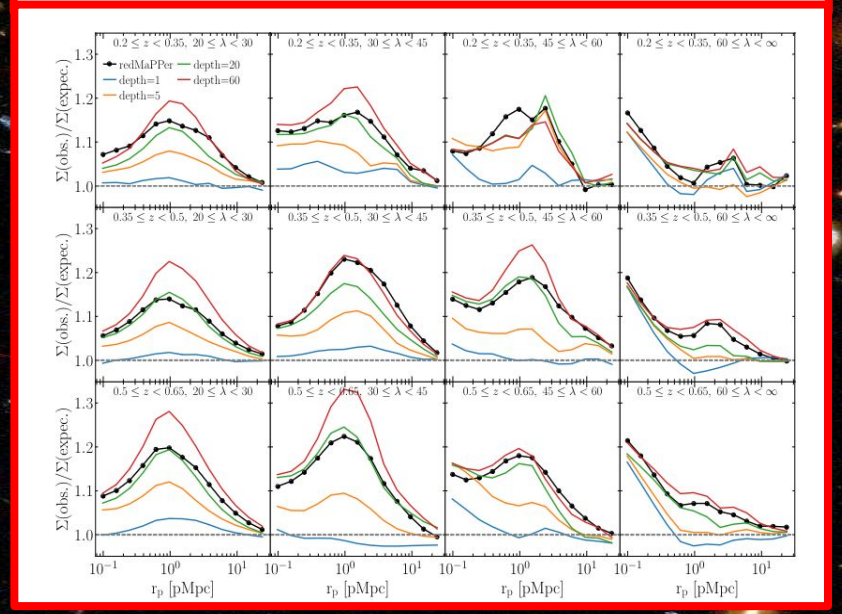

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Wu et al. DES Collaboration 2022

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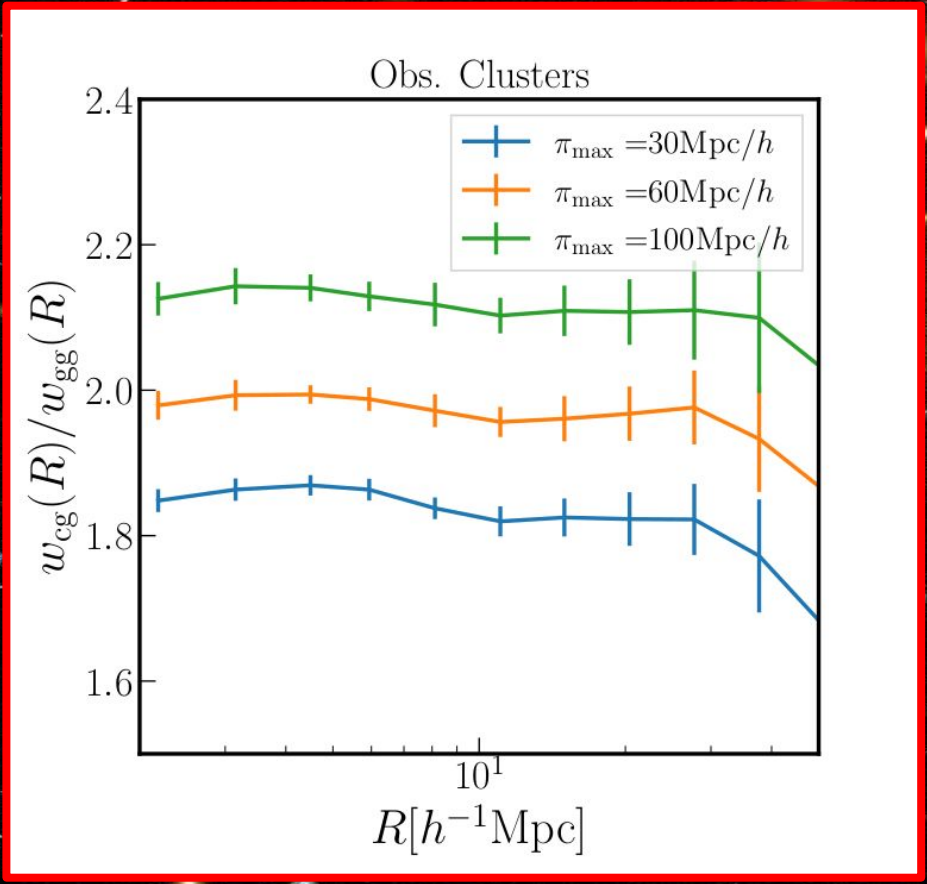
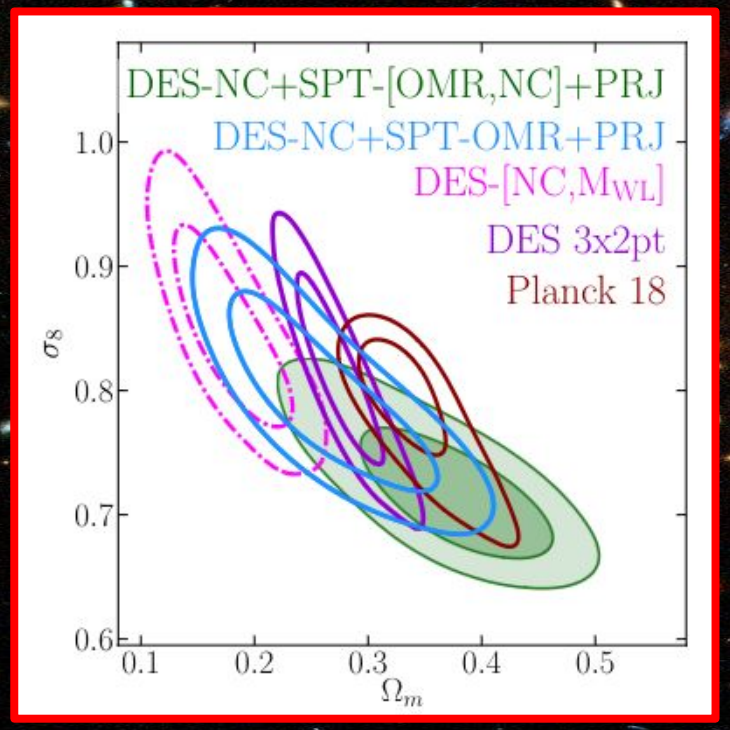


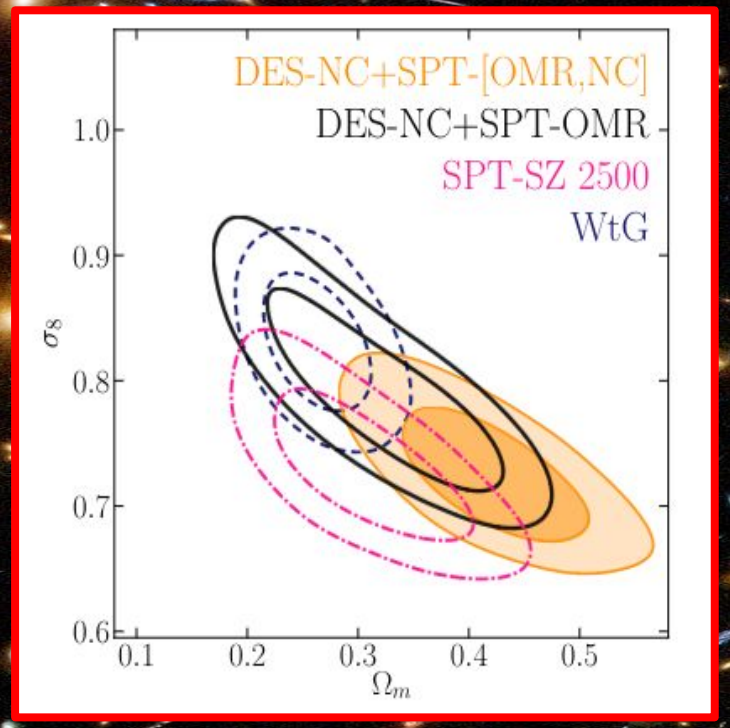
Sunayama et al. 2018

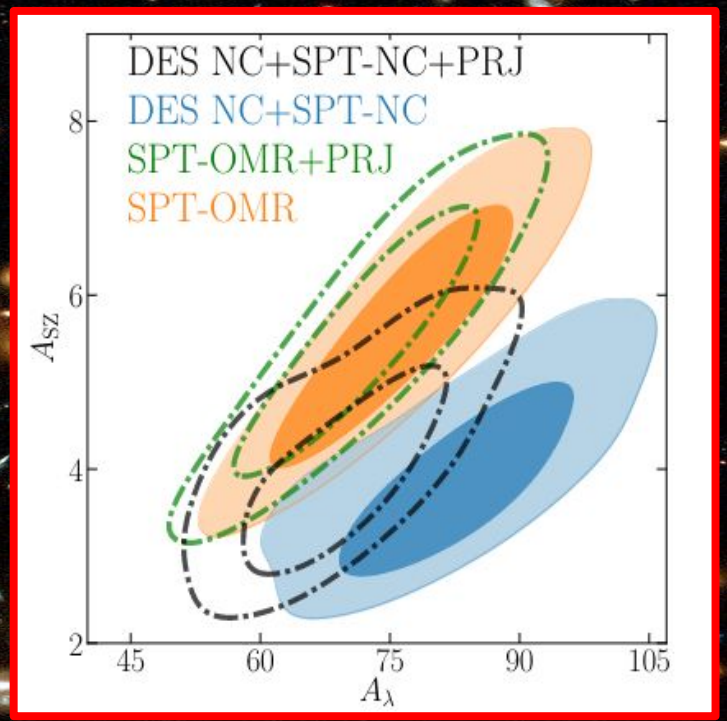
PROJECTED TWO POINT FUNCTION

$$\frac{w_{\rm cg}(R,\pi_{\rm max})}{w_{\rm gg}(R,\pi_{\rm max})} = \frac{b_c}{b_g}(1+\alpha_0(\pi_{\rm max}, d_{\rm proj}))$$

IMPACT ON COSMOLOGICAL PARAMETERS

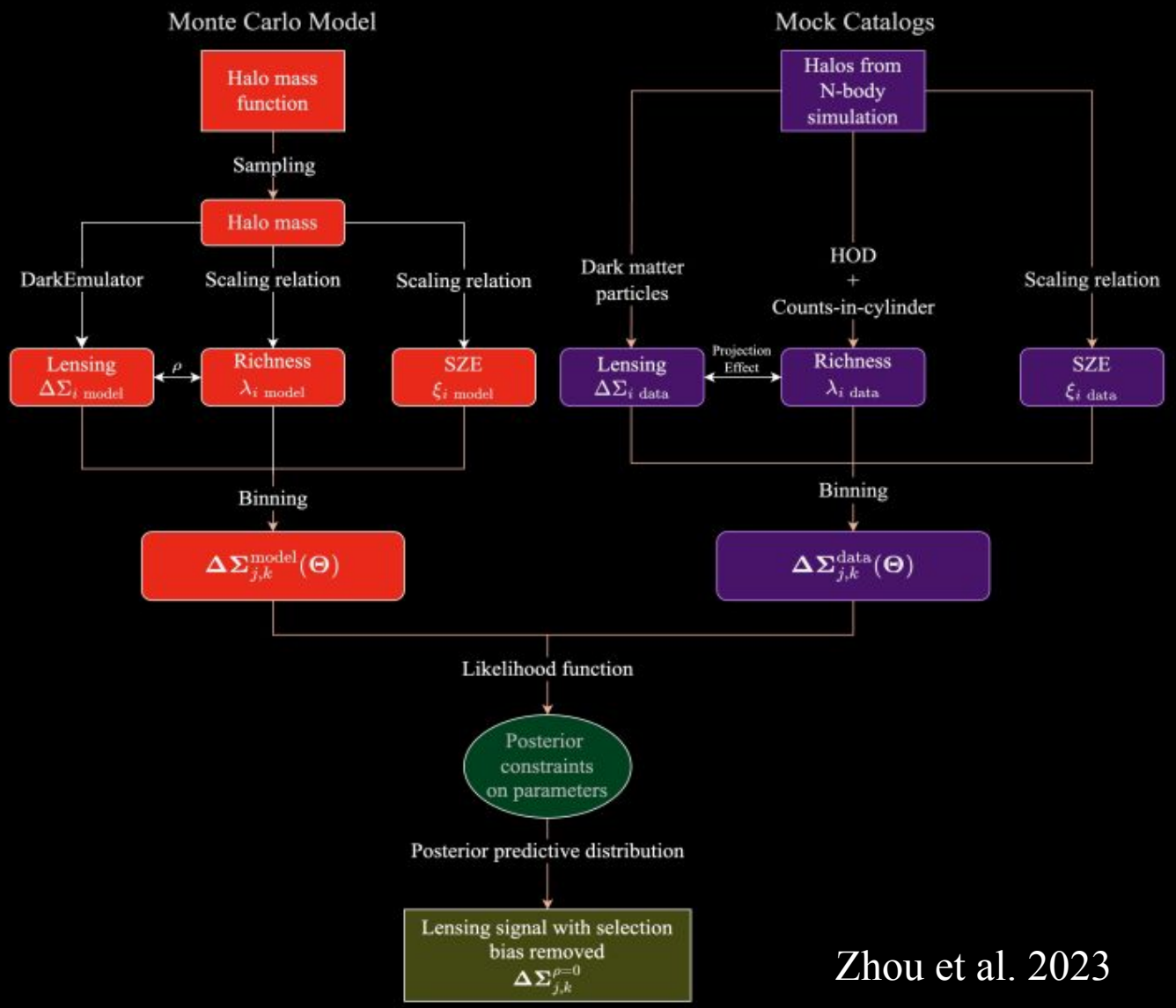






Costanzi et al. 2022

OUR APPROACH



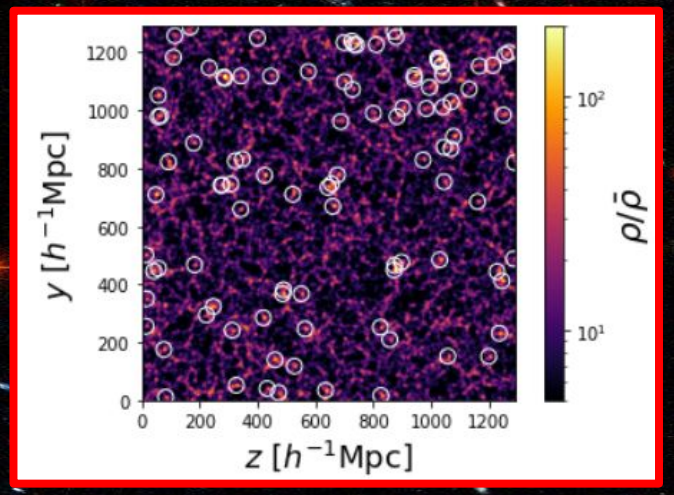
Zhou et al. 2023

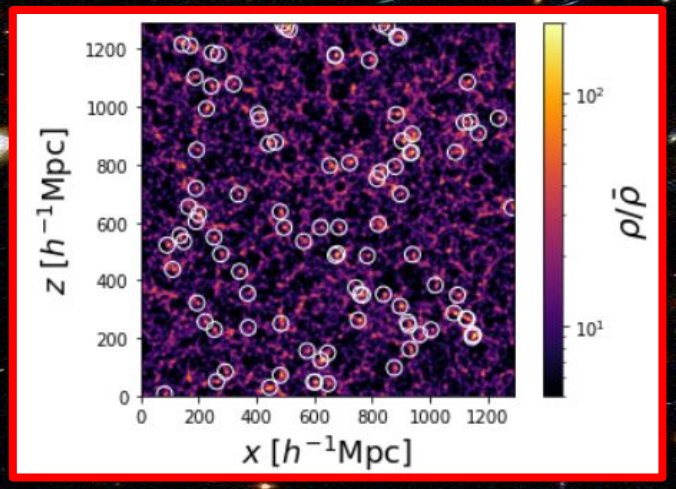
OUR APPROACH

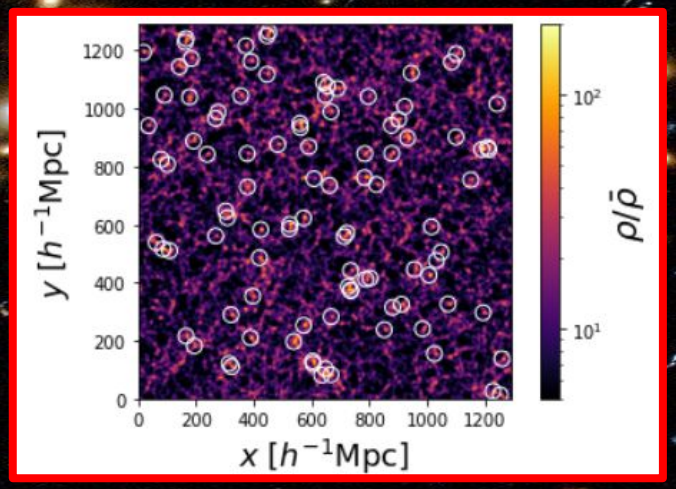
PathfInder Cluster COsmoLOgy

Name	Ω_m	h	Ω_b	n_s	σ_8
$C0$	0.3158	0.6732	0.0494	0.9661	0.8102
$C1$	0.1986	0.7267	0.0389	0.9775	0.8590
$C2$	0.1665	0.7066	0.0417	0.9461	0.8341
$C3$	0.3750	0.6177	0.0625	0.9778	0.7136
$C4$	0.3673	0.6353	0.0519	0.9998	0.7121
$C5$	0.1908	0.6507	0.0527	0.9908	0.8971
$C6$	0.2401	0.8087	0.0357	0.9475	0.8036
$C7$	0.3020	0.5514	0.0674	0.9545	0.8163
$C8$	0.4093	0.7080	0.0446	0.9791	0.7253

- TreePM Open-GADGET3
- 68 bilions DM particles
- 1290 comoving Mpc/h







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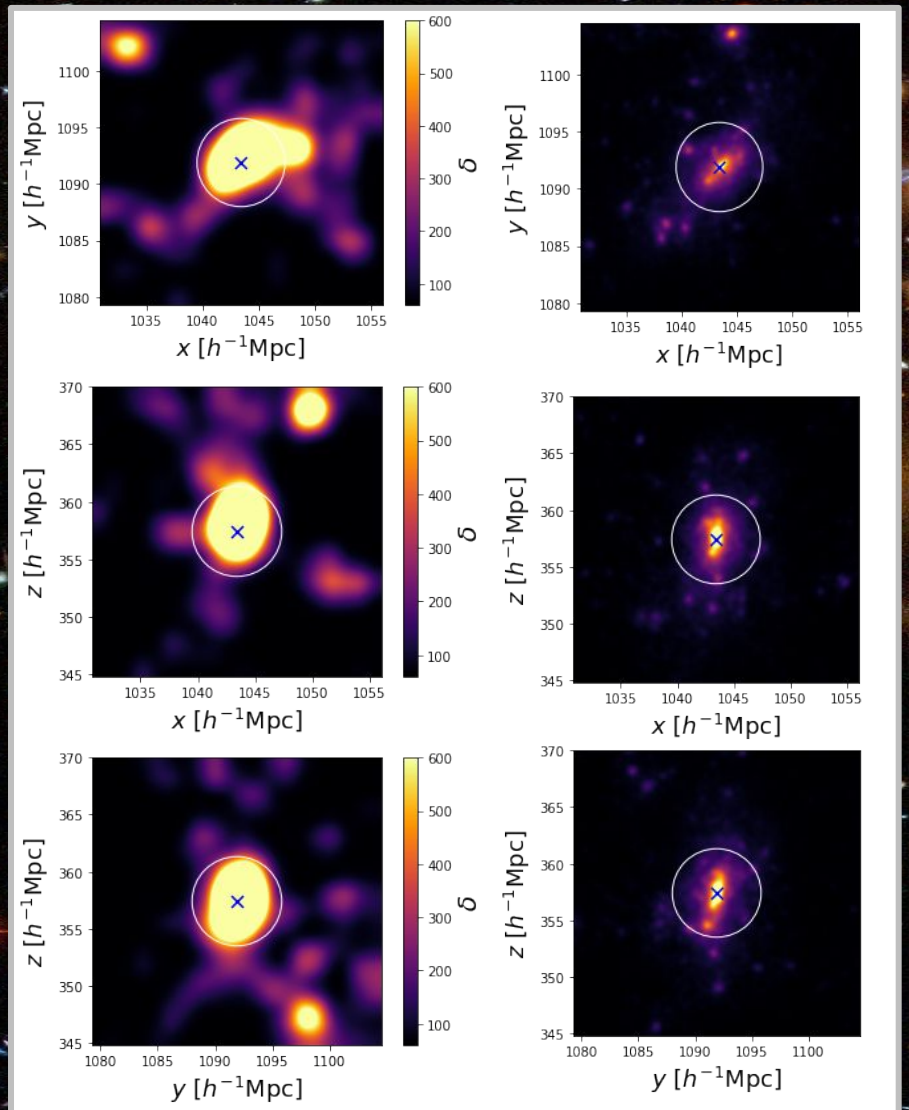
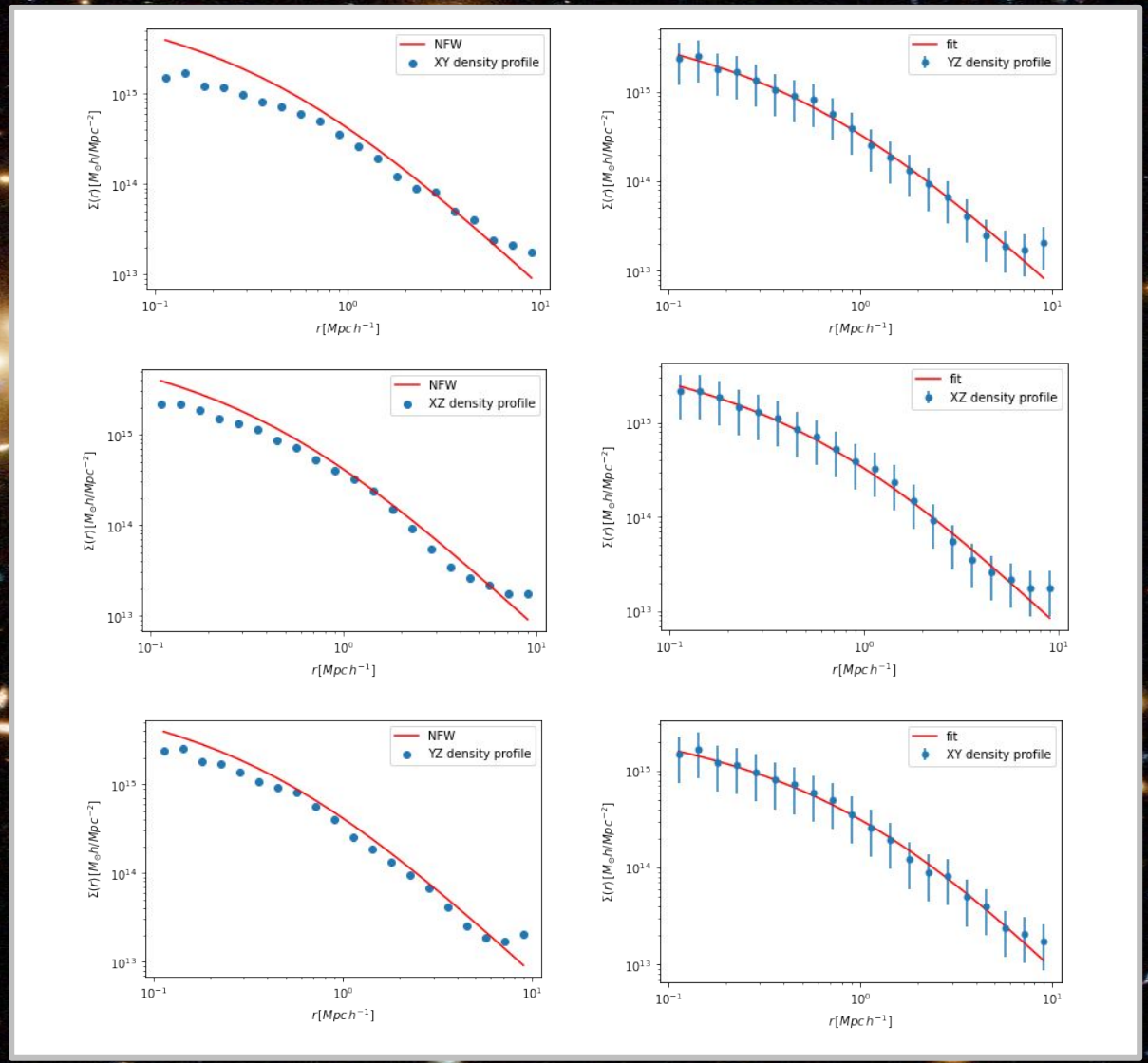
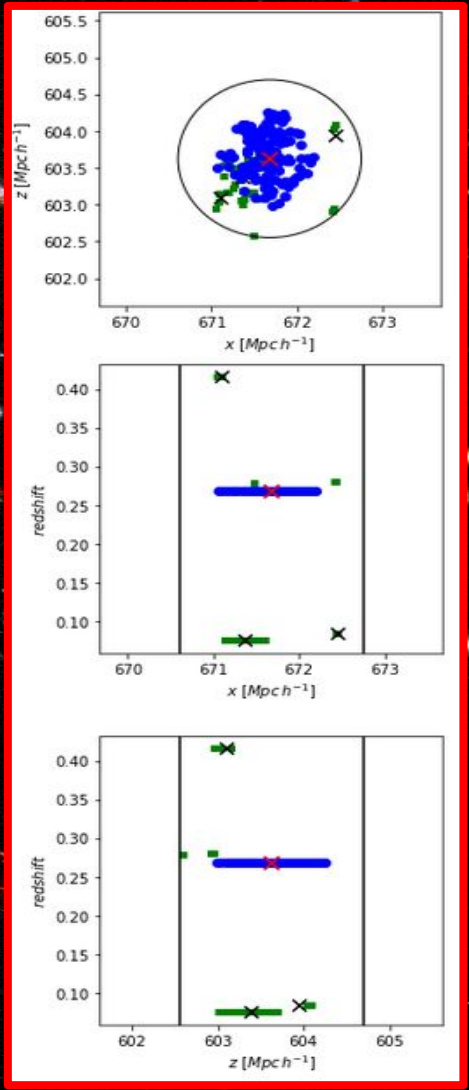
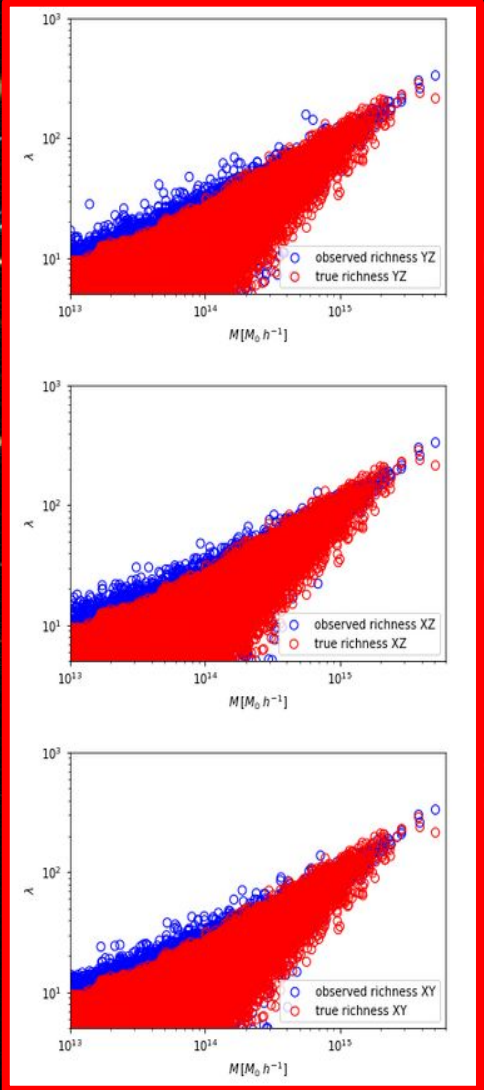
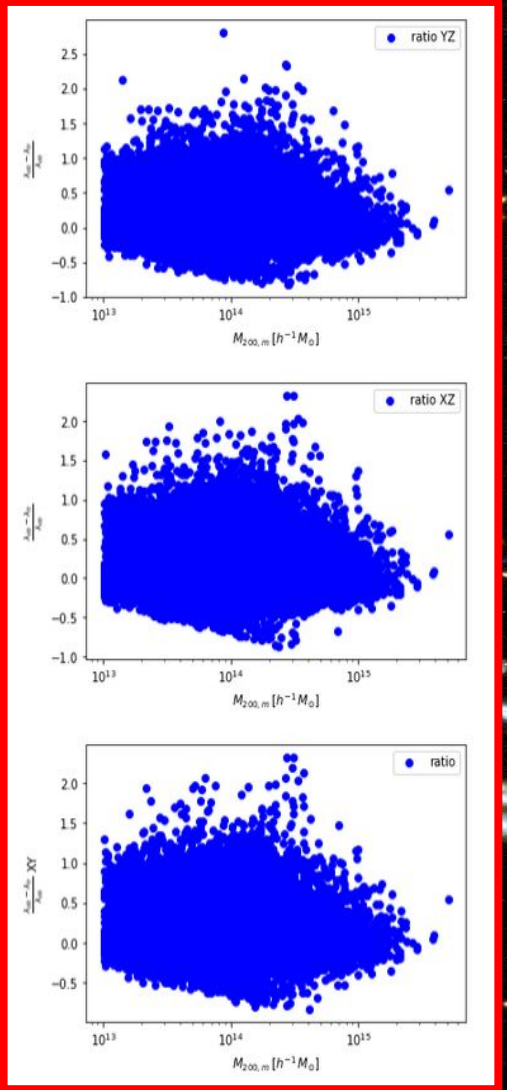




PRELIMINARY FOR NFW PAINTING



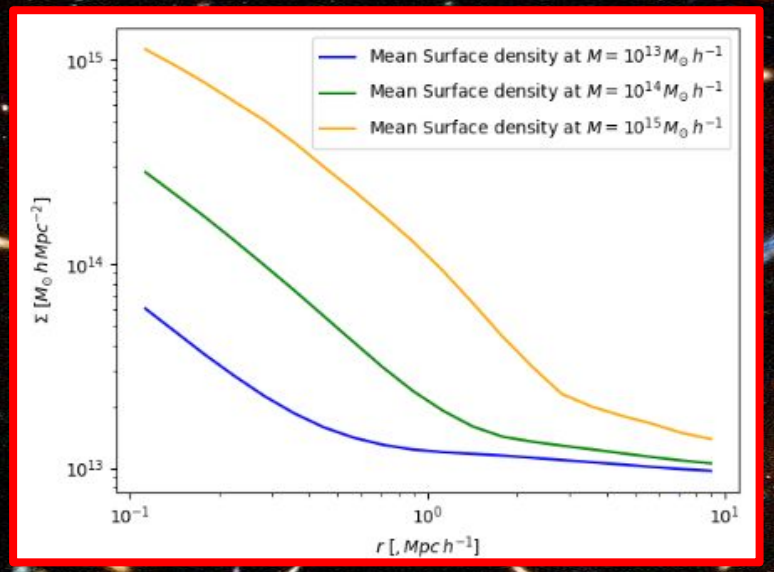


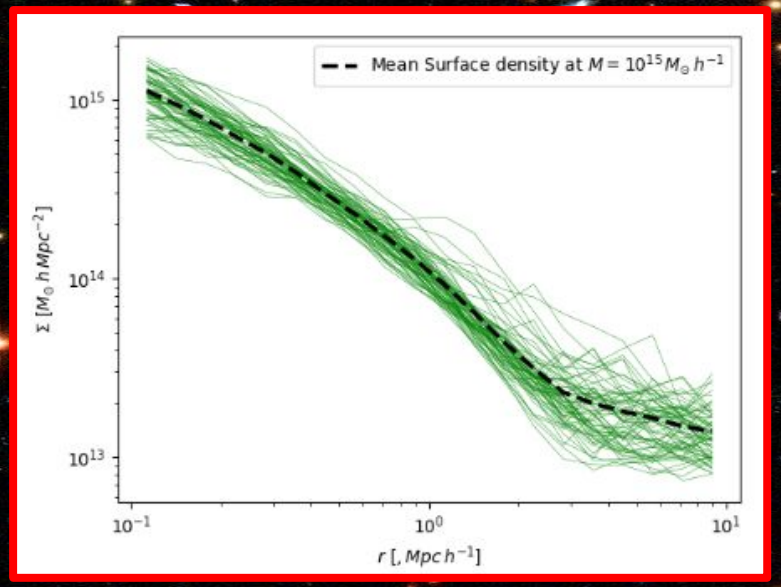


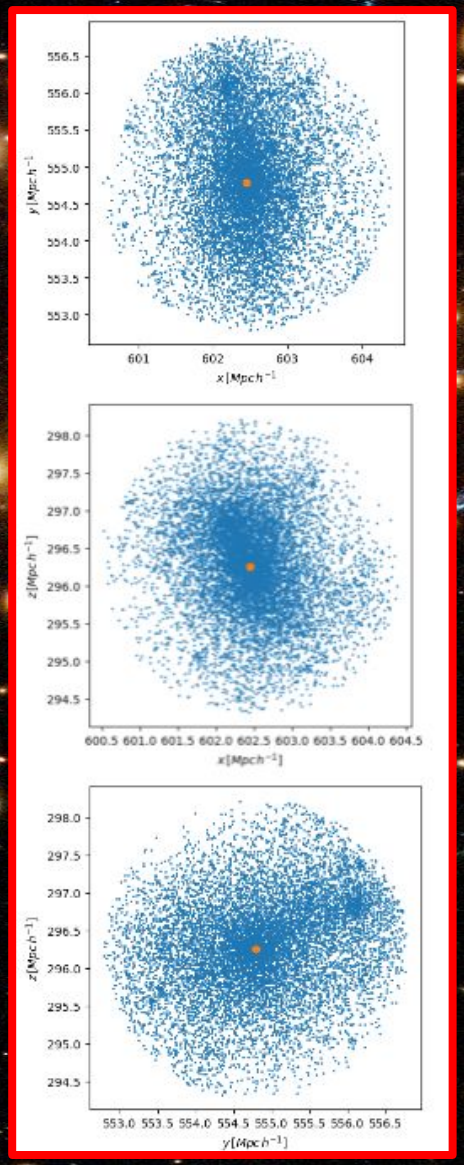
$$R_\lambda = \left(\frac{\lambda}{100}\right)^{0.2} \quad \text{physical } h^{-1}\text{Mpc}$$

$$w(\Delta z, z_{\rm cl}) = \begin{cases} 1 - \dfrac{(\Delta z)^2}{\sigma_z(z_{\rm cl})^2}\,, & |\Delta z| < \sigma_z(z_{\rm cl}) \\ 0\,, & \text{otherwise} \end{cases}$$

SURFACE DENSITY PROFILES AND DM PAINTING

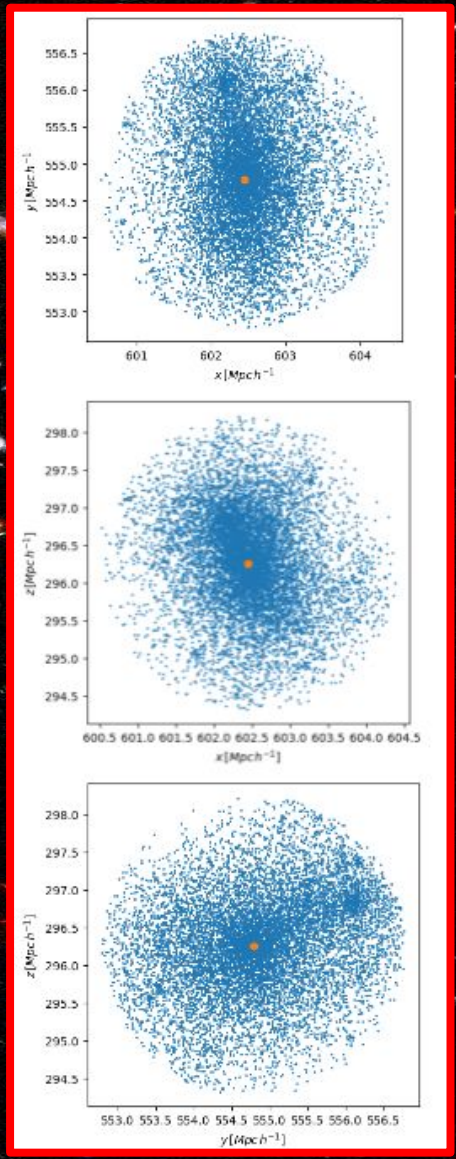


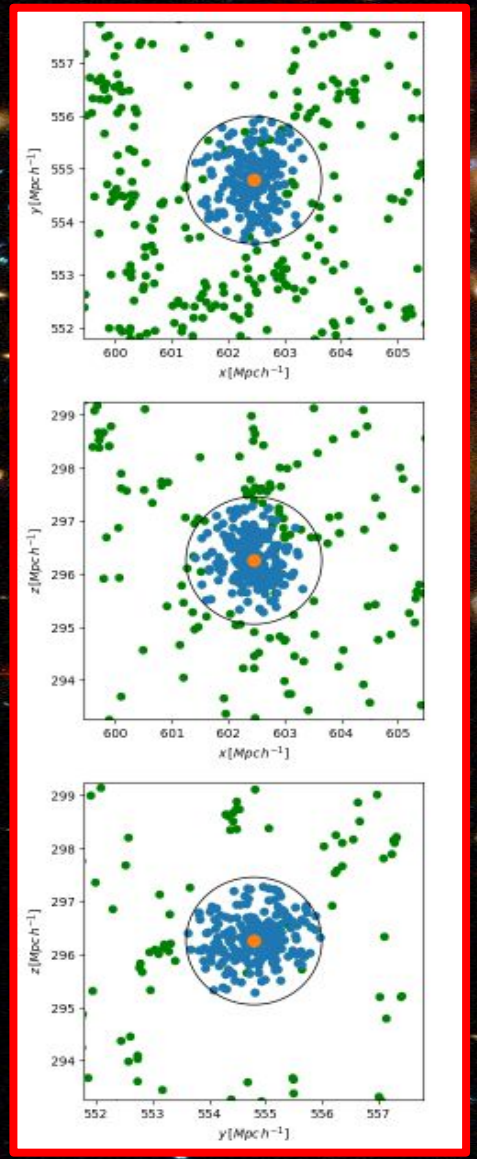




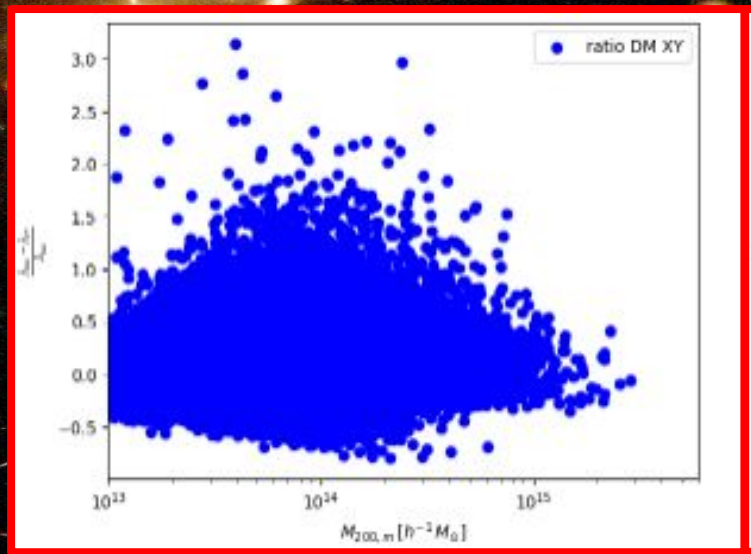
- Currently using one fourth of the box
- Preselecting DM particles in ellipsoids with KDtree
- Sigma profiles are evaluated in cylinders with projection depth of 100 comoving Mpc
- A sphere of radius 2 comoving Mpc is stored to pass to the galaxy painter
- From a base of ~24 millions object we have a sample ~270000 object above 1e13 solar masses

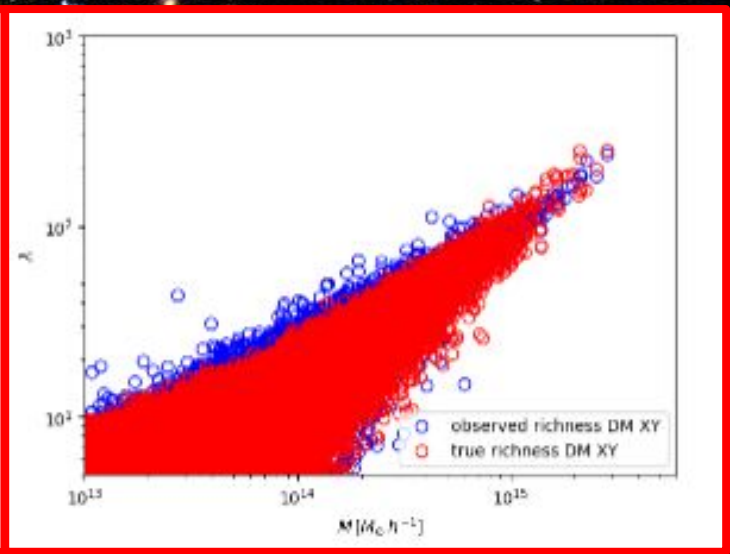
SURFACE DENSITY PROFILES AND DM PAINTING





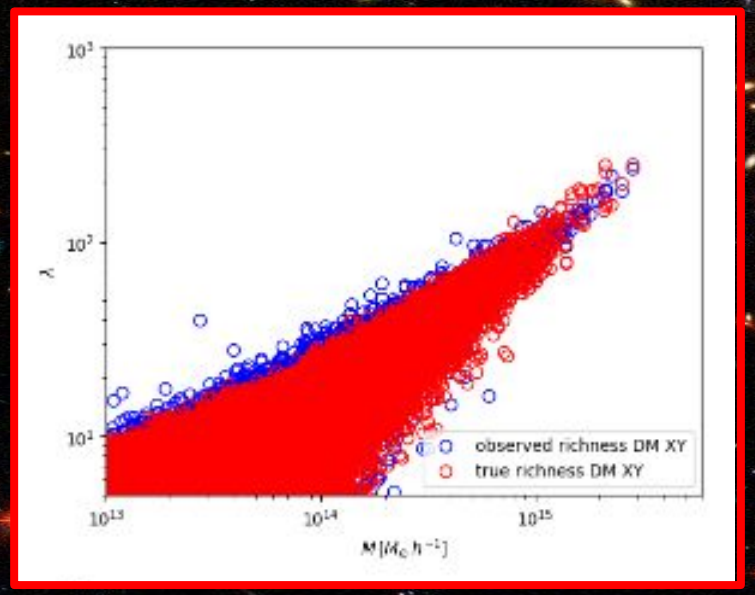
Galaxy are randomly drawn based on the DM positions inside a sub-sphere of radius give by the richness aperture

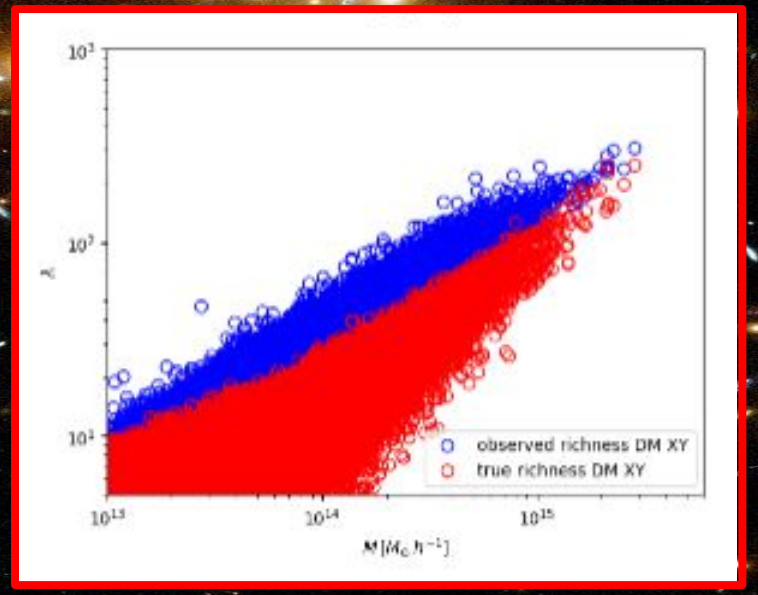


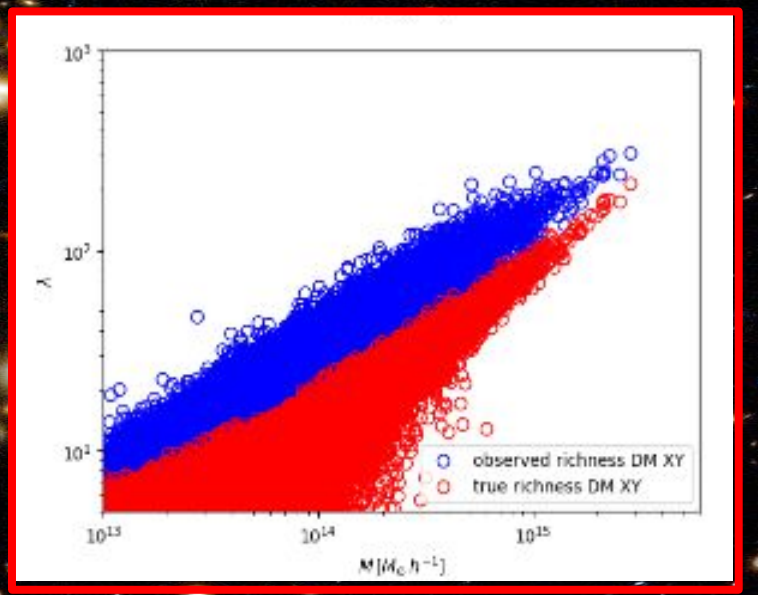


SURFACE DENSITY PROFILES AND RADIAL PROBABILITY

$$\mathrm{P}(\Delta r, M, c) = \frac{\Sigma_{NFW+bkg}(\Delta r, M, c) - \Sigma_{NFW+bkg}(r_{bkg}, M, c)}{\Sigma_{NFW+bkg}(\Delta r, M, c)}, \quad where \ r_{bkg} = 4\,Mpc\ h^{-1}$$







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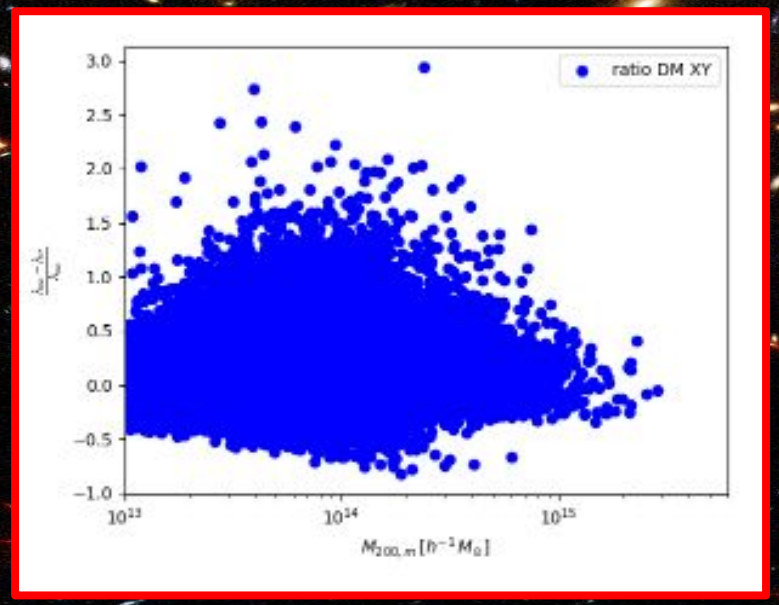
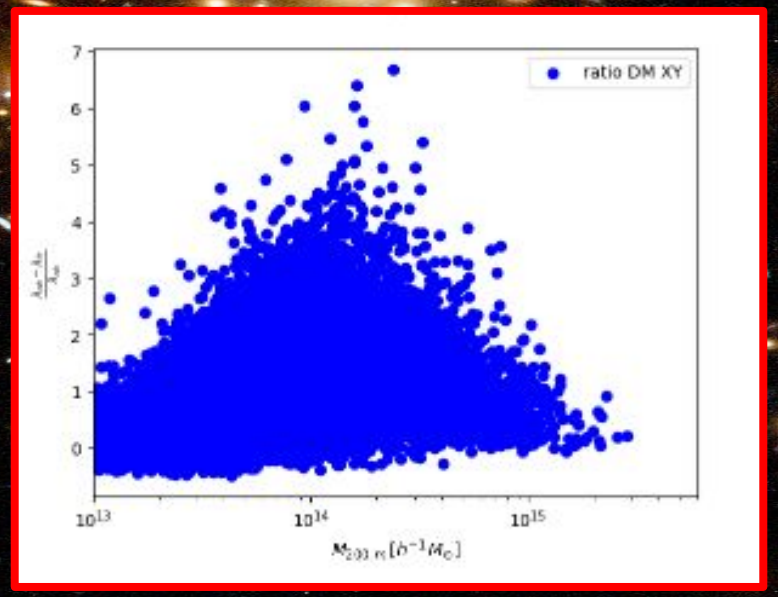
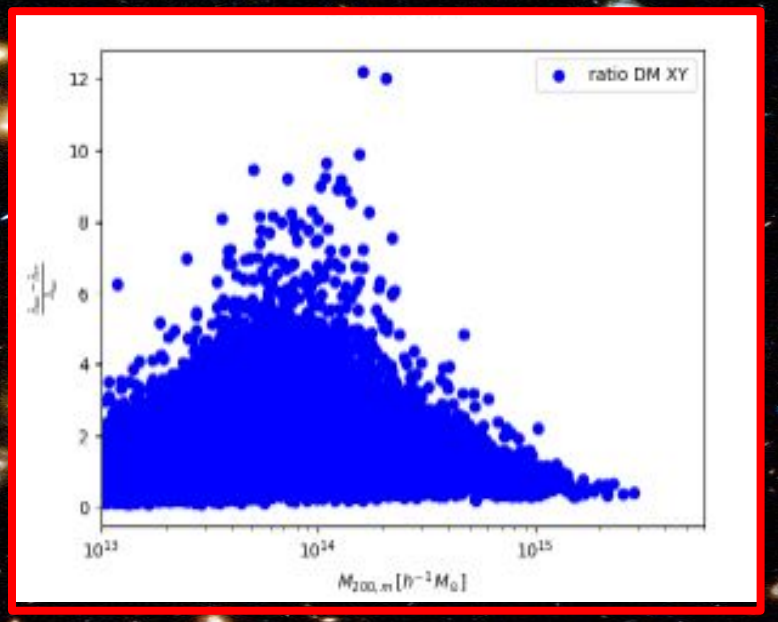
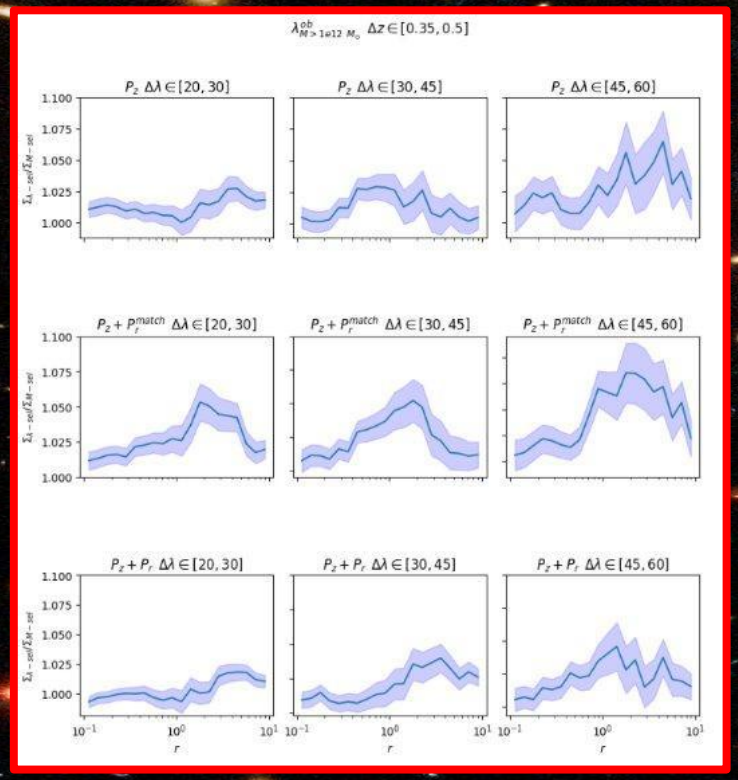


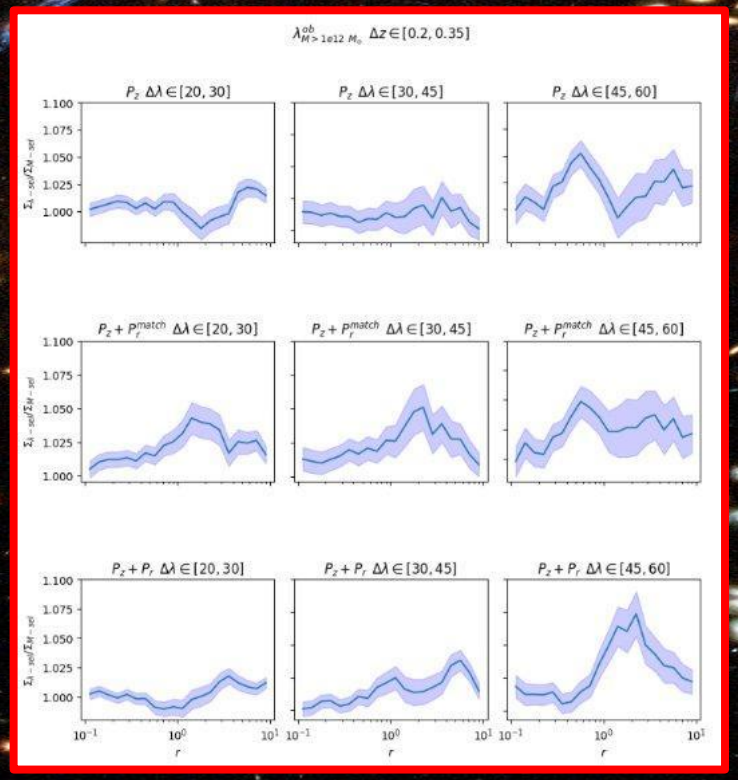


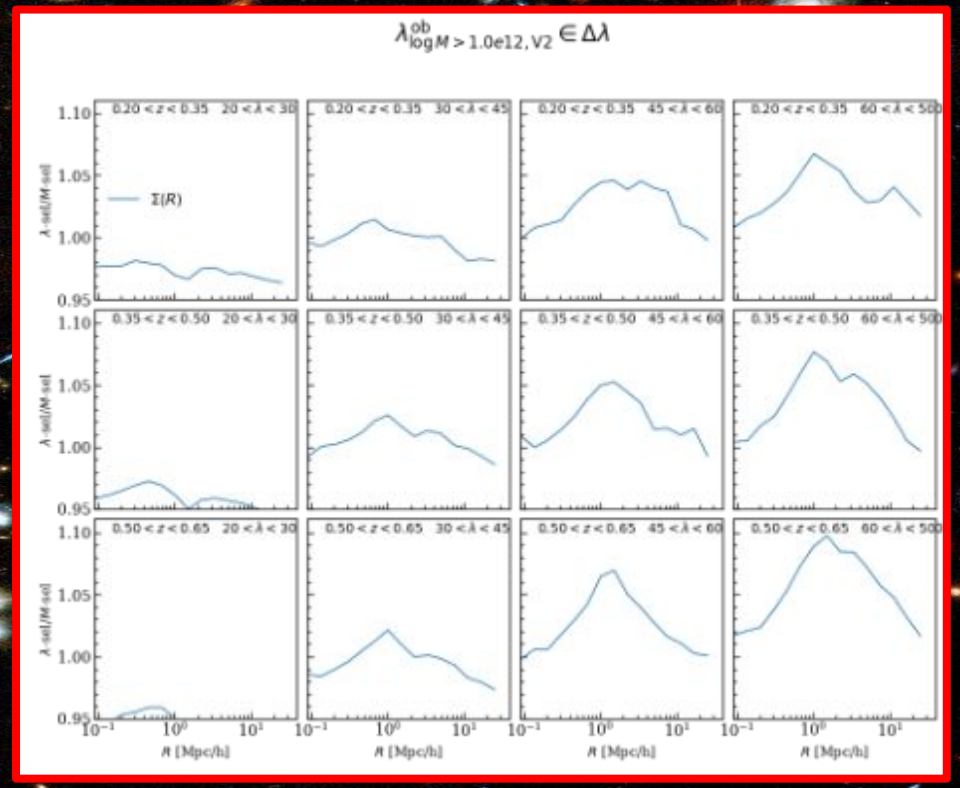


VALIDATION

We performed an initial validation on a subset of the Z=0 C0 box







MEMBERSHIP PROBABILITY EMULATOR

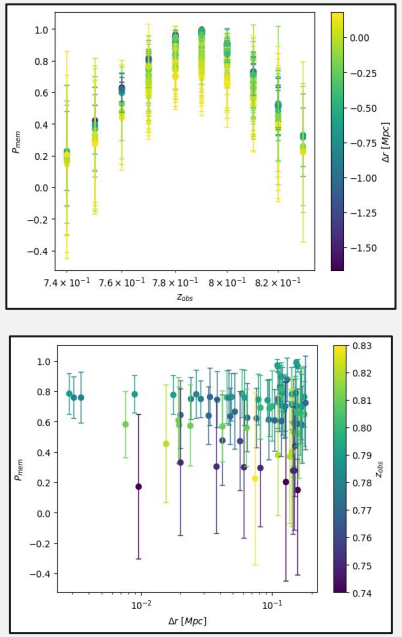
In order to obtain a Euclid-like output for the richness estimation, we trained a NN model on the Flagship2 30 deg^2 catalogue processed with PZWAV and Rich-CL

PREVIOUS PROBABILITY ASSIGNATION SCHEME

$$w_z(\Delta z, z_{cl}) = 1 - \frac{\Delta z^2}{\sigma_z^2(z_{cl})}$$

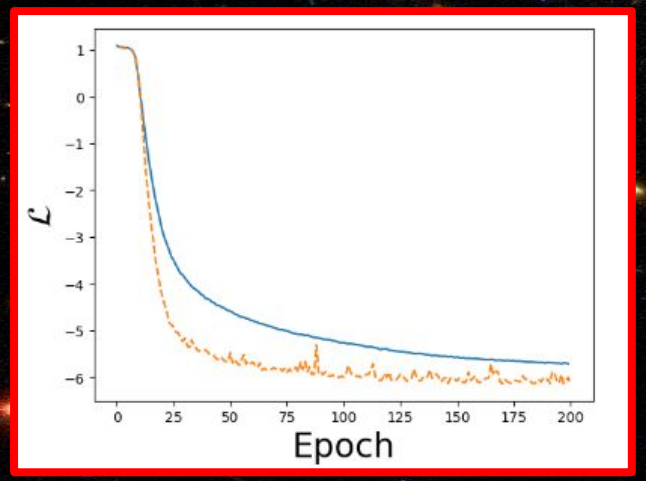
$$w_r(\Delta r, M, c) = \frac{\Sigma_{NFW+bkg}(\Delta r, M, c) - \Sigma_{NFW,bkg}(\Delta r_{bkg}, M, c)}{\Sigma_{NFW+bkg}(\Delta r, M, c)}$$

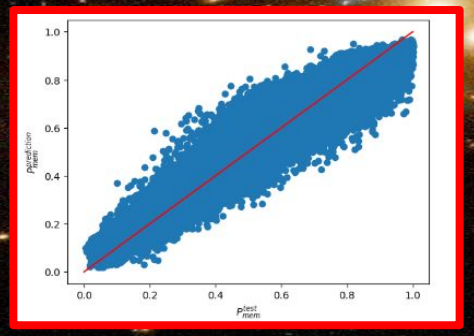
RICH-CL OUTPUT FOR THE FLAGSHIP2 30deg^2

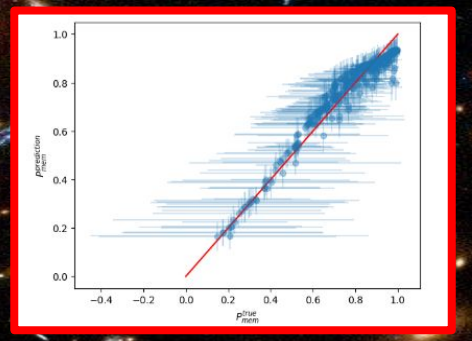


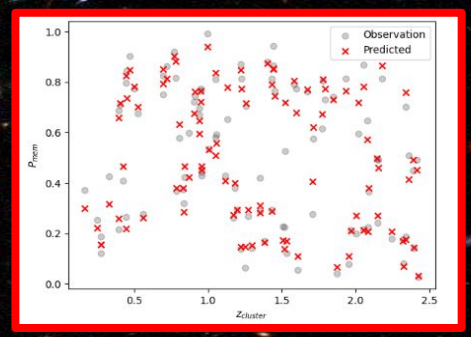
MEMBERSHIP PROBABILITY EMULATOR

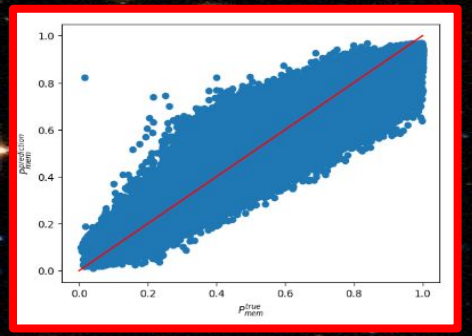
We implement the training via Pytorch and the hyperparameter optimization With an Optuna based trial process

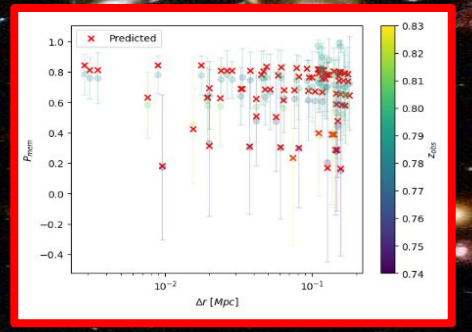


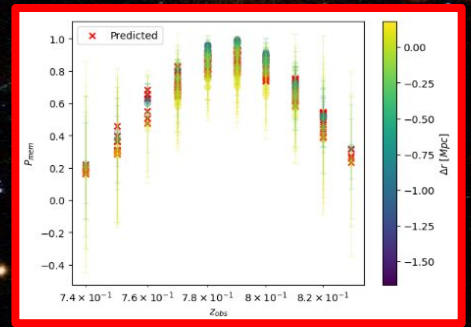






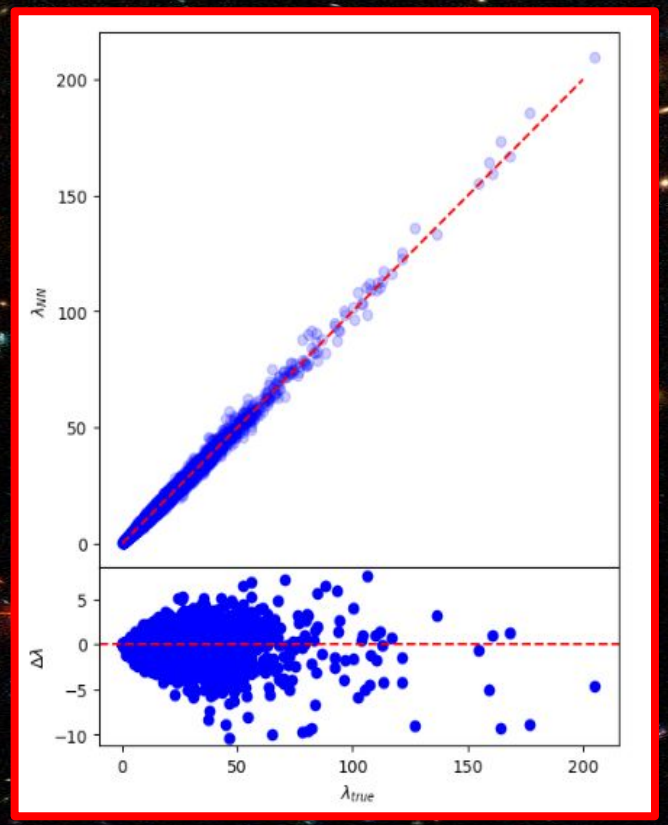


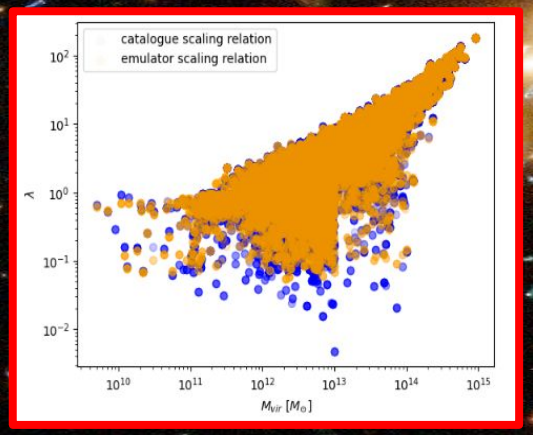


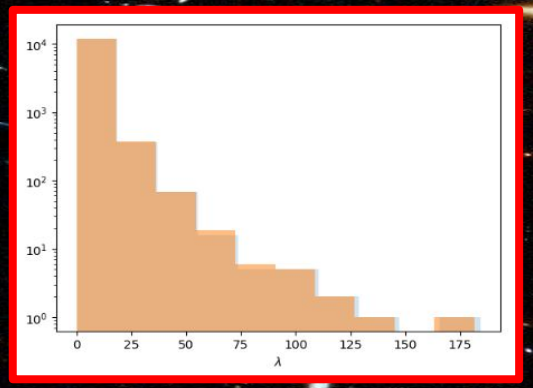


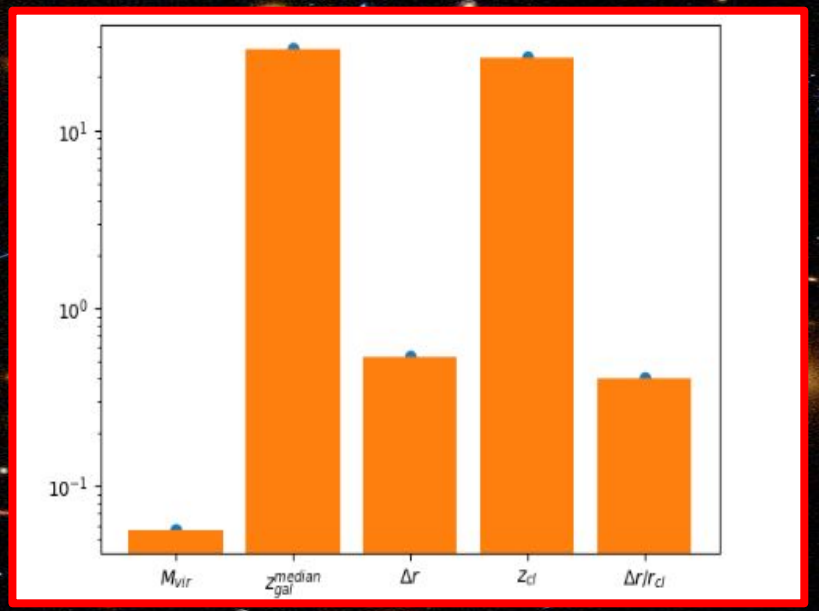
MEMBERSHIP PROBABILITY EMULATOR

We implement the training via Pytorch and the hyperparameter optimization With an Optuna based trial process









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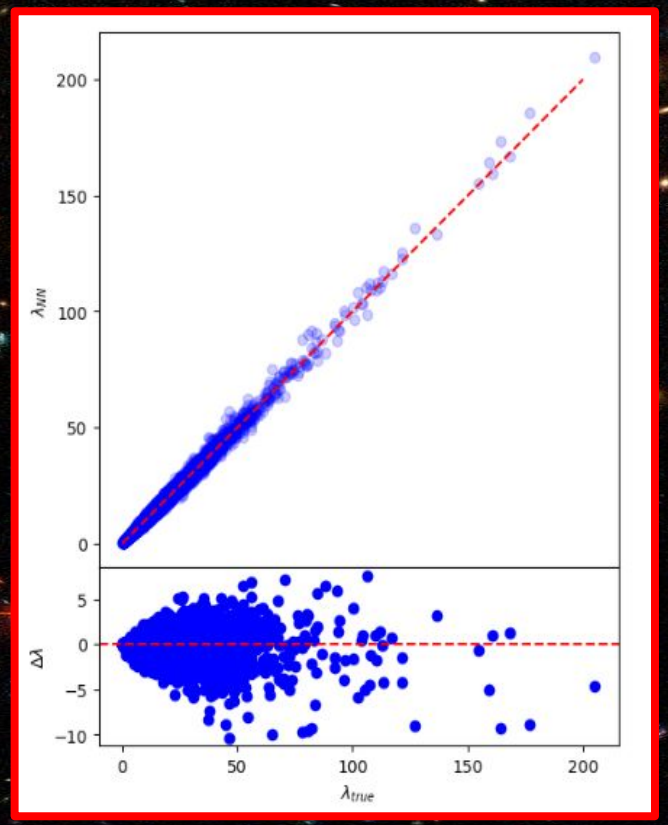

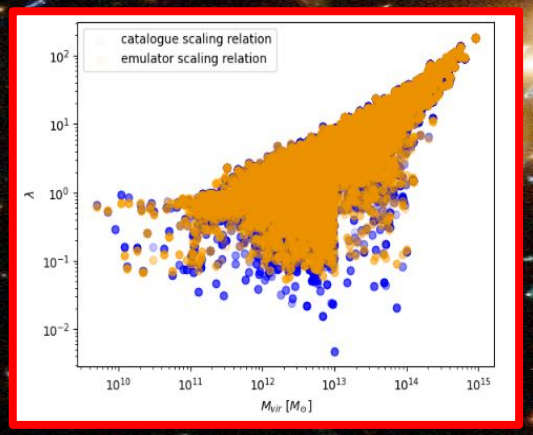

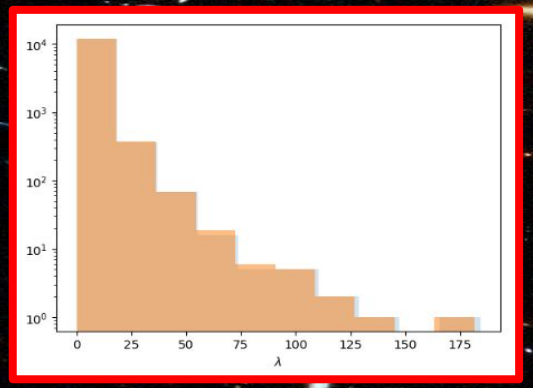

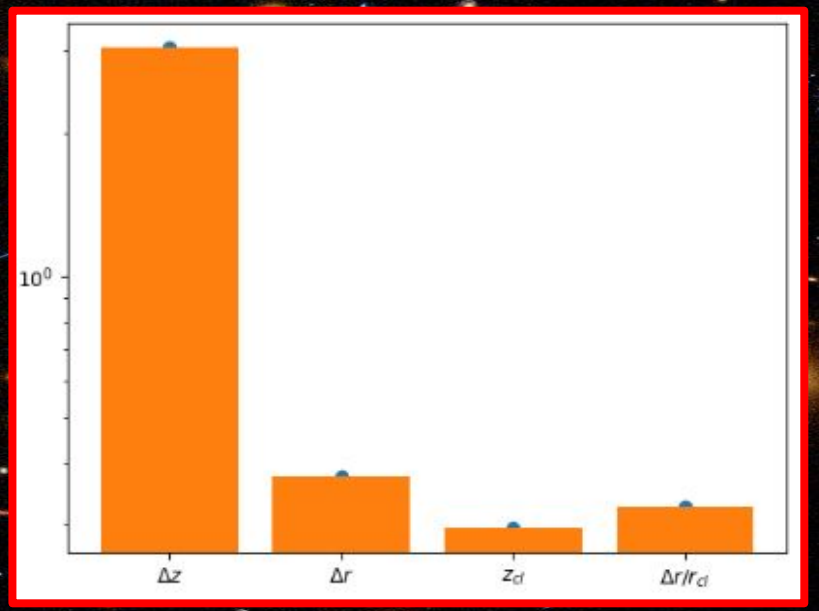

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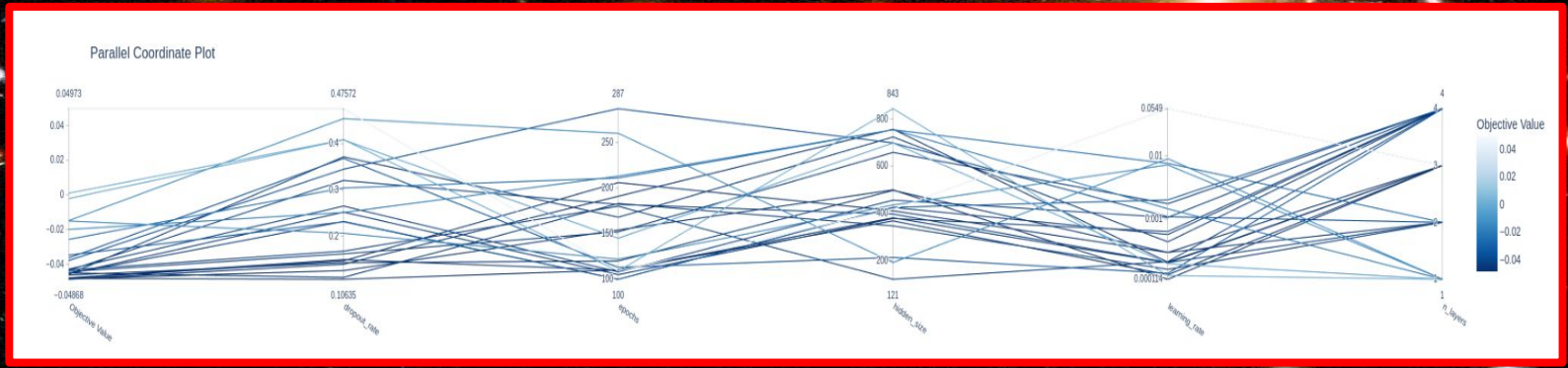


```
learning_rate: 0.0002107066626642909
epochs: 191
n_layers: 3
hidden_size: 756
dropout_rate: 0.13884307002455876
```

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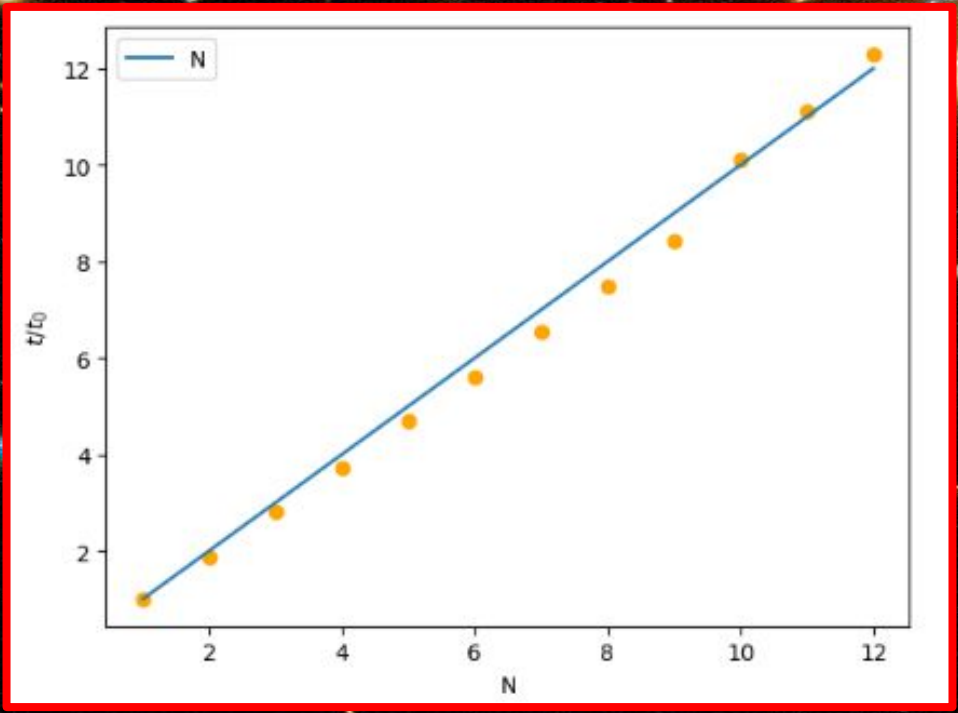


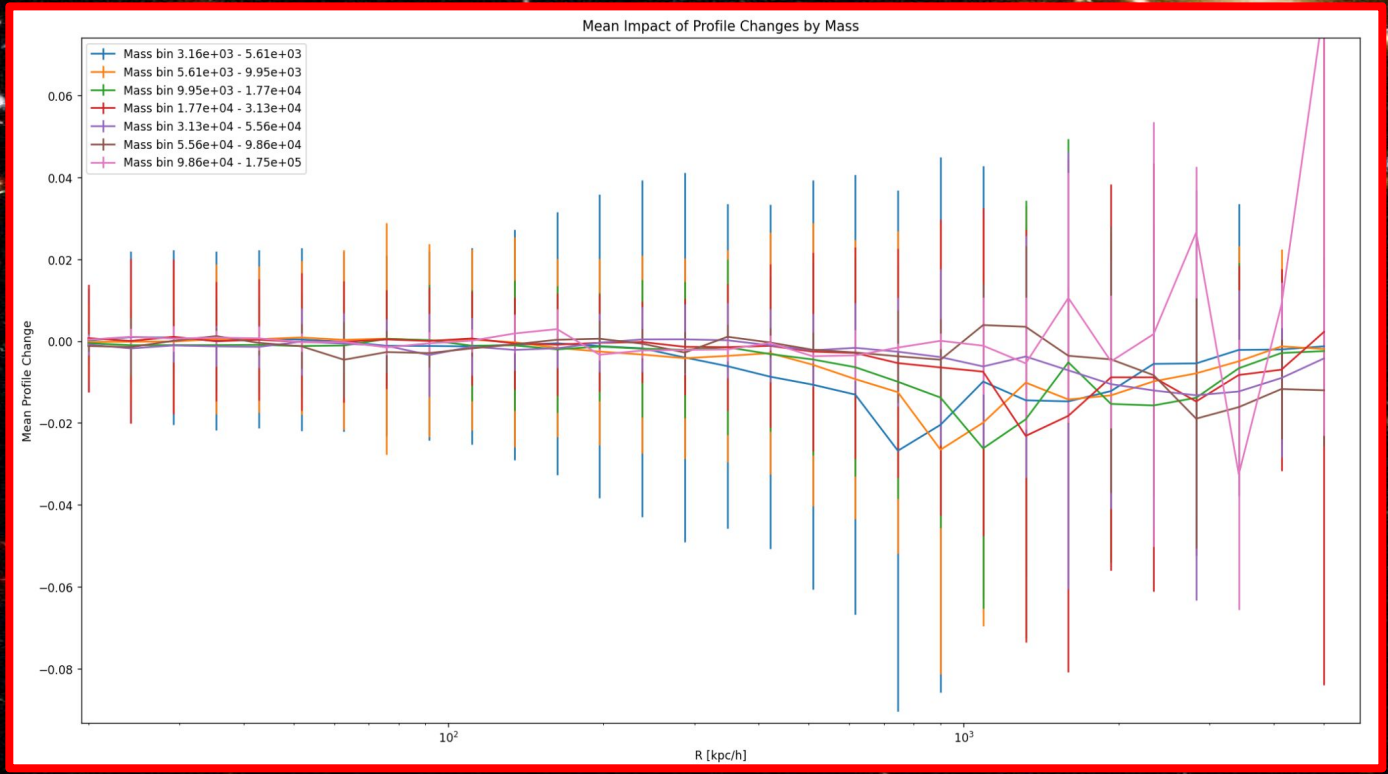
Considering that gain is limited, but adding parameters worsen the evaluation time:

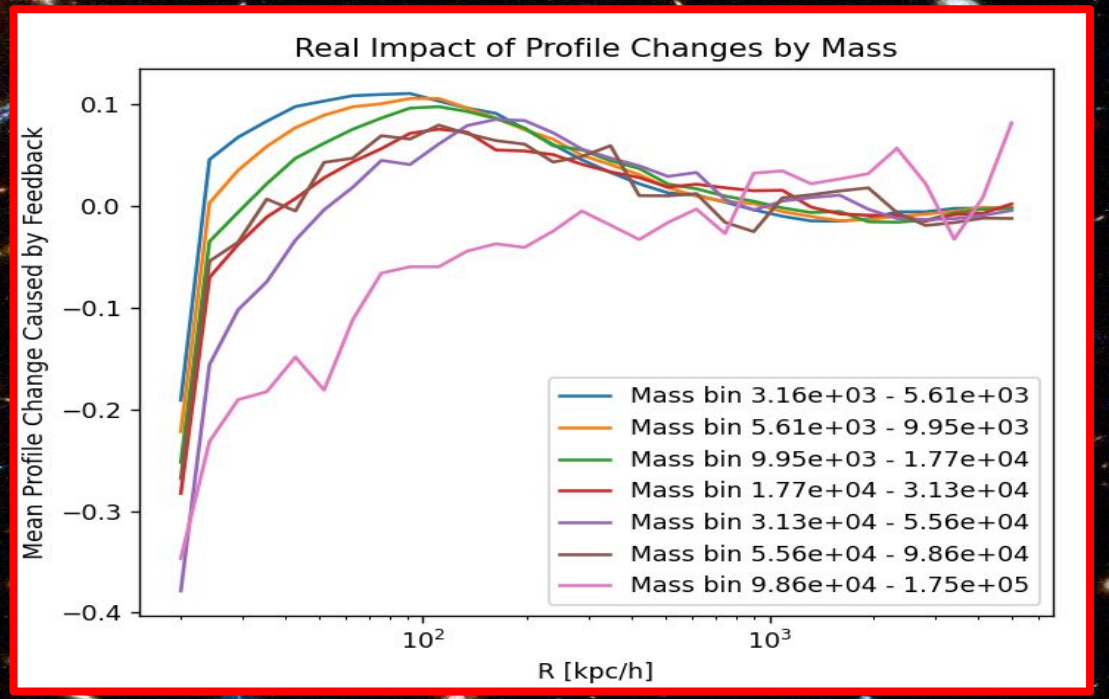
```
evaluetion time for model2_bis:5.7797768115997314
evaluetion time for model2:0.5806732177734375
evaluetion time for model1:3.1462643146514893
```

where model2 is the optimized model but with a value 100 for the hidden_size hyperparameter (since it is the less relevant and more time consuming to raise)

OPTIMIZATION AND BARYONIFICATION

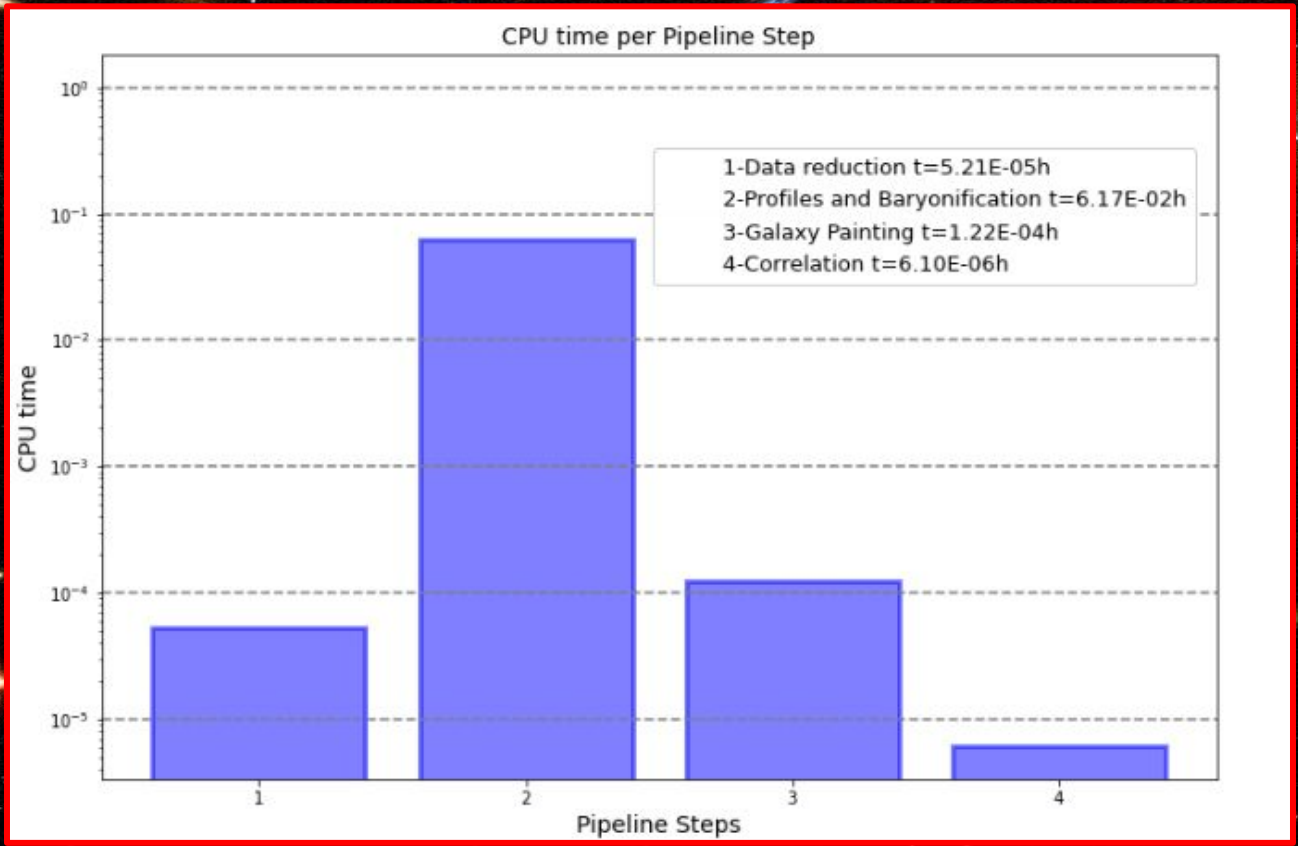
Currently we are testing the optimized version with a better scheme for the density profile extraction, which while allows also for fast baryonification implementation





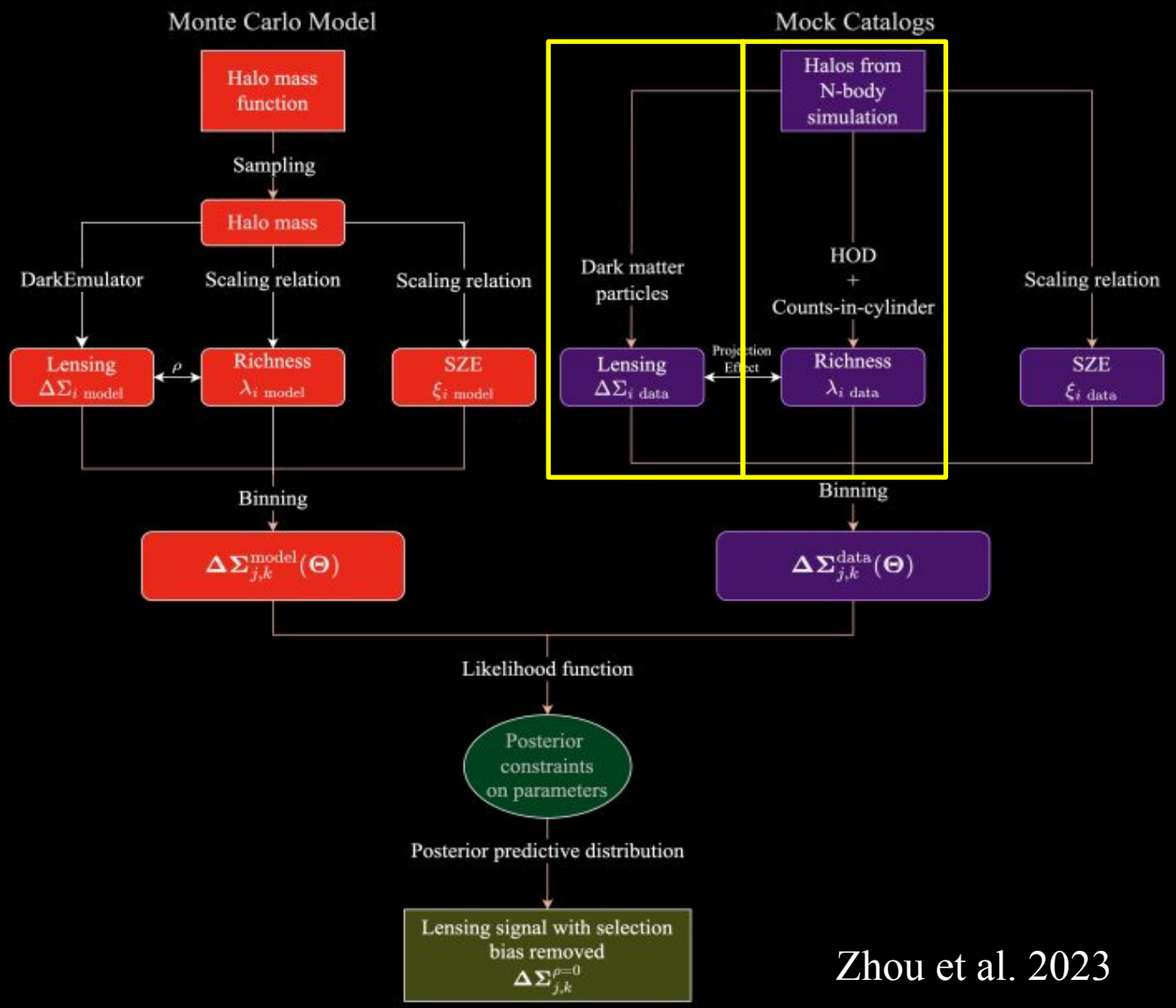
CURRENT CHALLENGES

Optimizing bottleneck in the pipeli during density profile evaluation



Currently we are testing the optimized version of the 2d profile calculator. The last version can produce both 2d and 3d profiles for a Magneticum box of 512 Mpc/h in 2 h running with 16 processes.

NEXT STEP



- Extend the machinery for richness and density profiles to the full PICCOLO cosmological boxes (now in progress)
- Validate the pipeline with the ouput of RICH-CL richness assignation (waiting for the Flagship2 200 deg^2 catalogue)

Zhou et al. 2023