Lensing Emulator

Tunç Türker

21 november 25'

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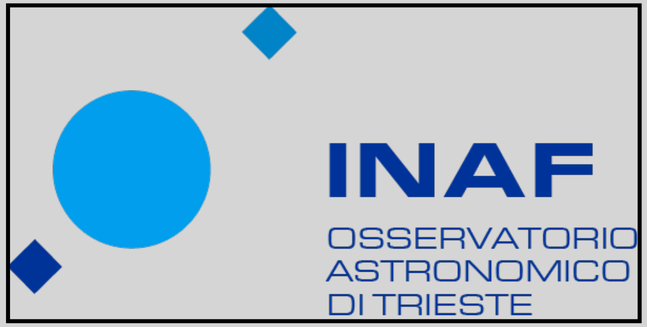

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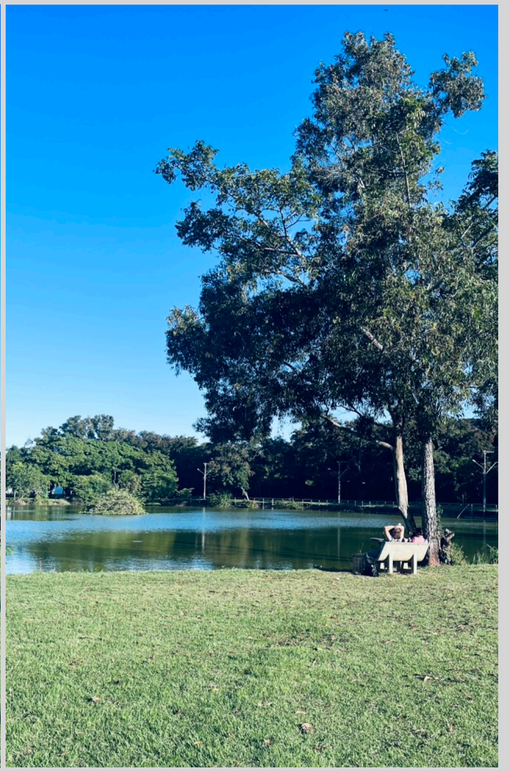
FUNDAÇÃO DE AMPARO À PESQUISA
E INOVAÇÃO DO ESPÍRITO SANTO

Universidade Federal do Espírito Santo

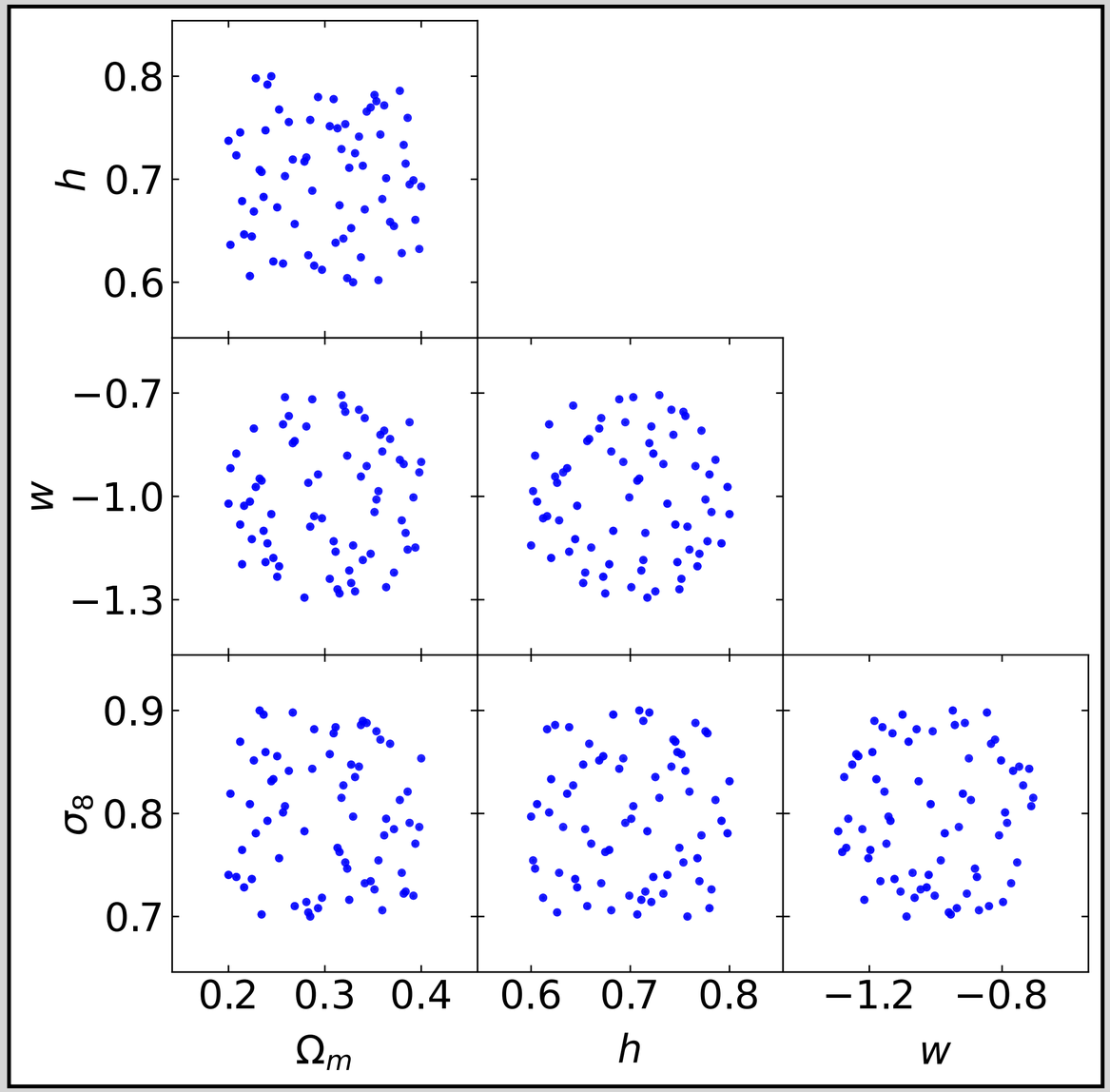


Accurate cosmological emulator for the probability distribution function of gravitational lensing of point sources

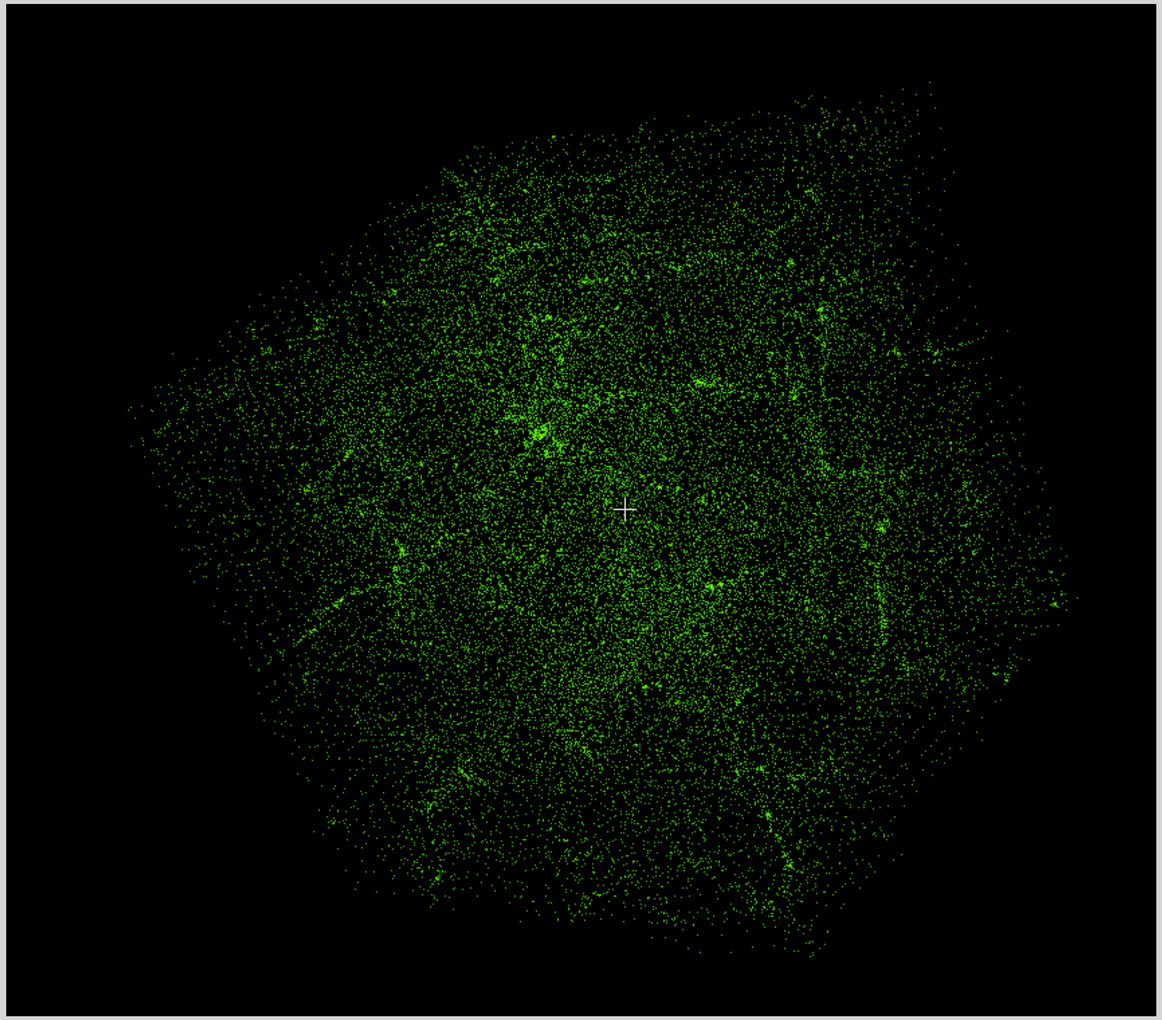
ACE_LENSING

Parameter Space

Ω_{m}	$[0.2, 0.4]$
σ_8	$[0.7, 0.9]$
w	$[-1.5, -0.7]$
h	$[0.6, 0.8]$

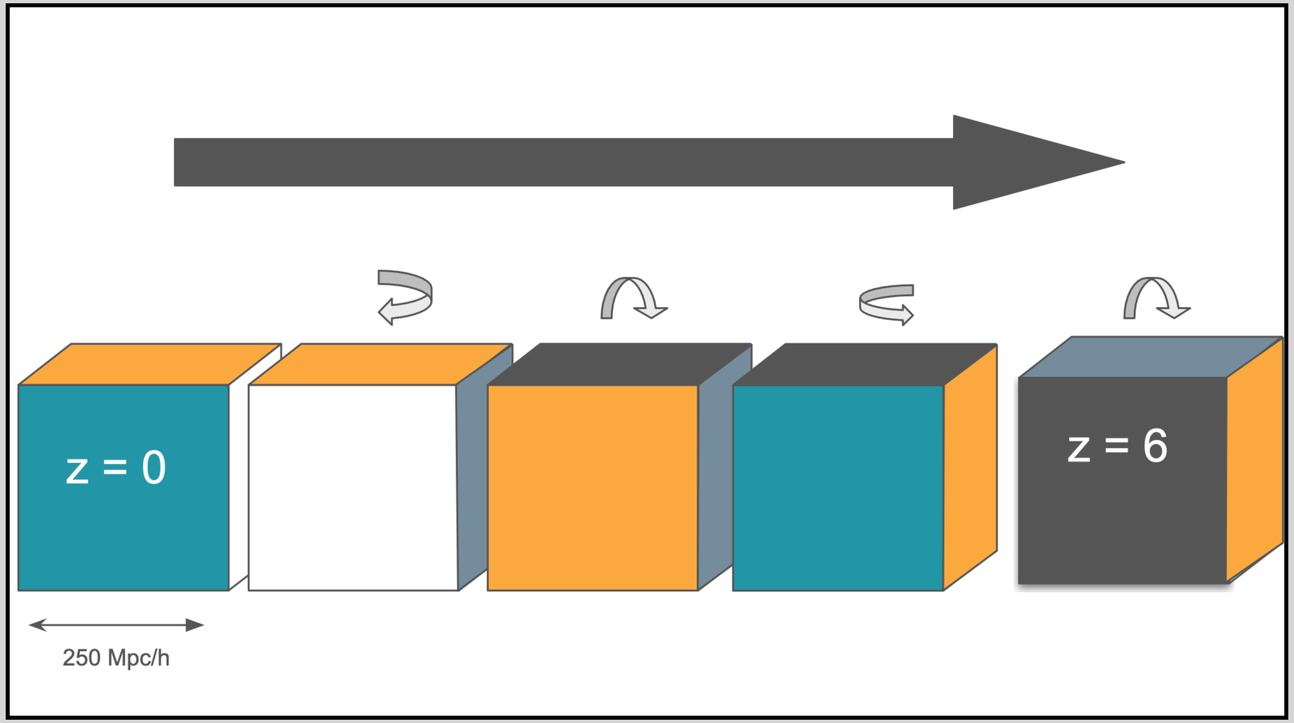


Simulations

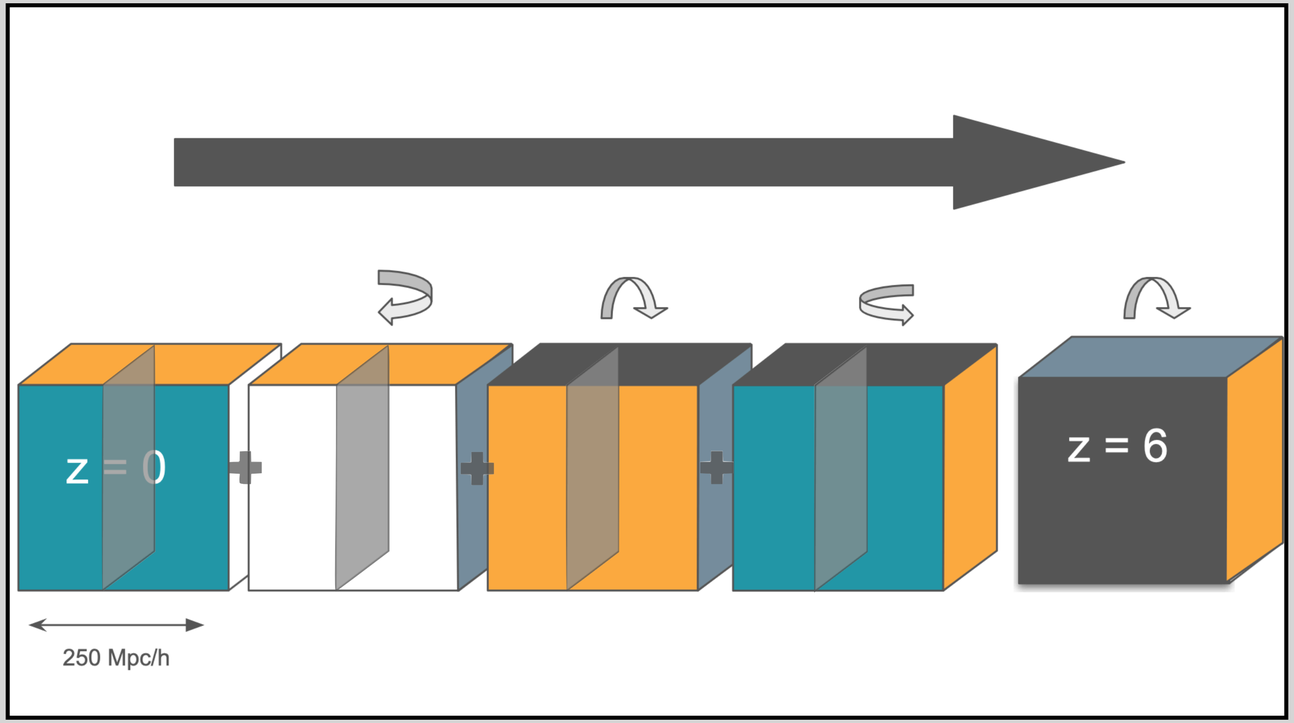


Simulation parameters	
Box size L	$250\,\mathrm{Mpc}\,h^{-1}$
Number of particles N	4×640^3
Particle-Mesh grid	2048^3
Initial redshift	49
Softening length	$6\,\mathrm{kpc}\,h^{-1}$
Particle mass	$4.1\,\Omega_\mathrm{m} \times 10^9\,M_\odot\,h^{-1}$

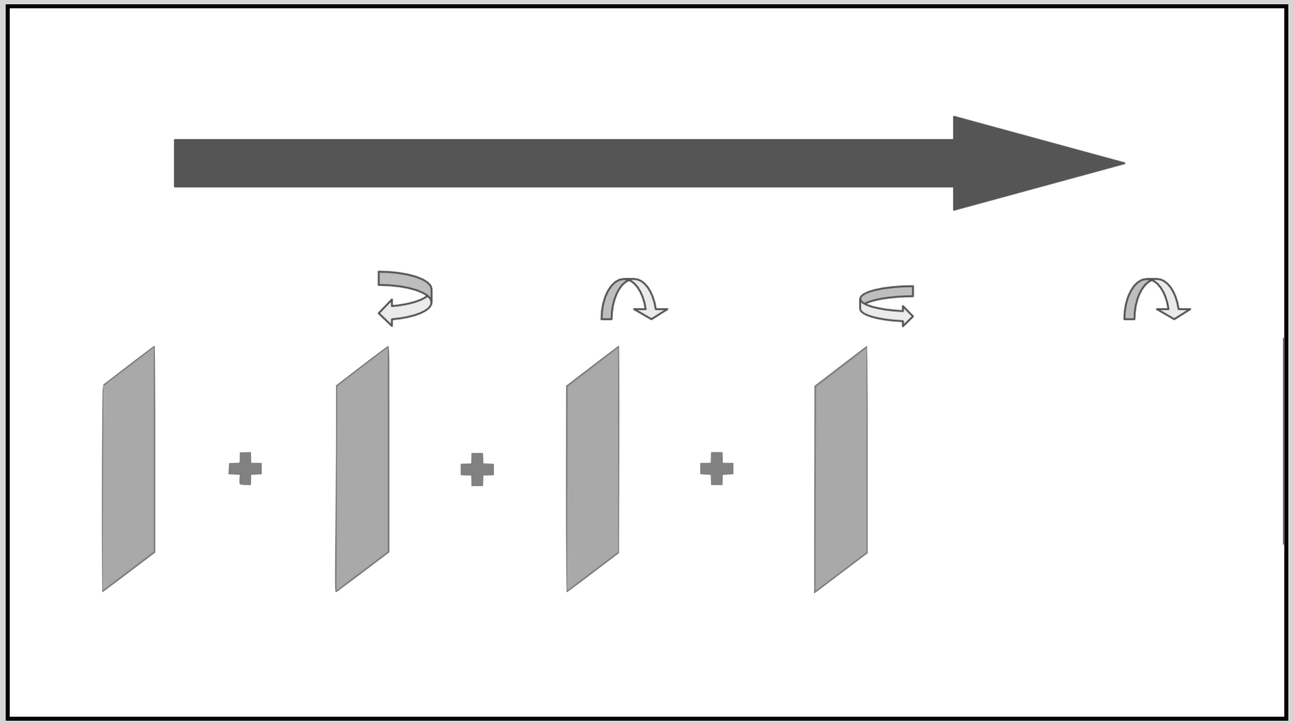
Past Light Cones



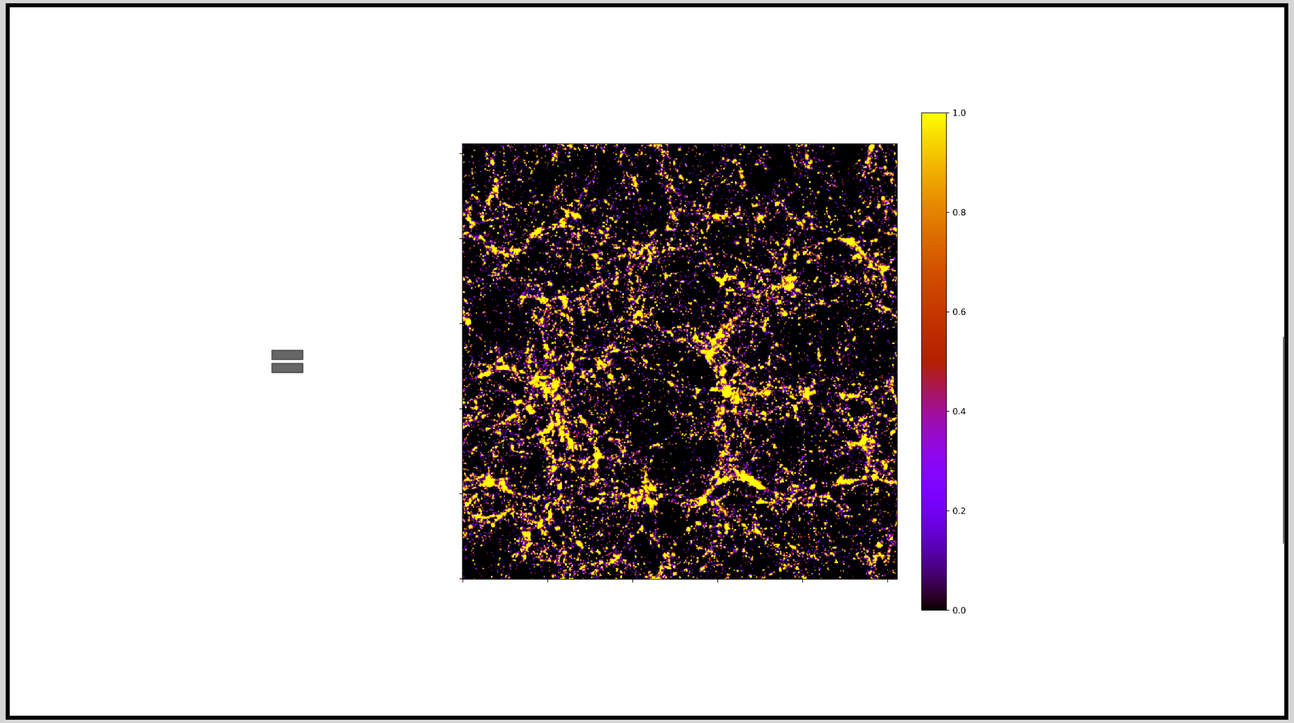
Past Light Cones



Past Light Cones



Past Light Cones



Magnification Maps

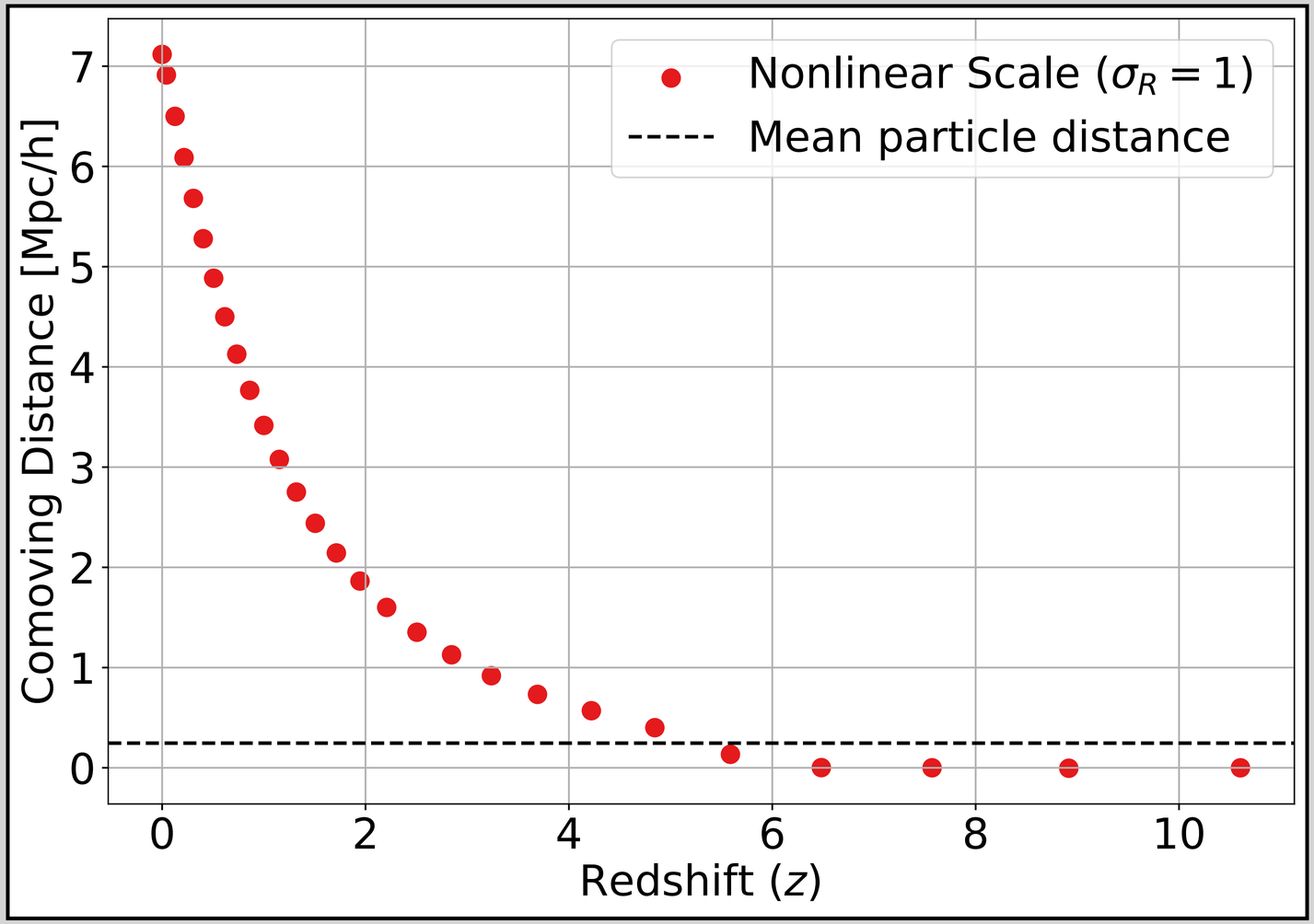
$$\kappa(\mathbf{x}) = \frac{4\pi G}{c^2} \sum_i W(z_i, z_s) \left[\Sigma_i(\mathbf{x}) - \langle \Sigma_i \rangle\right] (1 + z_i)^2 \frac{G(z_i)}{G(z_{\text{snap}})}$$

$$\tilde{\phi}(\mathbf{k}) = -\frac{2}{|\mathbf{k}|^2} \tilde{\kappa}(\mathbf{k})$$

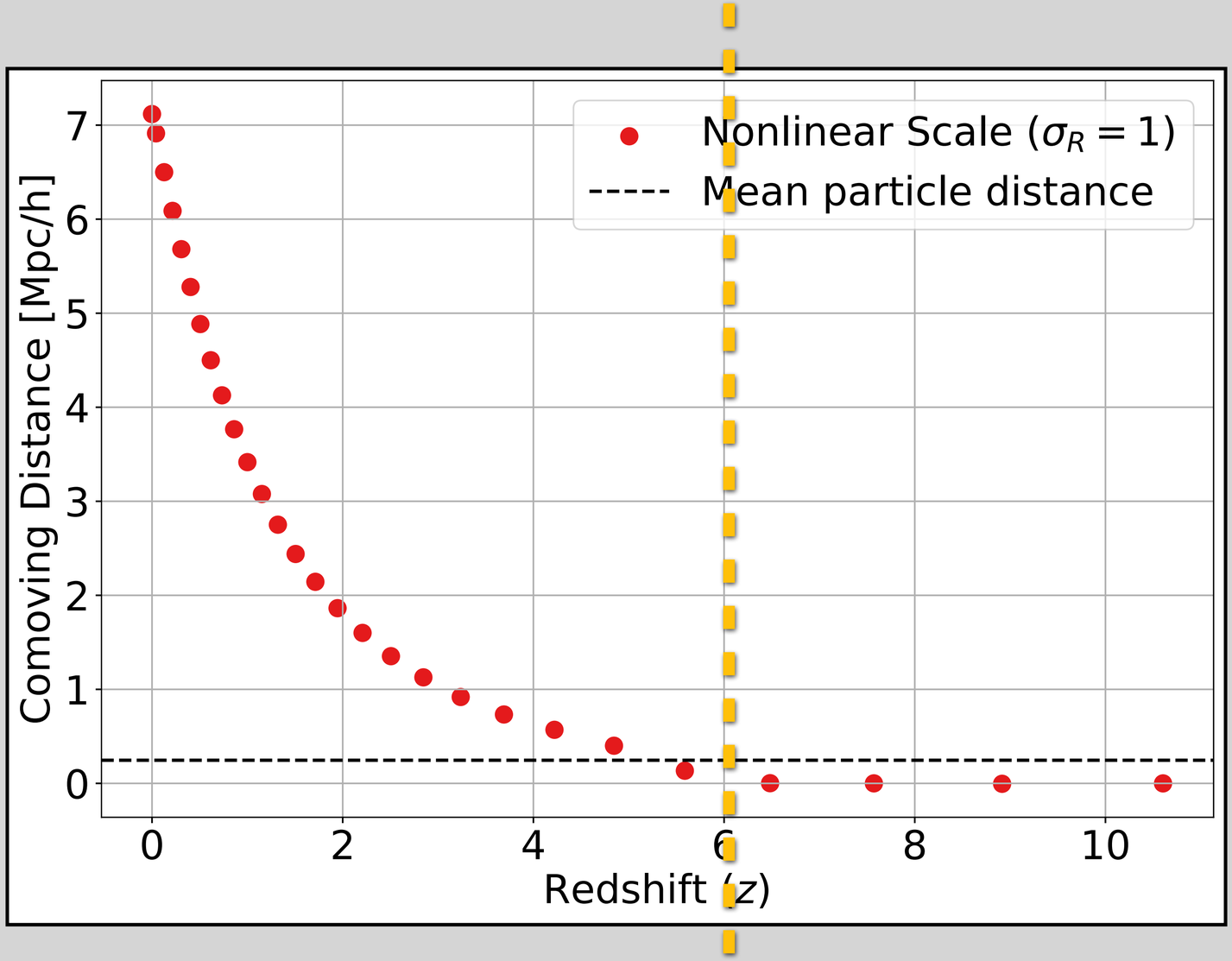
$$\gamma_1 = \frac{1}{2}(\partial_{xx}\phi - \partial_{yy}\phi), \qquad \gamma_2 = \partial_{xy}\phi$$

$$\mu = \frac{1}{(1-\kappa)^2 - \gamma^2}$$

Resolution


Nonlinear Scale ($\sigma_R = 1$)
Mean particle distance
Comoving Distance [Mpc/h]
Redshift (z)
0
1
2
3
4
5
6
7
0
2
4
6
8
10

Resolution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0
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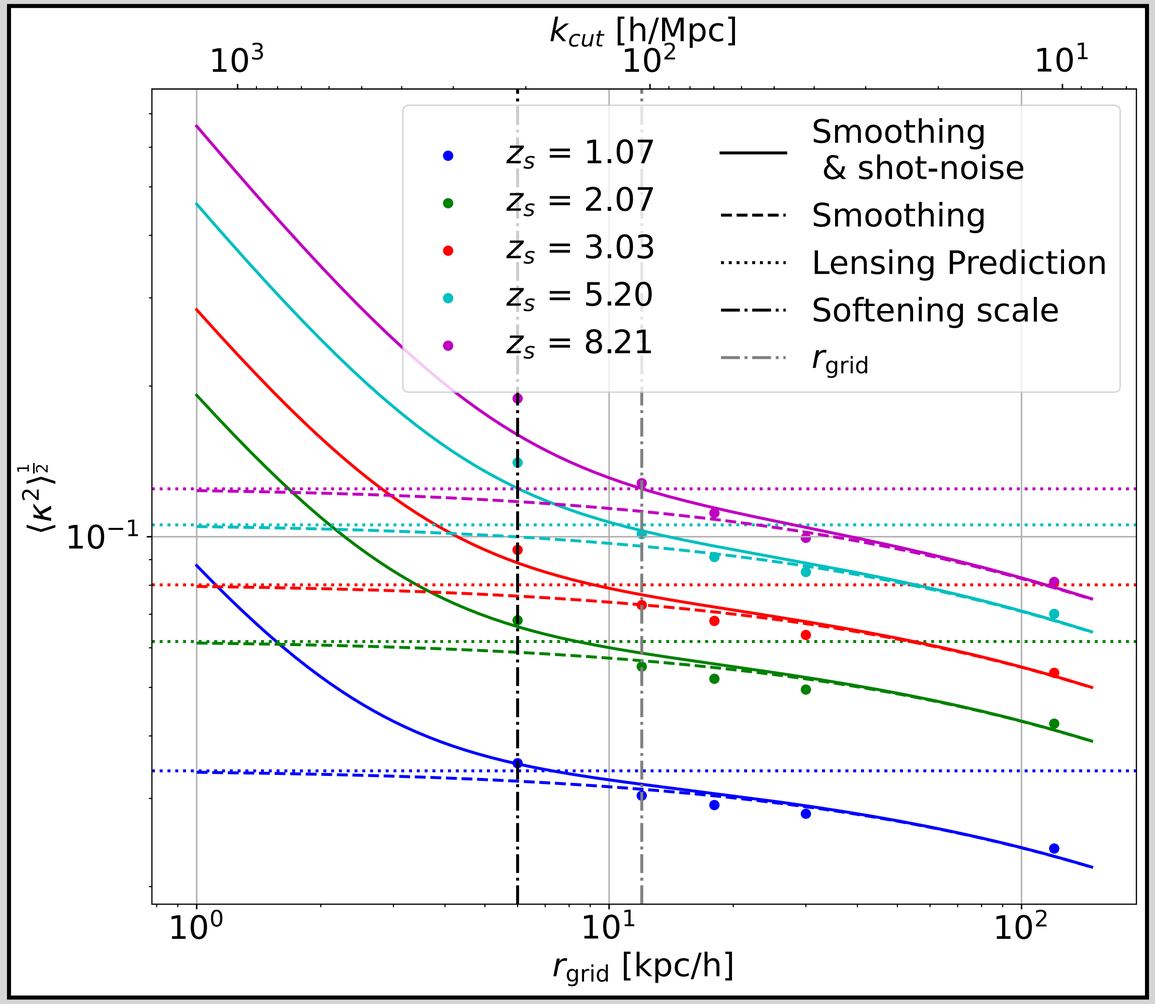
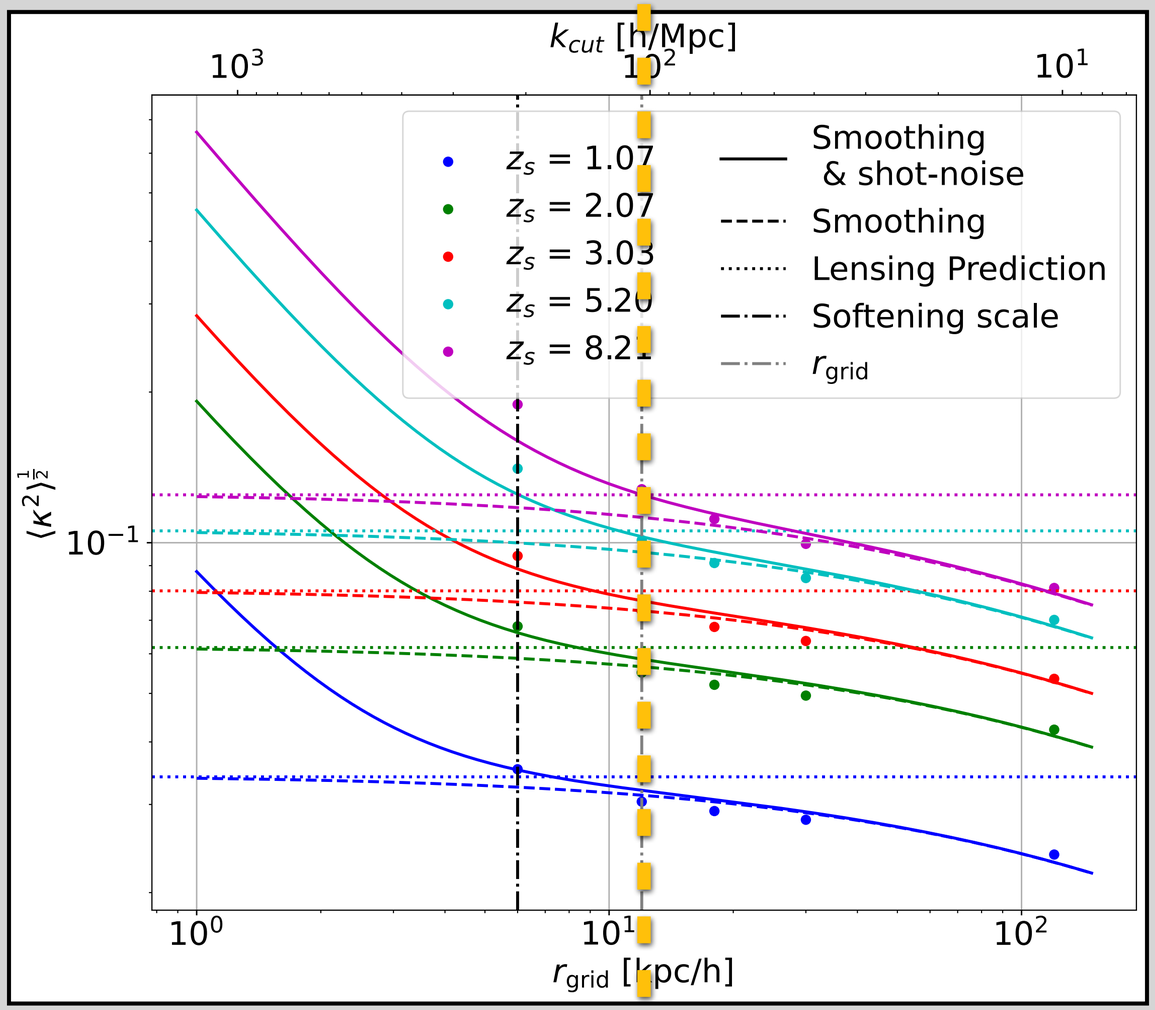
10

Convergence Check

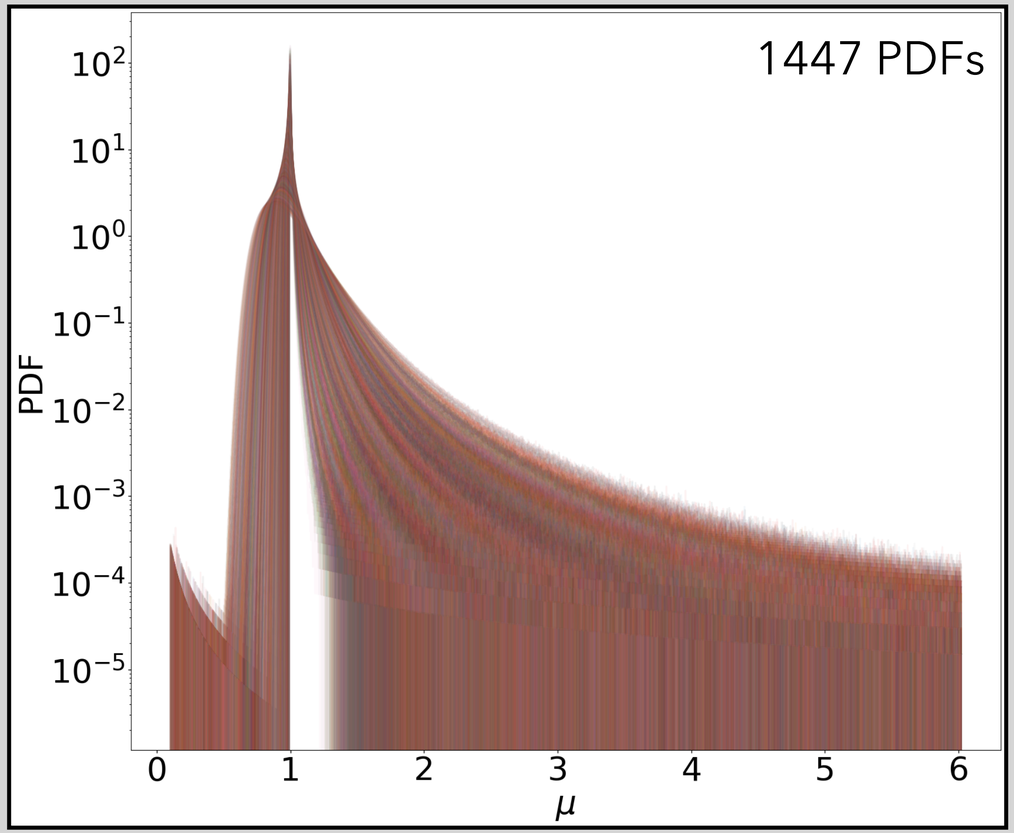


Convergence Check

20833×20833



PDFs



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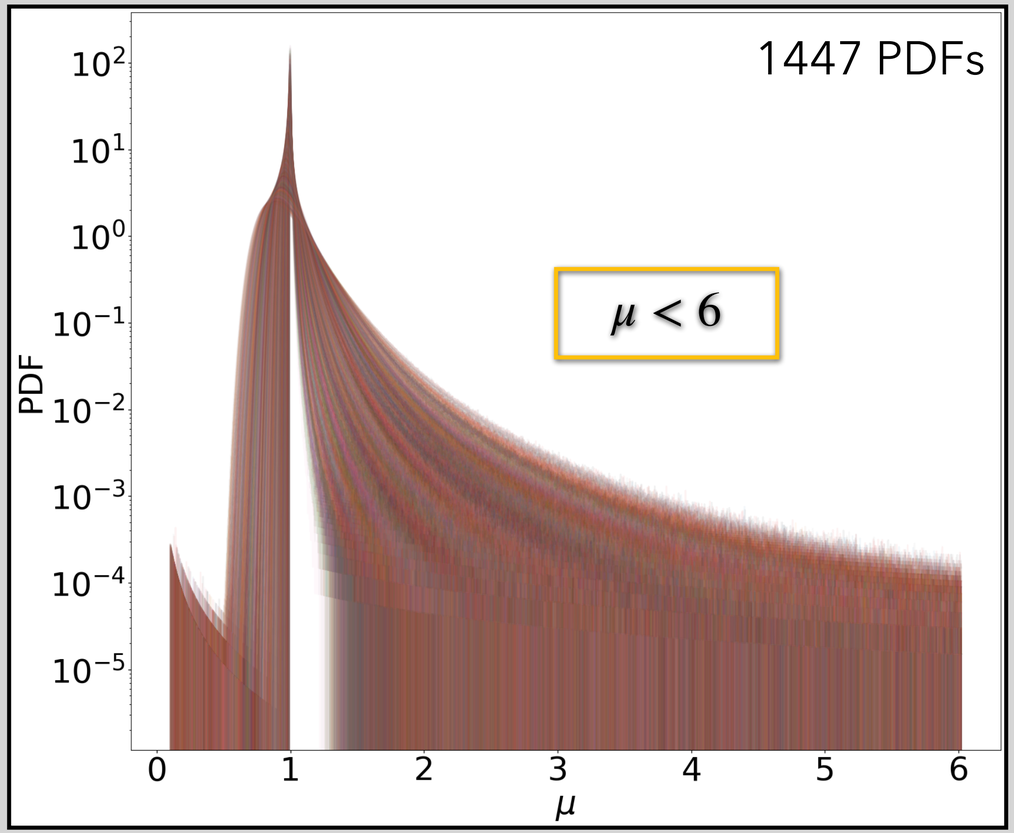

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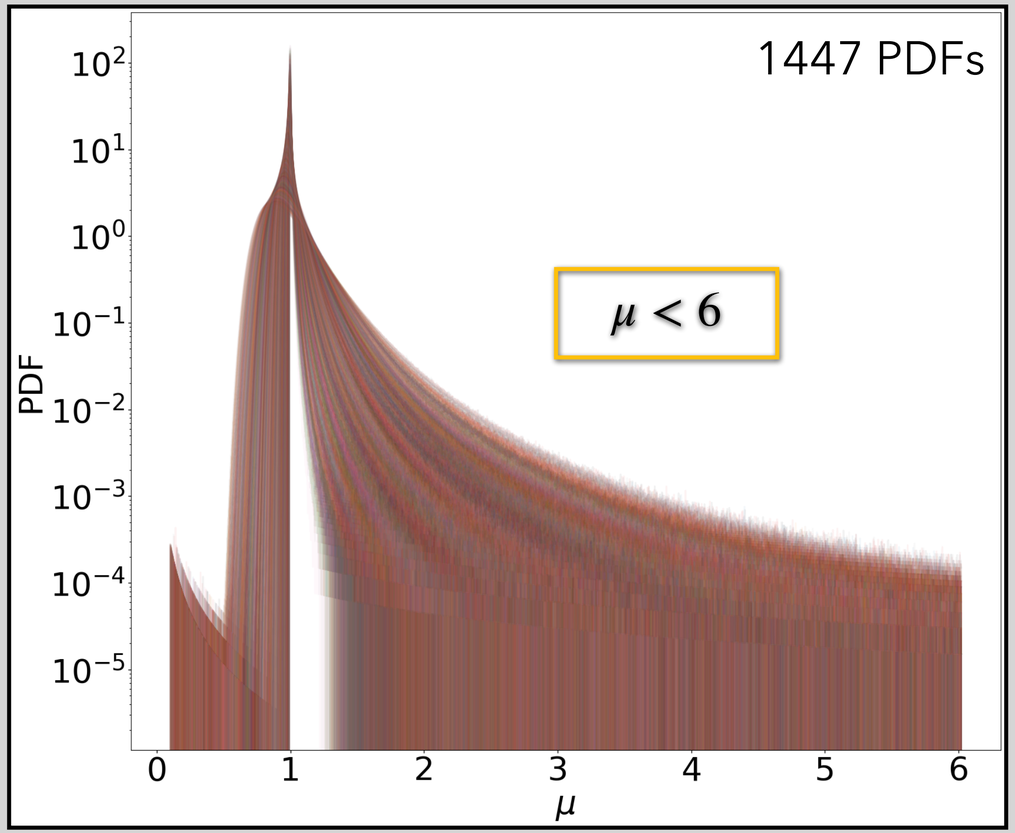
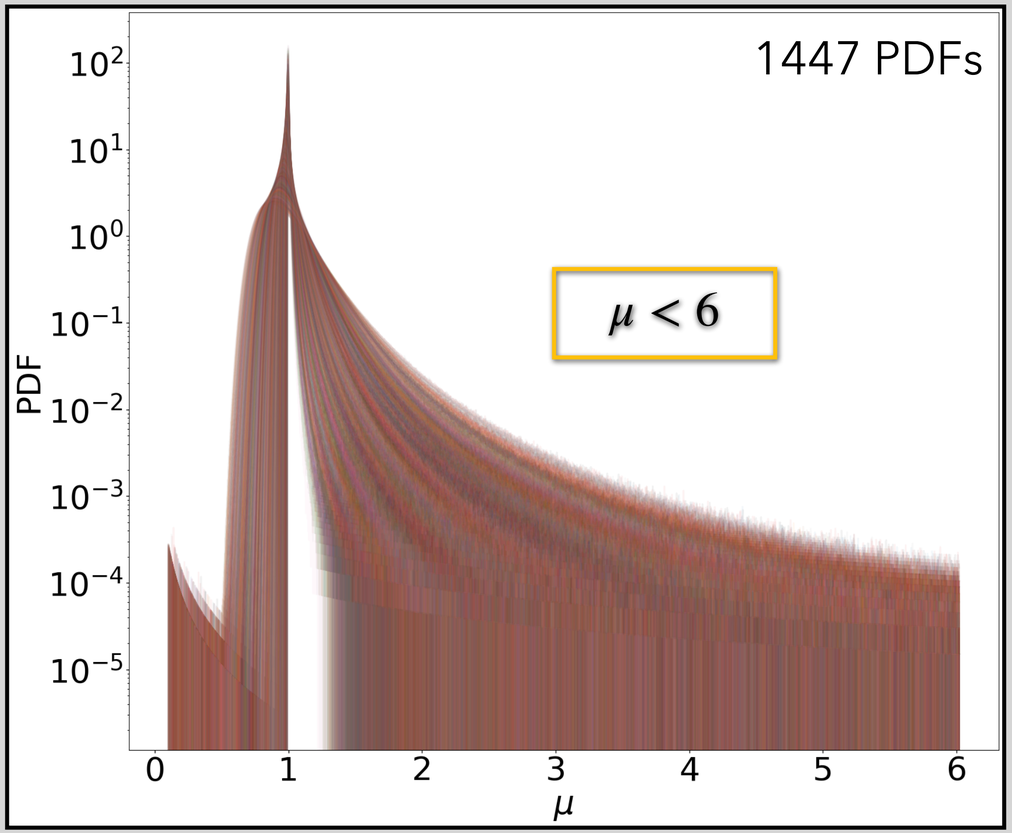
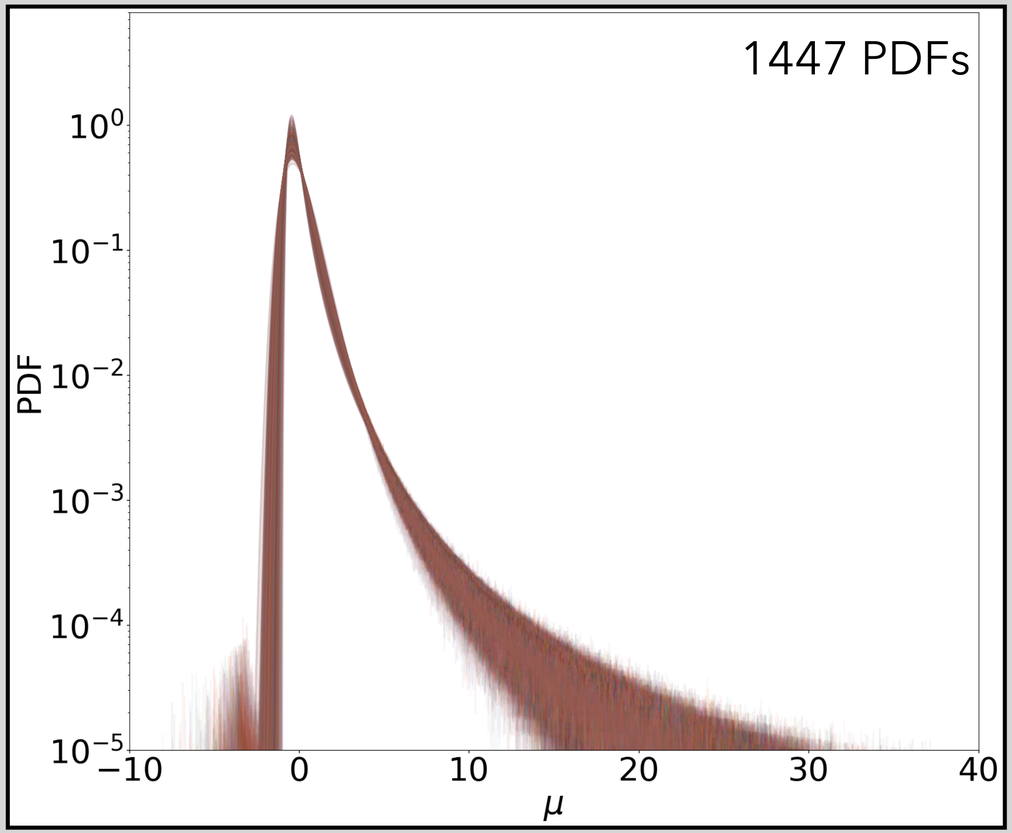


$$\frac{\mu - \bar{\mu}}{\sigma}$$

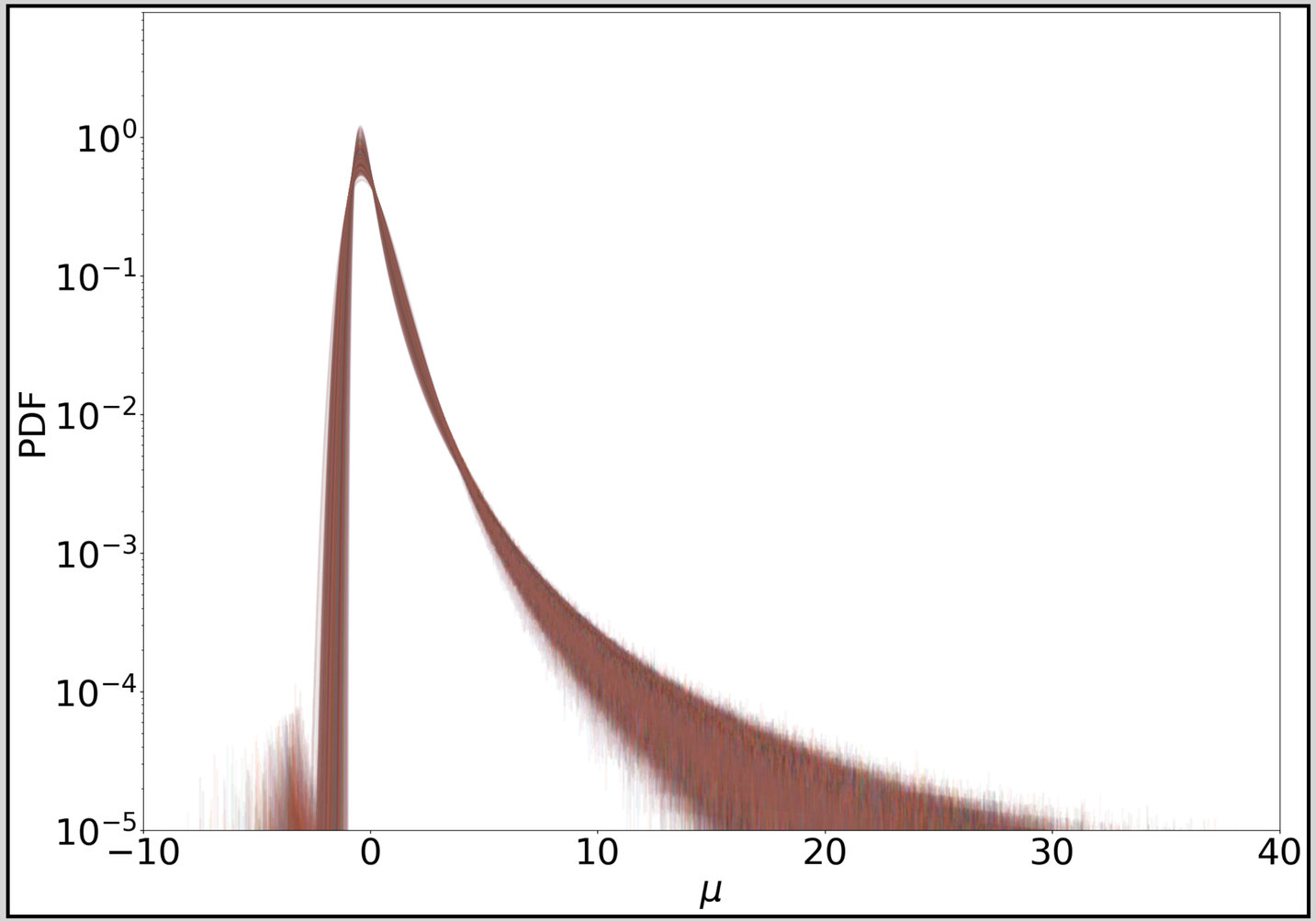
PDFs



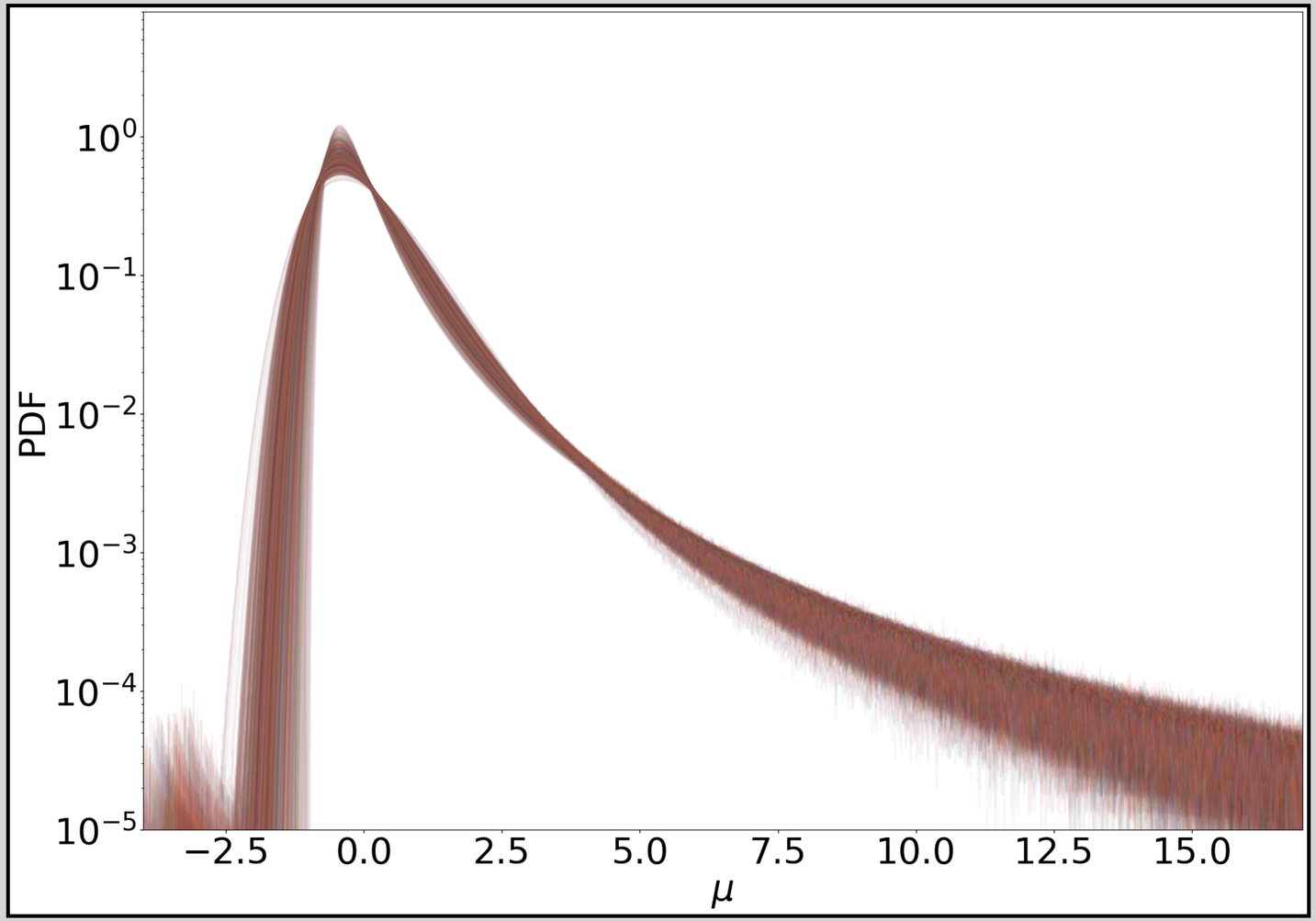
$$\frac{\mu - \bar{\mu}}{\sigma}$$



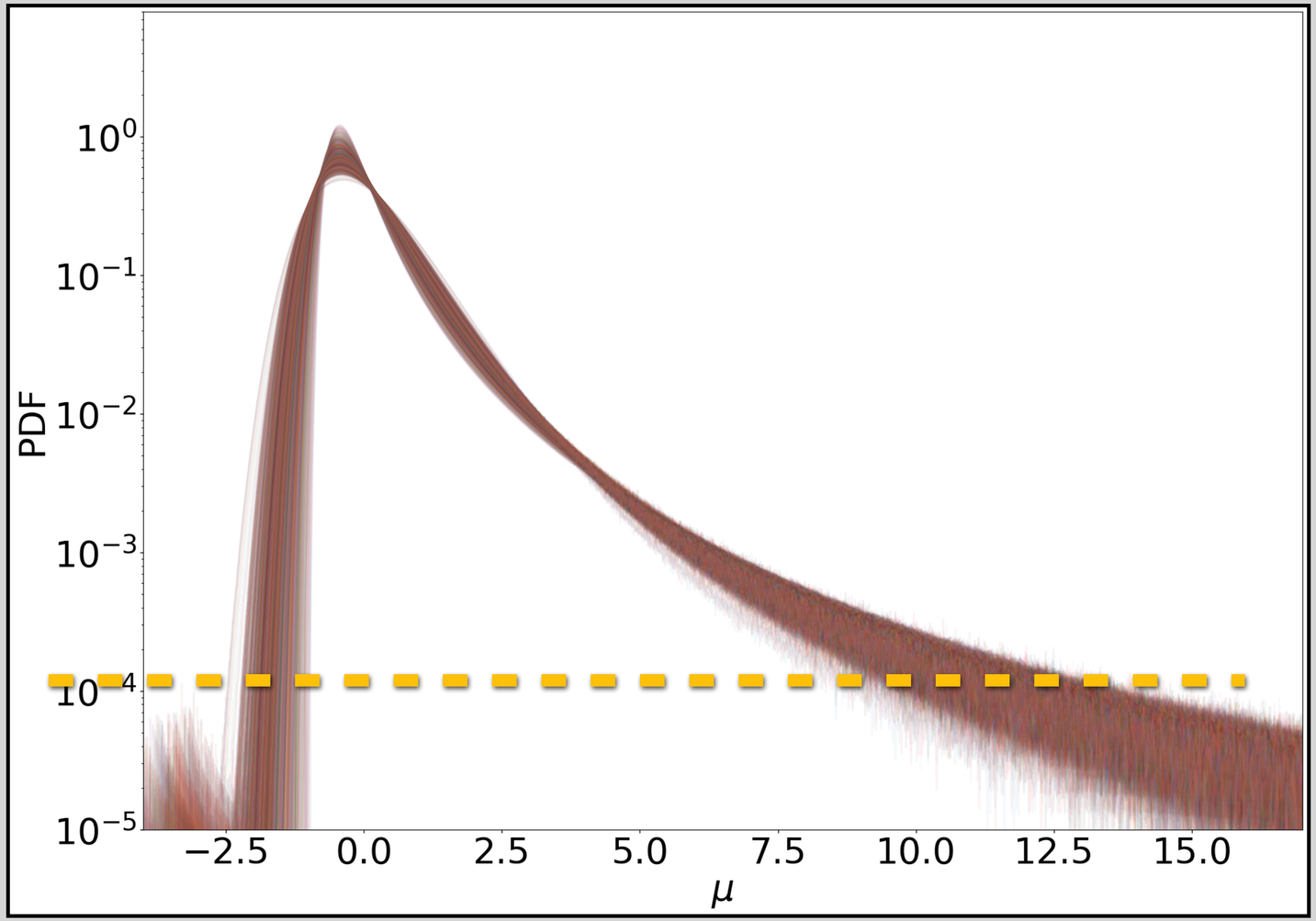
Standardized PDFs



Standardized PDFs



Standardized PDFs



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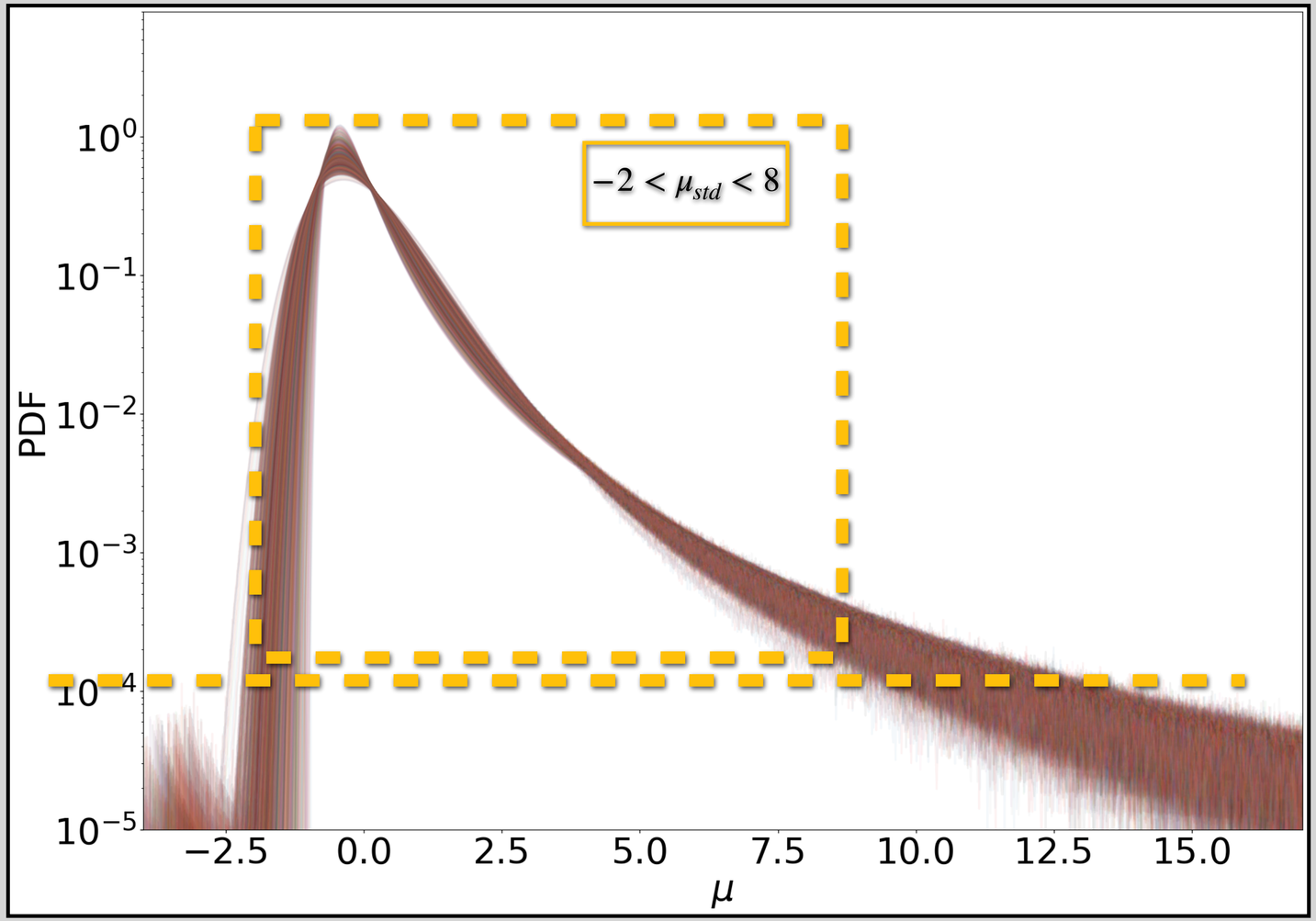

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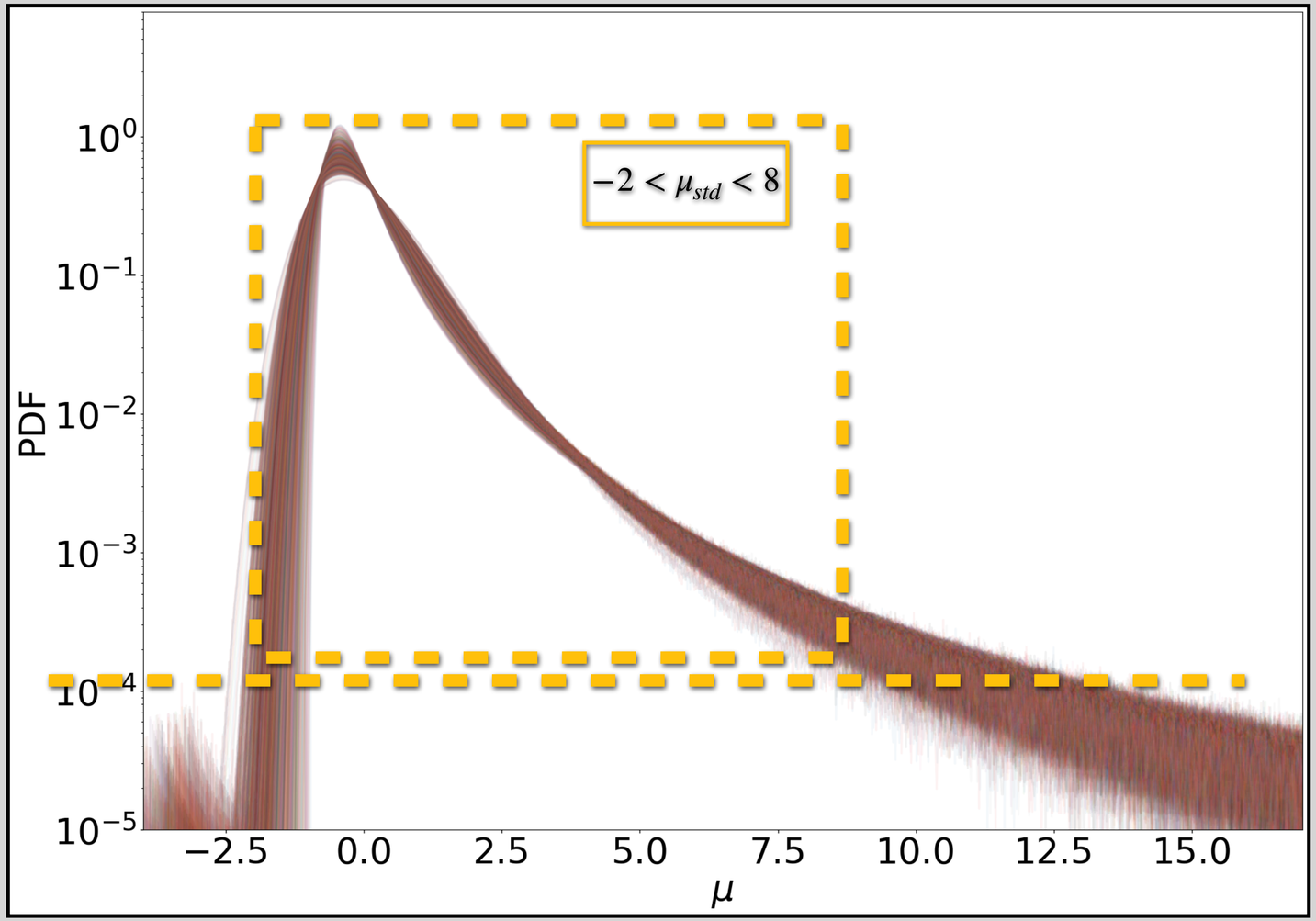

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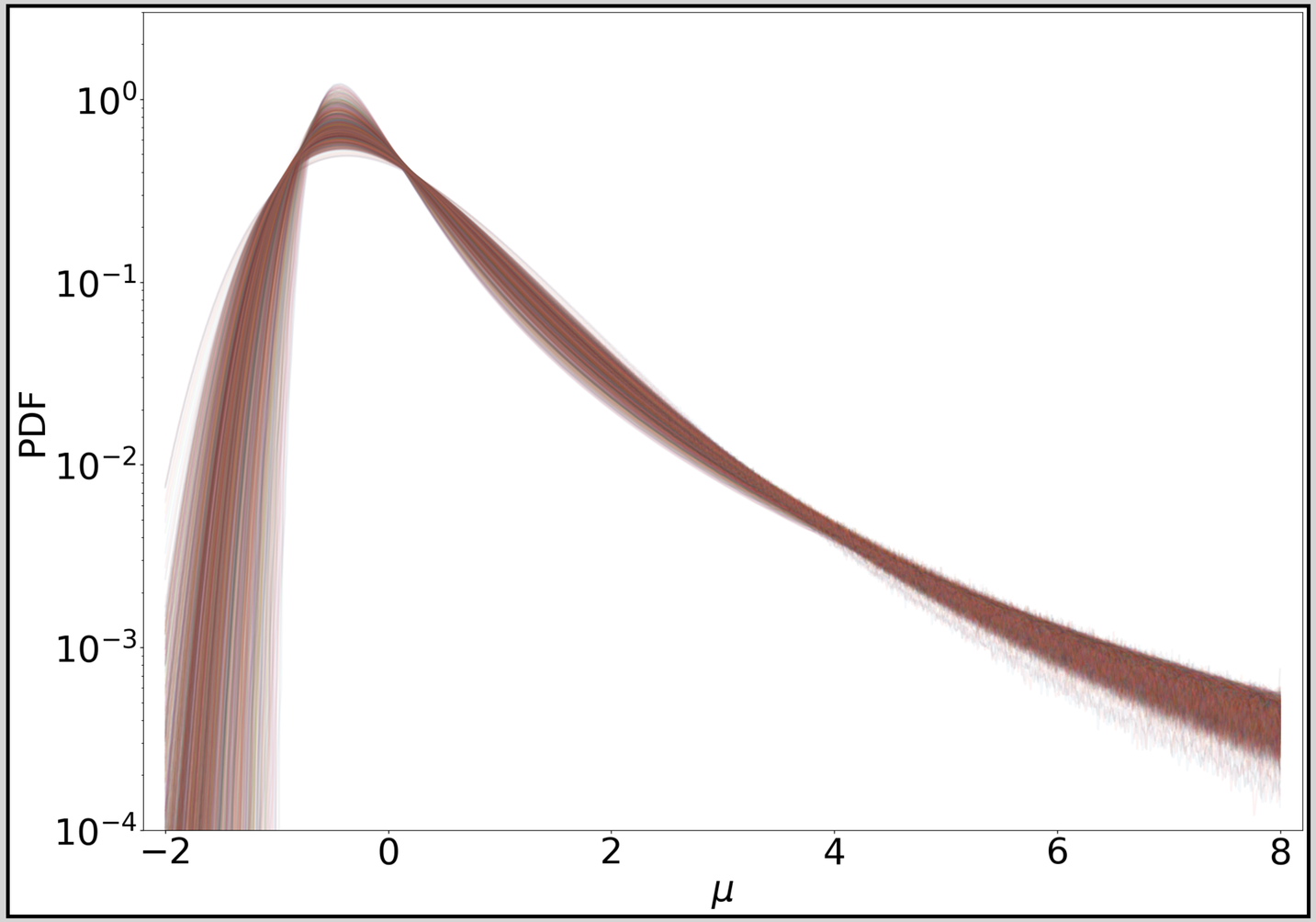
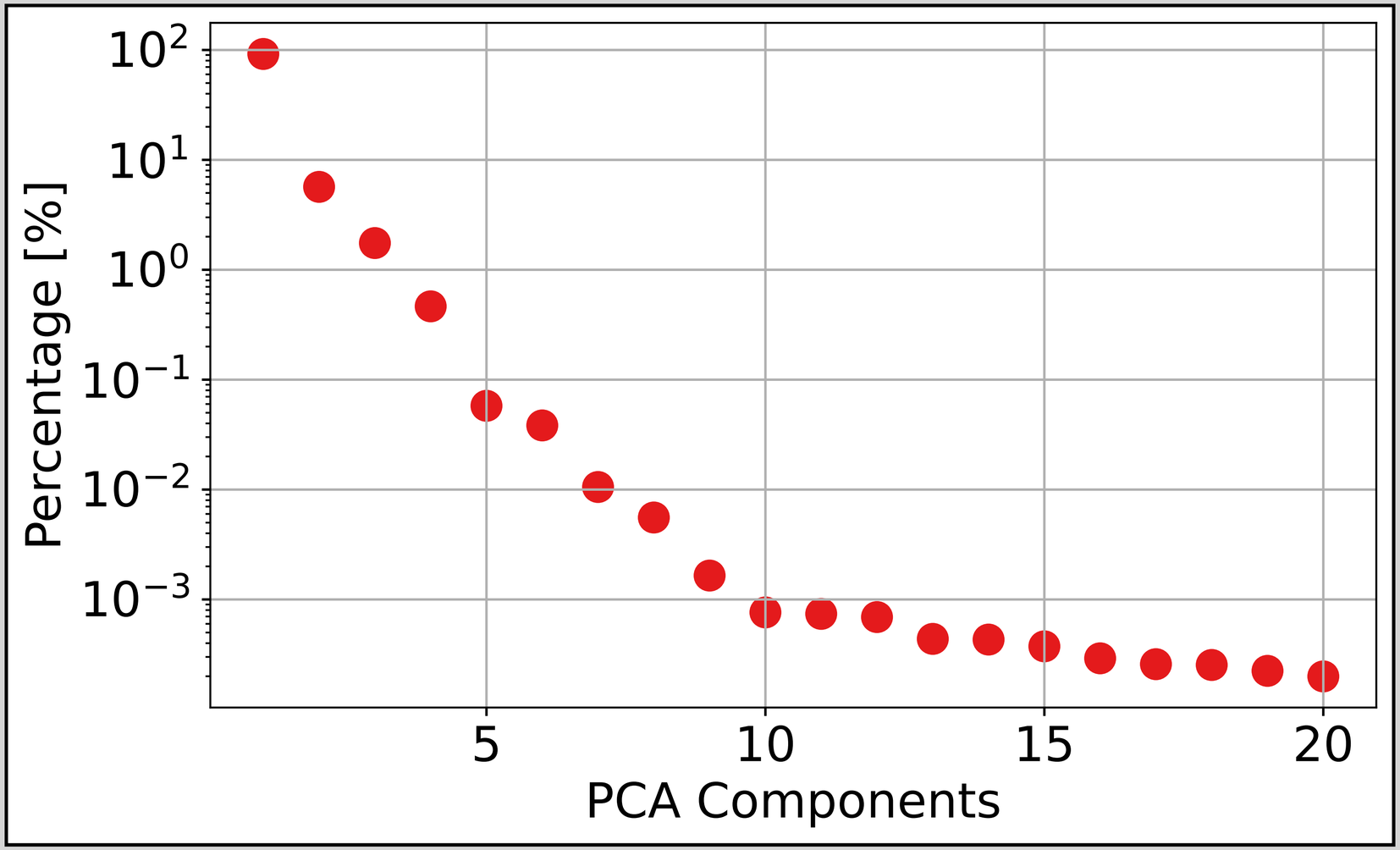
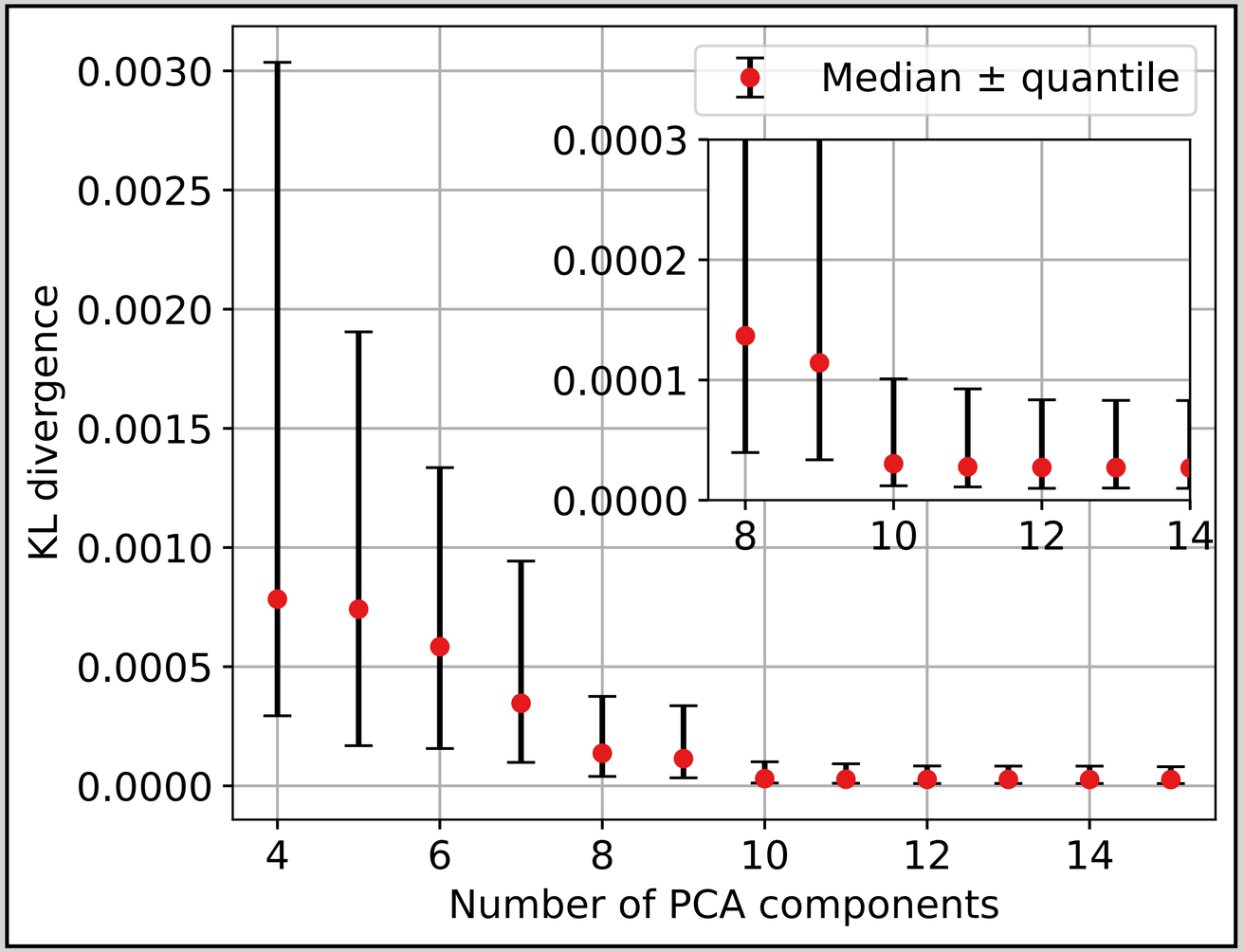


Principal Component Analysis

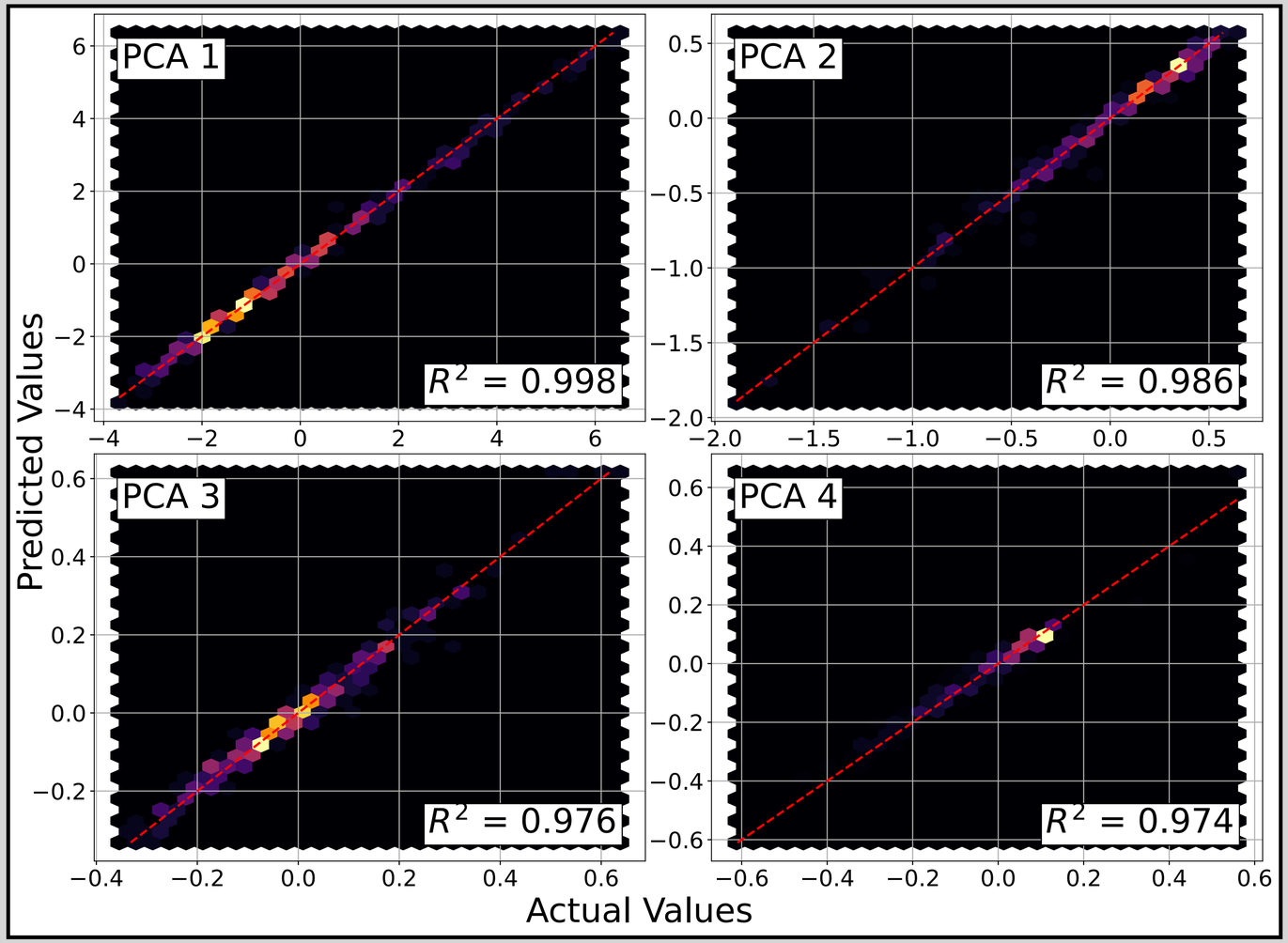


Principal Component Analysis

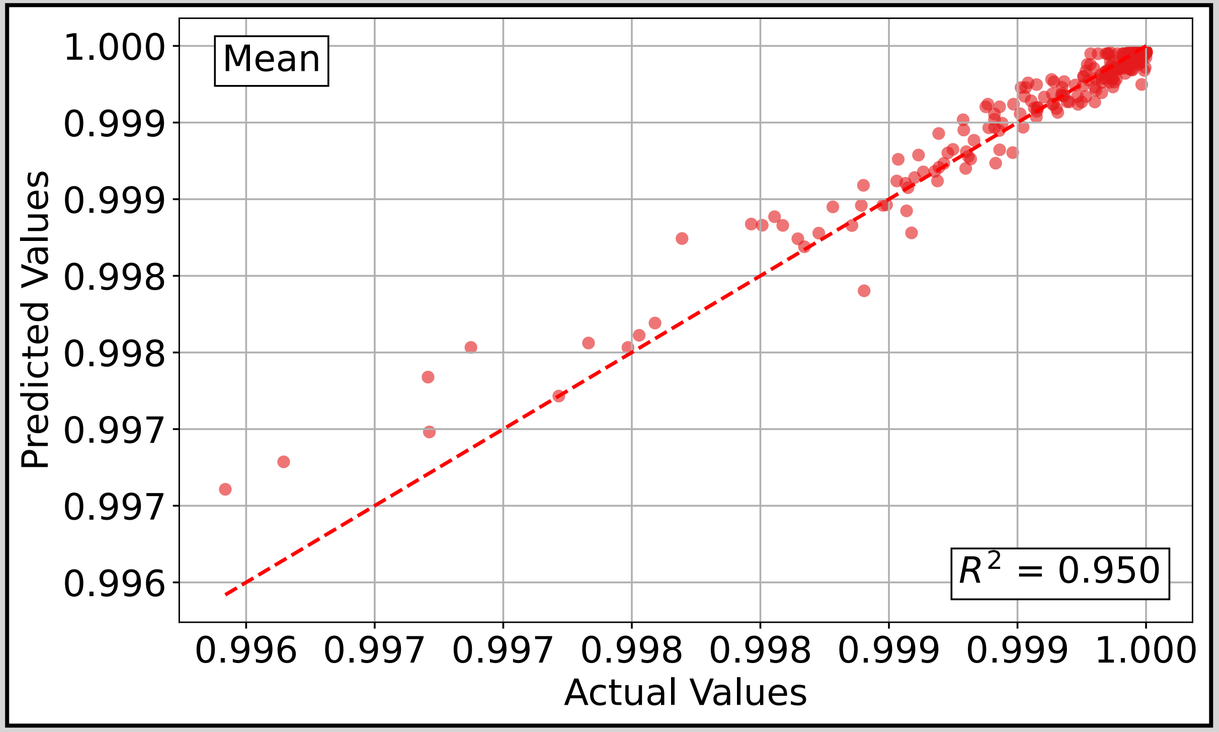
$$D_{\mathrm{KL}}(P \parallel Q) = \sum P(x) \log \left(\frac{P(x)}{Q(x)} \right)$$

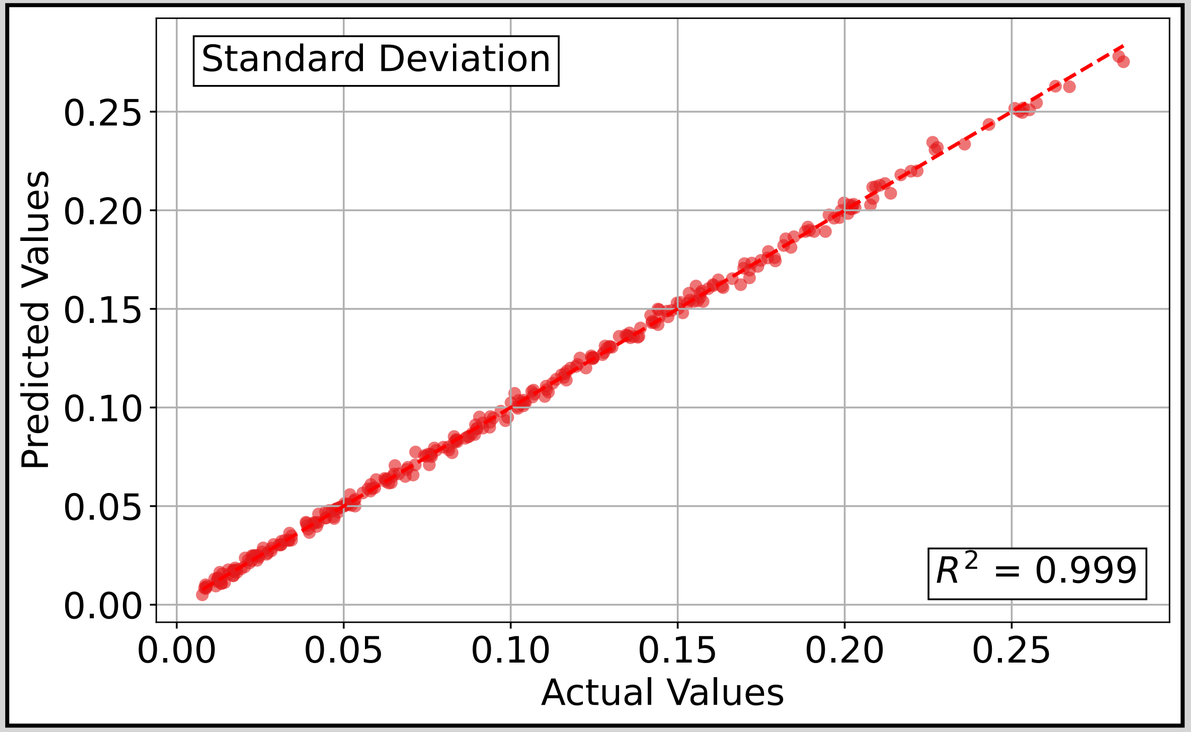


XGBoost


PCA 1
R^2 = 0.998
PCA 2
R^2 = 0.986
PCA 3
R^2 = 0.976
PCA 4
R^2 = 0.974
Predicted Values
Actual Values

XGBoost


Mean
Predicted Values
Actual Values
1.000
0.999
0.999
0.998
0.998
0.997
0.997
0.996
0.996 0.997 0.997 0.998 0.998 0.999 0.999 1.000
R^2 = 0.950

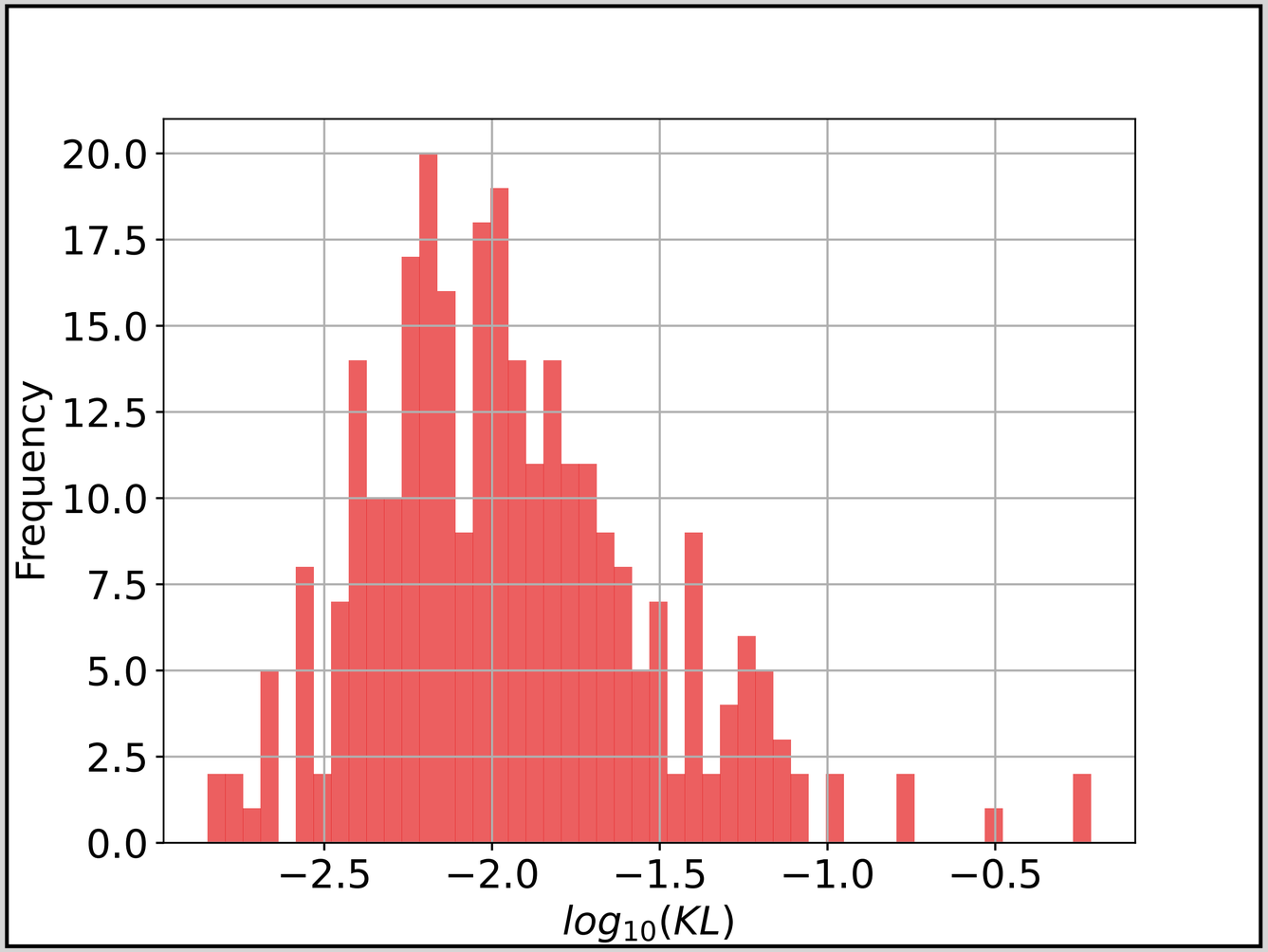

Standard Deviation
Predicted Values
Actual Values
0.25
0.20
0.15
0.10
0.05
0.00
0.00 0.05 0.10 0.15 0.20 0.25
R^2 = 0.999

Results

Mean KL Div.: 0.014

Median KL Div.: 0.007

Std. of KL Div.: 0.031



Results