Cosmology from HSC Y1 Weak Lensing with Combined Higher-Order Statistics and Simulation-based Inference

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studied in the context of baryonic feedback [16]. work, we use the MFs, PM, and PDF of the Sub-r Suprime-Cam (HSC) first-year (HSC Y1) data, and nbination with the angular power spectrum (PS), to the cosmological parameters Ω_m, the total matter

inference. In Section V we show the robustness of o against systematic effects. Our results are presented i VI, and we conclude in Section VII.

of (Ω_m, S_8) values, a total of 50 realizations are con- by randomly selecting observer positions in the sim- ox, providing a set of quasi-independent realizations y one simulation. This set of simulations is hereafter *smology-varied*.

quantities are given by Ref. [49, 50]

$$V_0(\nu_t) = \frac{1}{4\pi} \int_\Sigma d\Omega \,,$$

as much information as possible. The posterior esti- then performed over the compressed data.

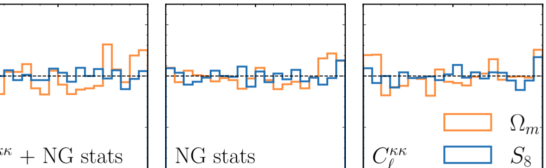
A. Neural network and data compression

$(C_\ell^{\kappa\kappa}, \mathrm{MFs}_\nu, \mathrm{PM}_\nu, \mathrm{PDF}_\nu)$ of length 118 for an i redshift z, and length 354 when combining all thre bins. The training is performed for each cosmologica eter at a time, so that an NN learns the relation betwe $\theta = \{\Omega_m\}$, and X and $\theta = \{S_8\}$, separately.

on to allow the NN to efficiently map them in terms
rgets (cosmological parameters). As a common be-
he NN tends to predict values close to the mean of
neters range, as doing so artificially reduces the loss
[25, 63, 67].

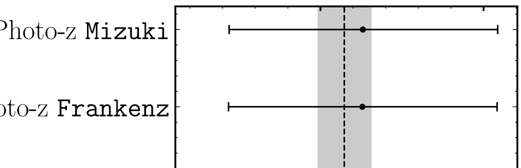
ployed to infer the posterior distribution for each cosn
parameter.

B. Parameter inference



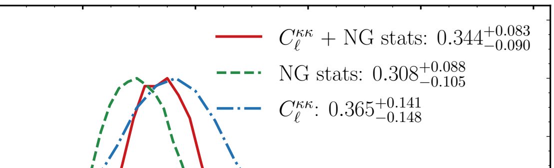
V. SYSTEMATICS

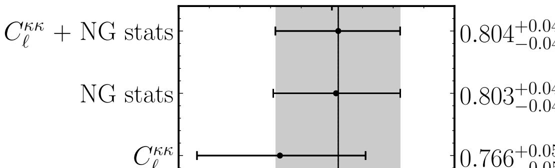
We assess the impact of different systematic effec
counted for in our simulations, quantifying potentia
troduced by each of them, besides evaluating the ac

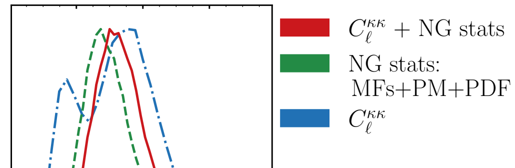
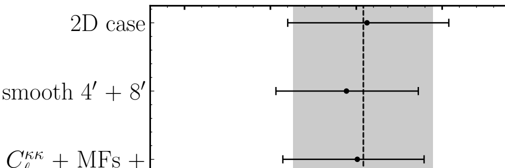


A. HSC Y1 analysis

We present in Figure 4 results of our method appli
HSC Y1 data, showing Ω_m and S_8 posteriors and f
straints obtained using a combination of Gaussian


$C_\ell^{\kappa\kappa}$ + NG stats: $0.344^{+0.083}_{-0.090}$
NG stats: $0.308^{+0.088}_{-0.105}$
$C_\ell^{\kappa\kappa}$: $0.365^{+0.141}_{-0.148}$


$C_\ell^{\kappa\kappa}$ + NG stats
NG stats
$C_\ell^{\kappa\kappa}$
0.804
0.803
0.766


$C_\ell^{\kappa\kappa}$ + NG stats
NG stats:
MFs+PM+PDF
$C_\ell^{\kappa\kappa}$

2D case
smooth 4′ + 8′

ale cuts applied to $C_\ell^{\kappa\kappa}$, intended to minimize the im-
ystematics. This suggests that most of the information
is also captured by the NG statistics, besides the ex-
NG information they are capable of extracting from
ergence fields. In particular, using each statistic in-

text: `Numpy` [81], `Astropy`[10] a community-develo
Python package for Astronomy [82, 83], `Matplotl`
`IPython` [85], `Scipy` [86], `scikit-learn`
`TensorFlow` [88]. This research used computing
at Kavli IPMU. This research used resources at the

statistics stage: Finally, we apply our SBI pipeline he HSC Y1 data, using both the NG statistics only

(MFs+PM+PDF) and their combination with finding good agreement (within 1σ) with the s vious results.

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