

Constraining cosmology from HSC weak lensing maps with CNNs

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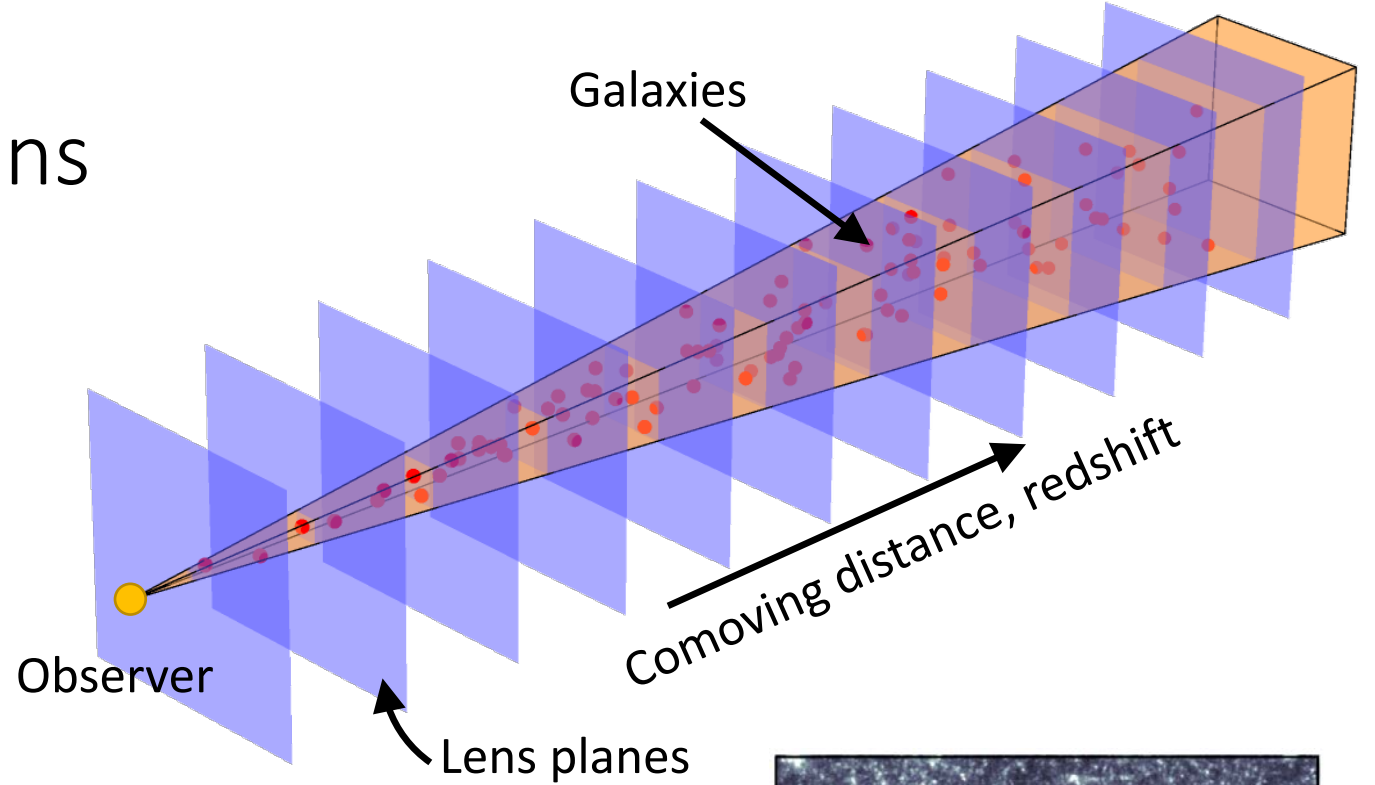
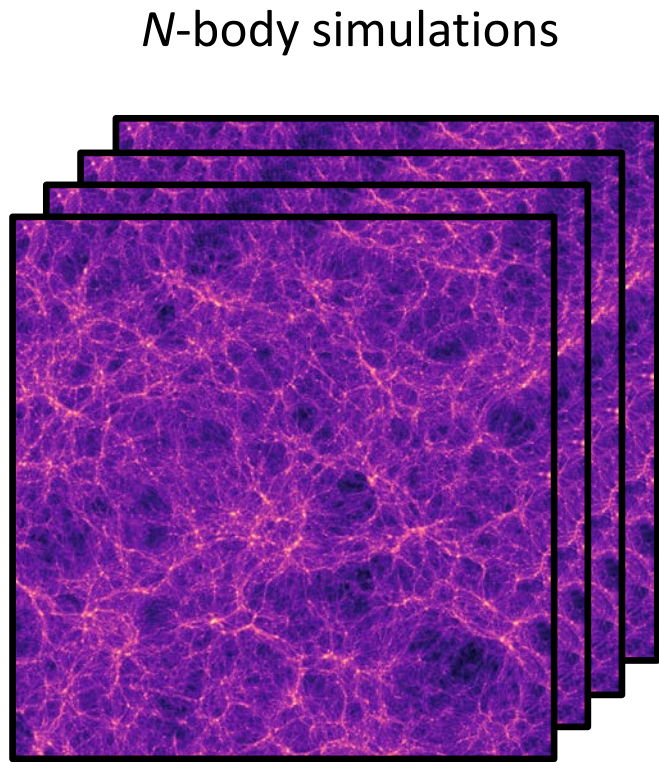
Department of Astronomy, Columbia University

Lu et al. (2021)

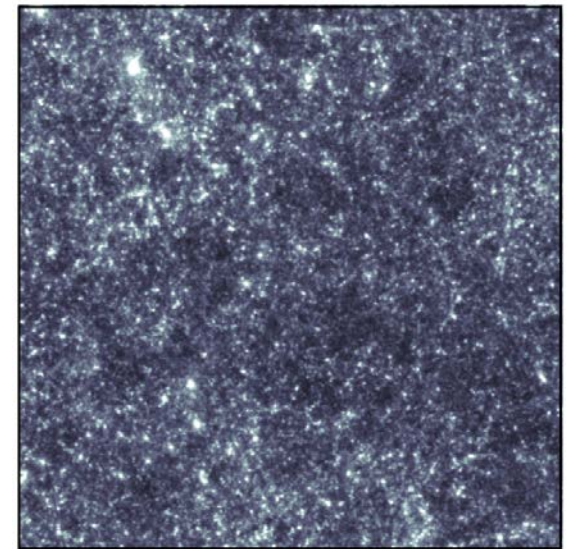
Lu et al. (2022)

Lu et al. (2022) in preparation

Weak lensing simulations



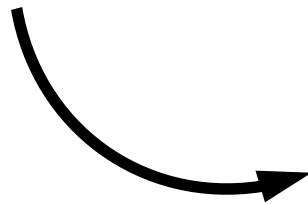
Noiseless κ map
with $z_{\text{source}} = 1$



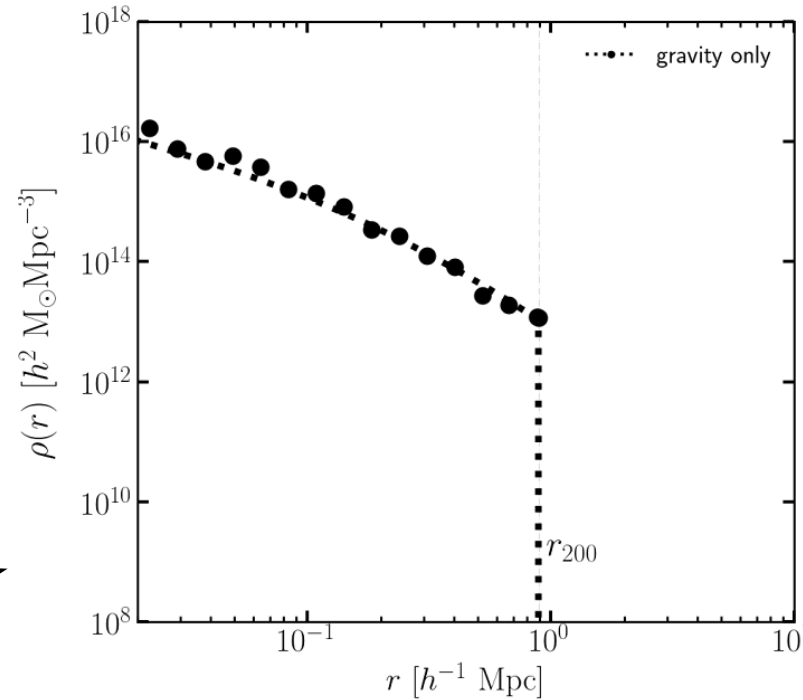
Osato et al. (2021)

Baryonic model

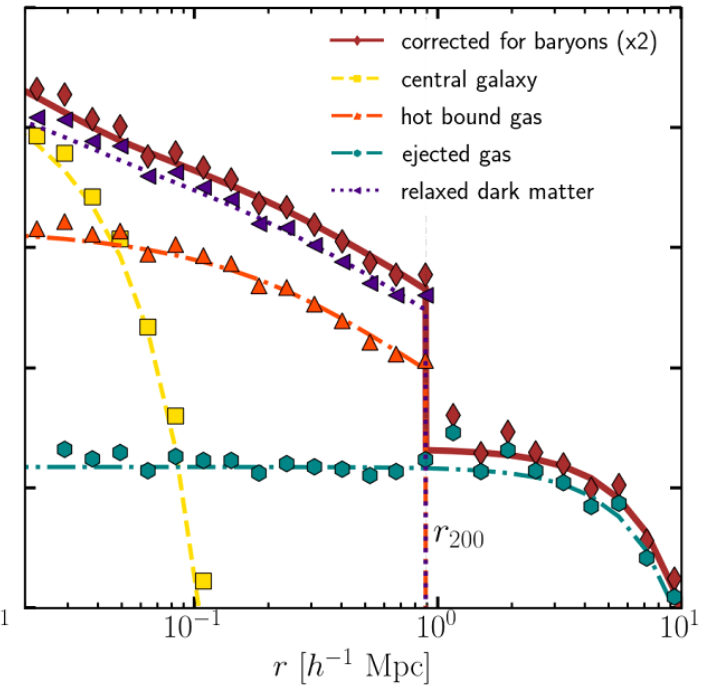
- A lot of hydrodynamical simulations
- Modify weak lensing statistics directly
- **Modify matter distribution in N -body simulations**



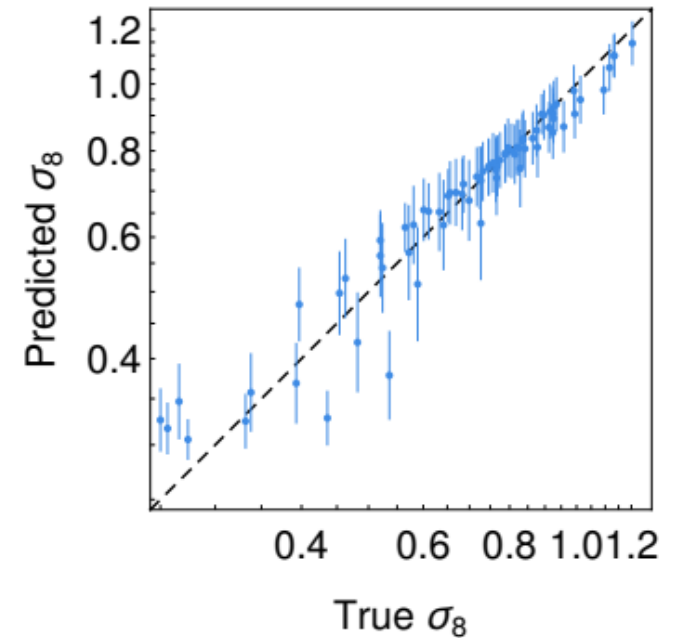
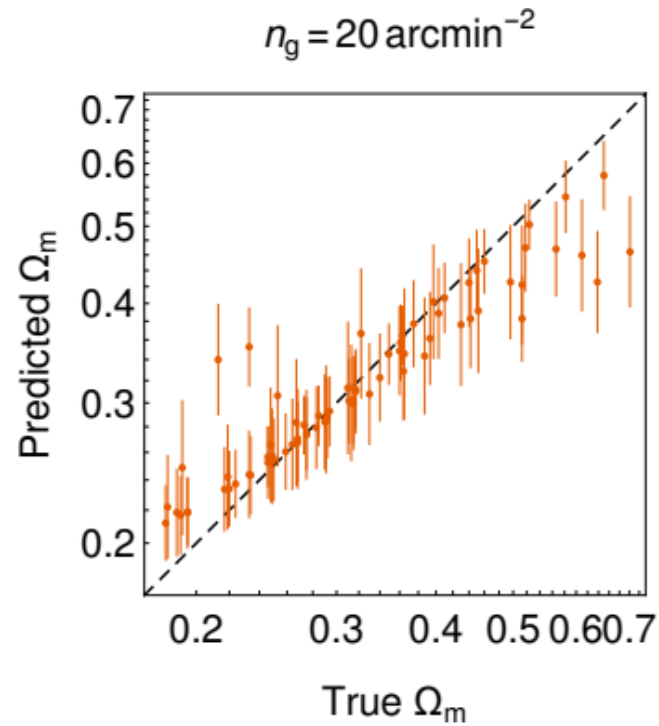
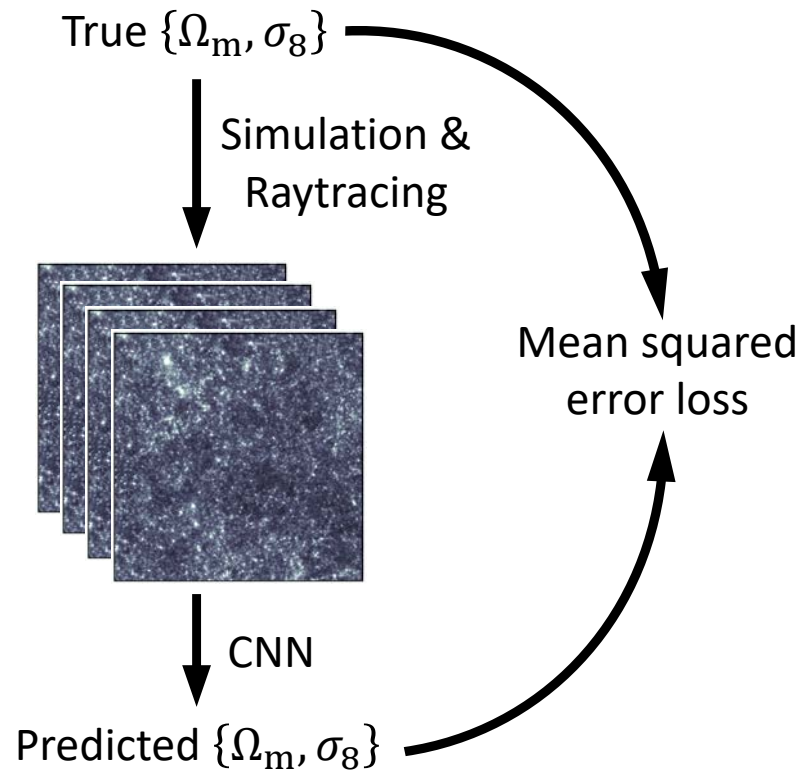
Dark matter-only N -body



With baryonic physics
(modelled by 4 parameters)



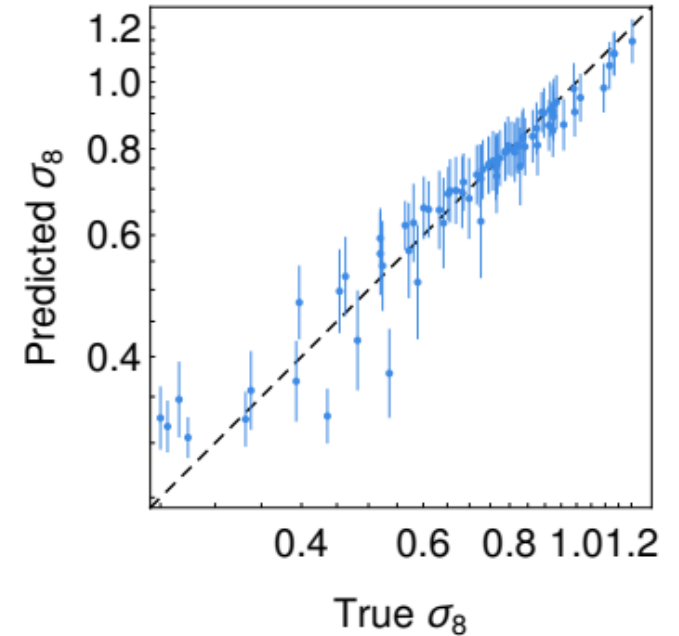
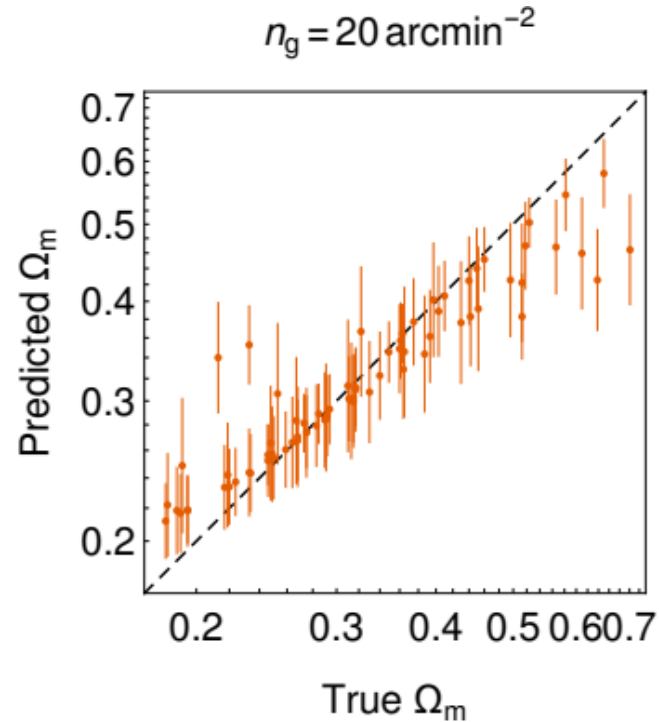
Convolutional neural networks



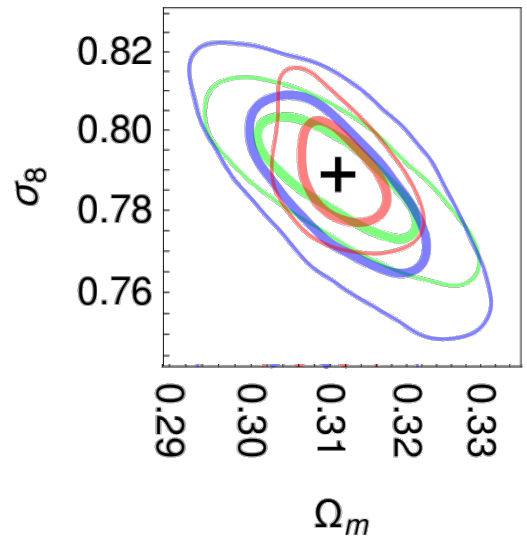
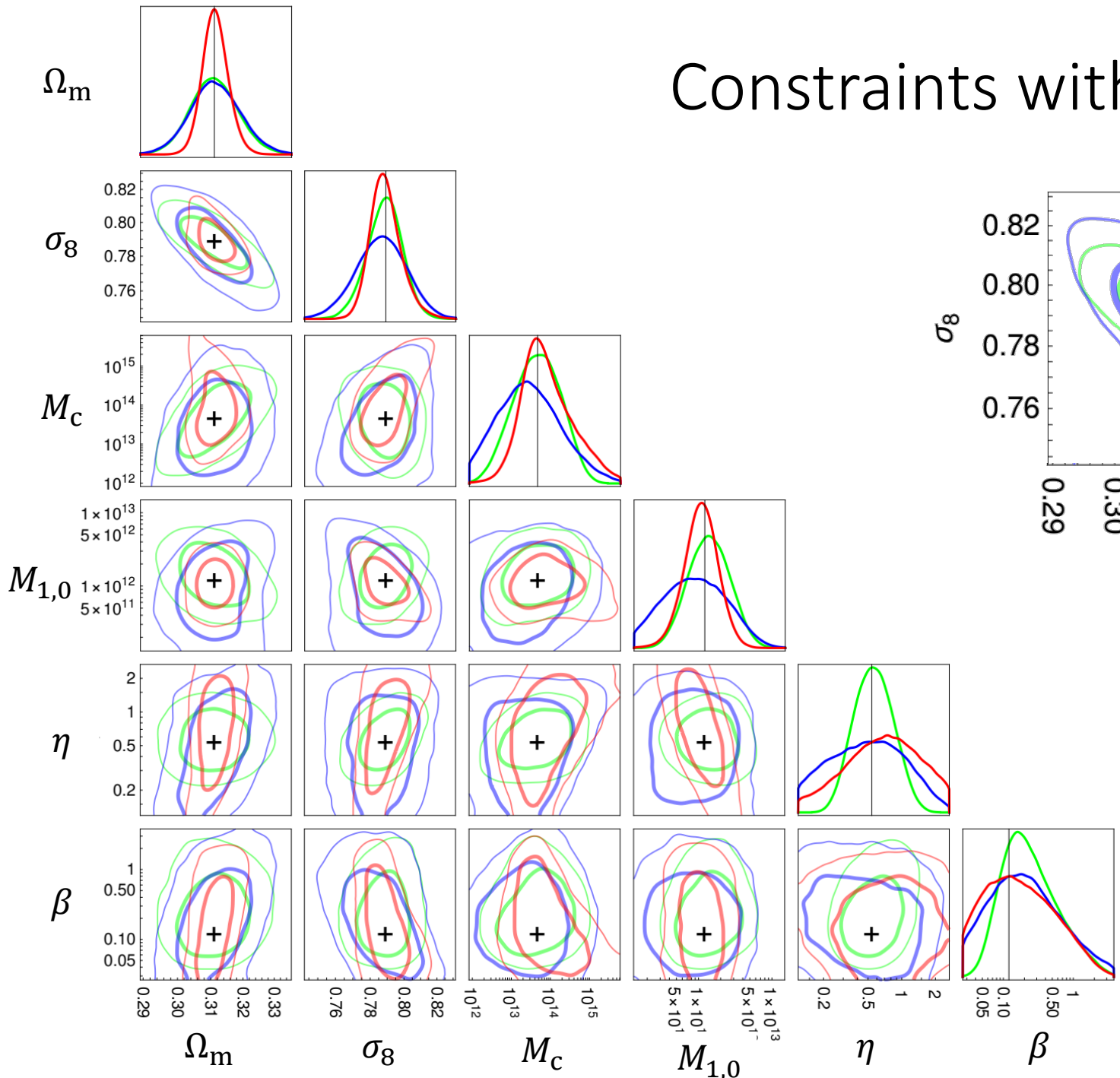
Convolutional neural networks

Use the CNN as a summary statistic:

- Ignore the meaning of its outputs
- Derive a likelihood function with the test set



Constraints with the simulations ($z_{\text{src}} = 1$)



$A_{\text{survey}} = 1500 \text{ deg}^2$ $n_{\text{gal}} = 20 \text{ arcmin}^{-2}$

- Power spectrum
- Peak counts
- CNN

| Method | $\Omega_m - \sigma_8$ contour area (10^{-4}) | |
|----------------|--|----------------------------------|
| | Fiducial baryonic model | Marginalize over baryonic models |
| Power spectrum | 0.93 | 3.45 |
| Peak counts | 0.94 | 5.89 |
| CNN | 0.44 | 2.08 |

HSC first-year catalog

- $A_{\text{survey}} = 137 \text{ deg}^2$, $n_{\text{gal}} = 18.5 \text{ arcmin}^{-2}$
- The survey area is divided into 19 subfields
- Galaxies with $0.3 \leq z \leq 1.5$ are divided into 4 redshift bins
- Many systematics:
 - Intrinsic alignments
 - Baryonic effects
 - Photo-z errors
 - Multiplicative bias uncertainty, $\sim 1\%$
 - PSF correction and modelling error

One of the convergence maps
of the lowest z bin

