Measuring the cosmological parameters with machine learning techniques.

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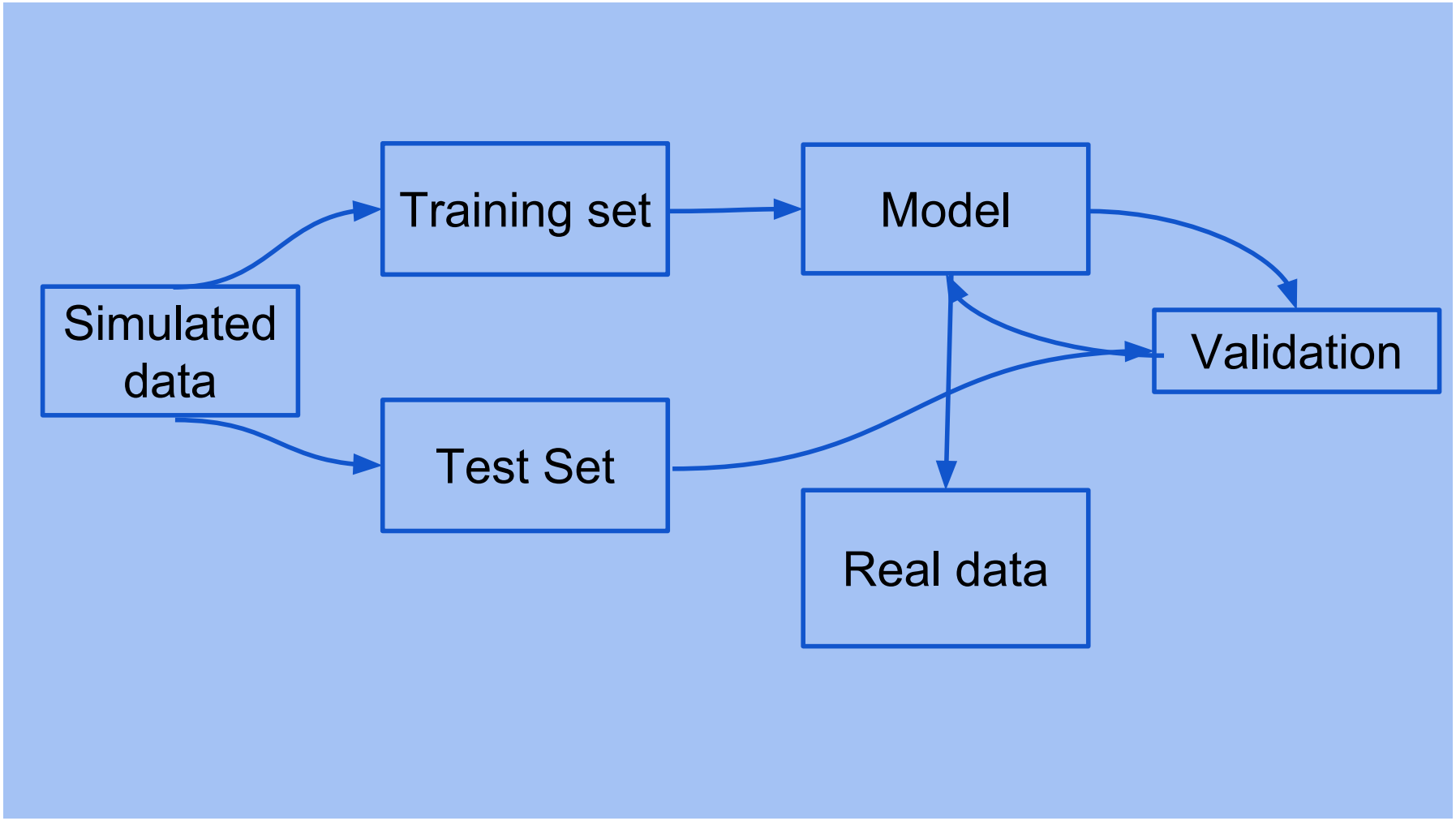
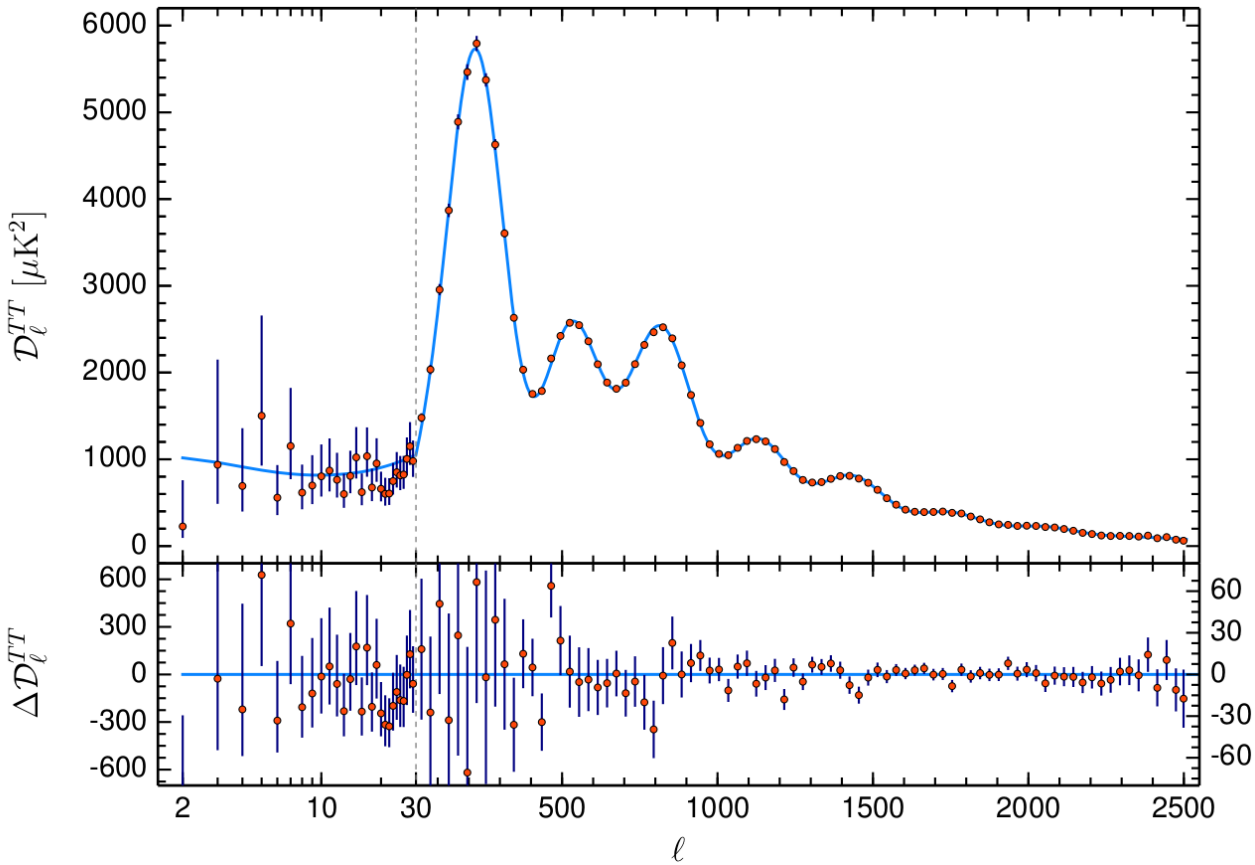
Supervised Learning.



The Standard model.

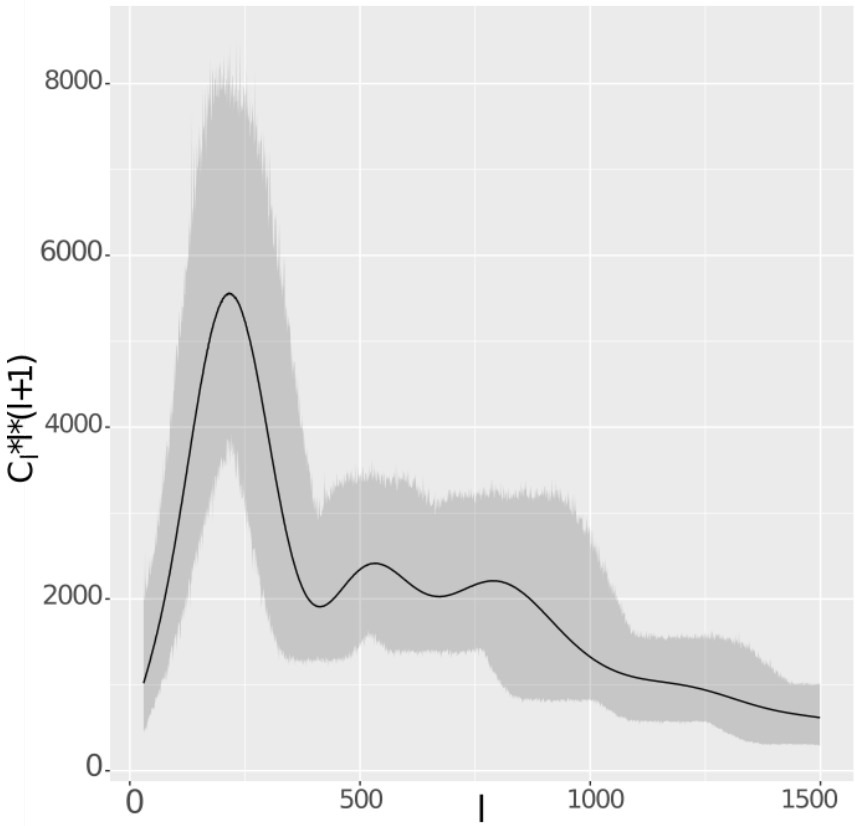
Homogeneous and isotropic Universe $\rightarrow$ FRW metric

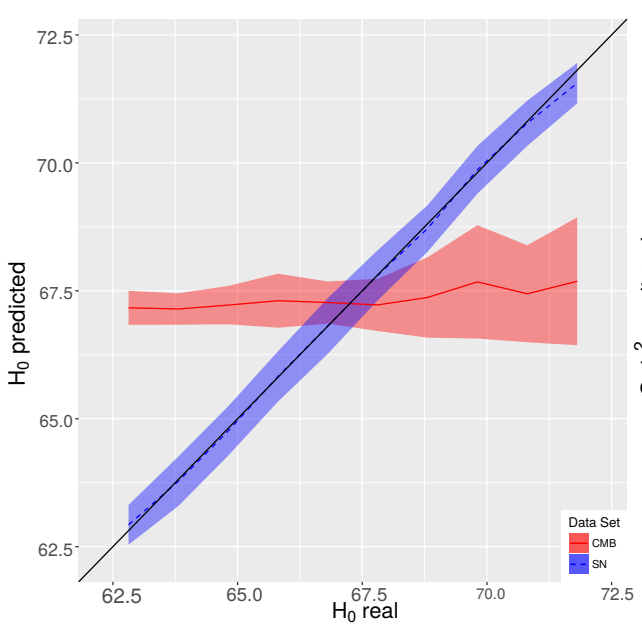


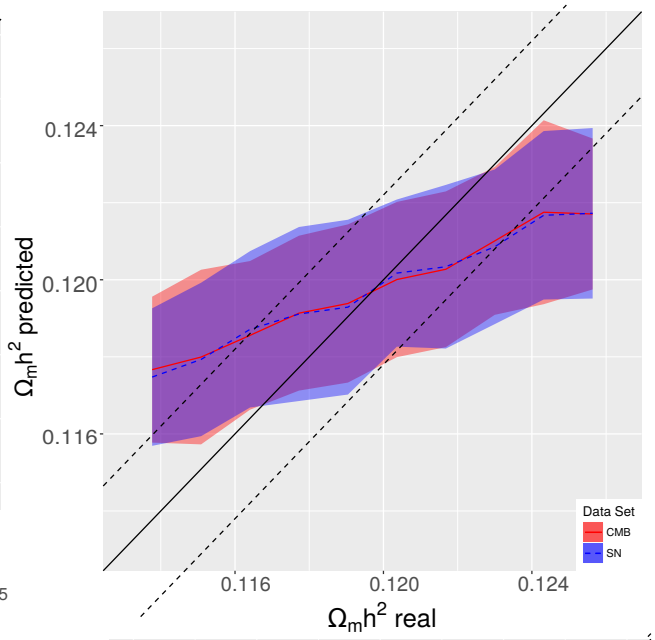
Planck Collaboration 2018 (1807.06209)

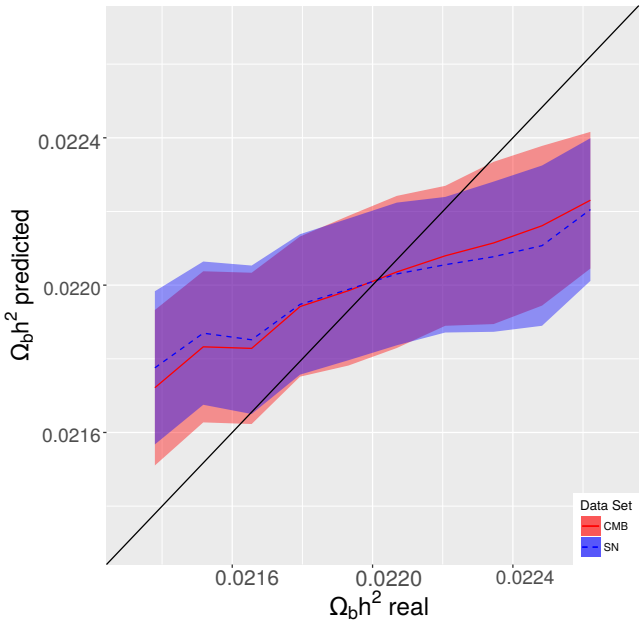
CAMB: Code for Anisotropies in the Cosmic Background (Lewis & Challinor)

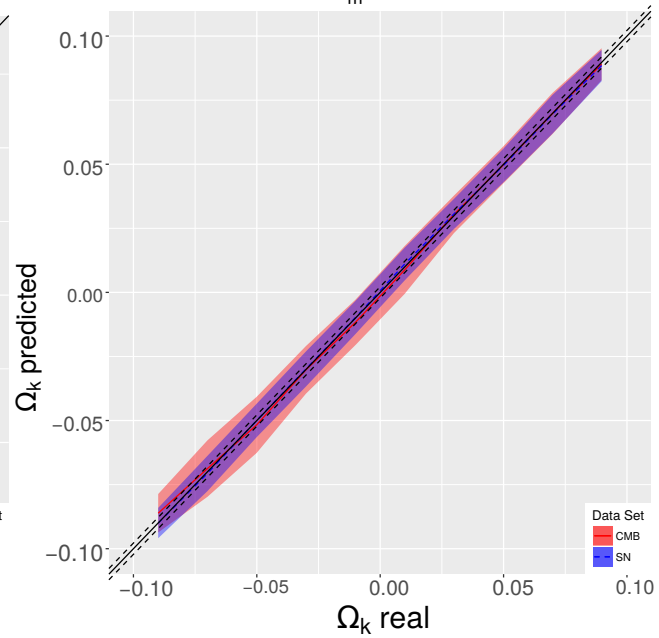
Parameter	Minimum	Maximum	Planck
$\Omega_m h^2$	0.1131	0.1263	0.1197
$\Omega_b h^2$	0.02131	0.02269	0.022
Ω_k	–0.1	0.1	0
H_0	62.31	72.31	67.31
n	0.9469	0.9841	0.9655
A_s	$1.988 * 10^{-9}$	$2.408 * 10^{-9}$	$2.198 * 10^{-9}$
τ	0.021	0.1349	0.078



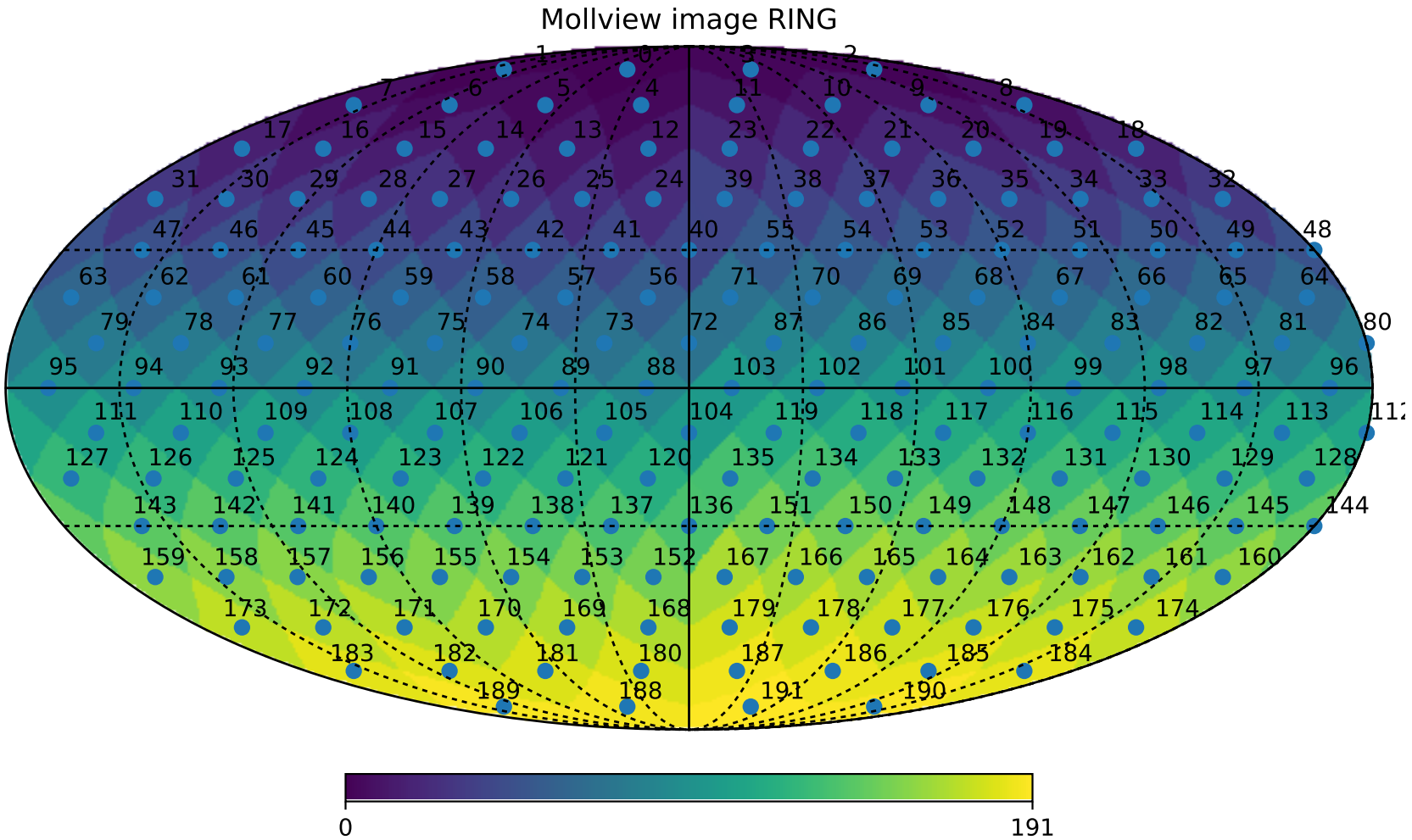

72.5
70.0
67.5
65.0
62.5
H_0 predicted
62.5
65.0
67.5
70.0
72.5
H_0 real
Data Set
CMB
SN


0.124
0.120
0.116
$\Omega_m h^2$ predicted
0.116
0.120
0.124
$\Omega_m h^2$ real
Data Set
CMB
SN

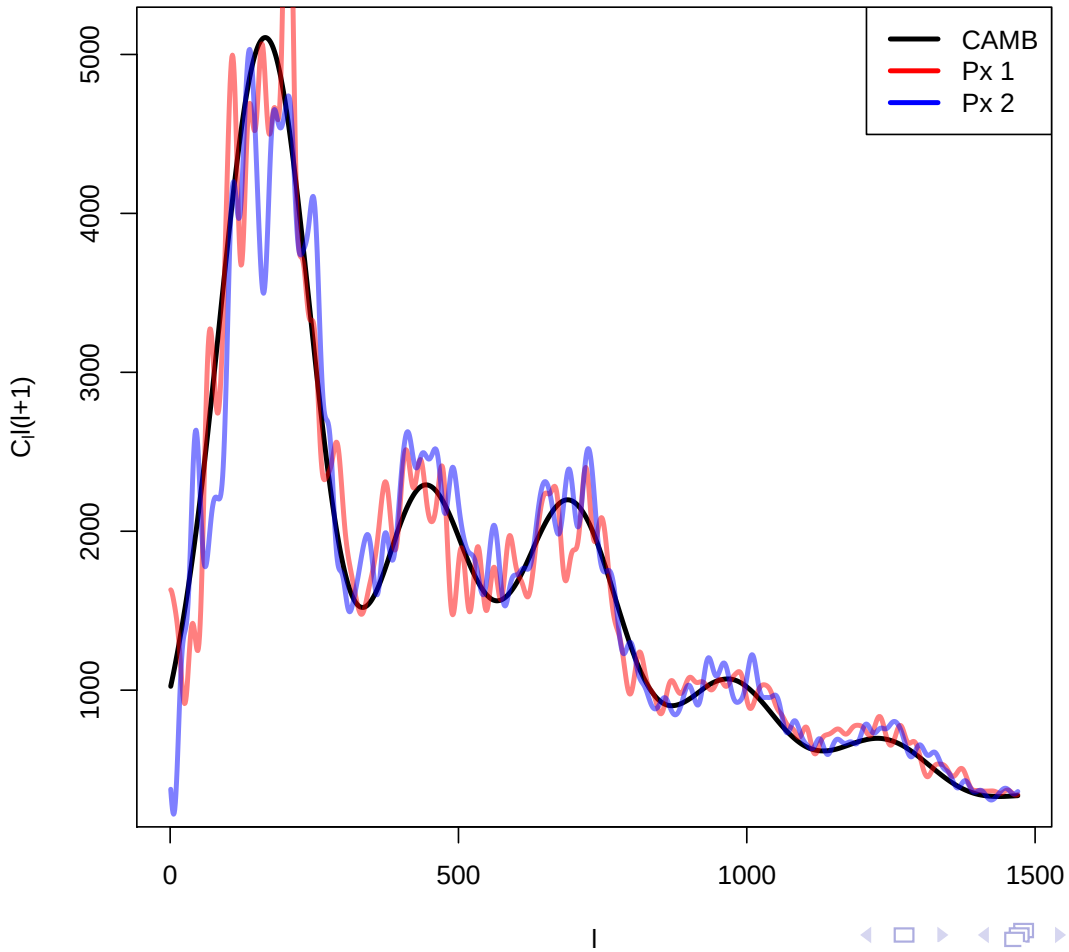

0.0224
0.0220
0.0216
$\Omega_b h^2$ predicted
0.0216
0.0220
0.0224
$\Omega_b h^2$ real
Data Set
CMB
SN


0.10
0.05
0.00
−0.05
−0.10
Ω_k predicted
−0.10
−0.05
0.00
0.05
0.10
Ω_k real
Data Set
CMB
SN

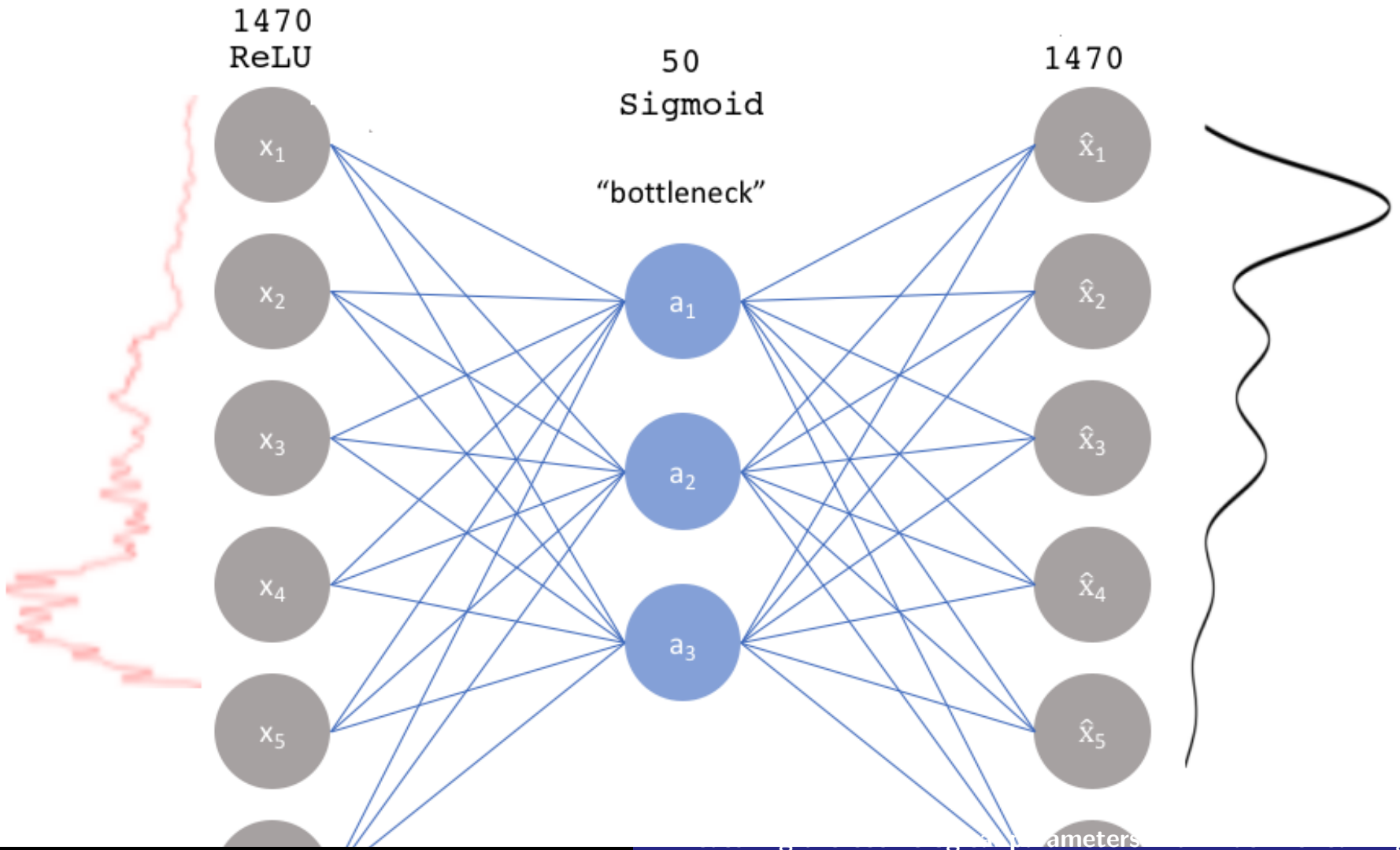
Measuring the cosmological parameters angular distributions.

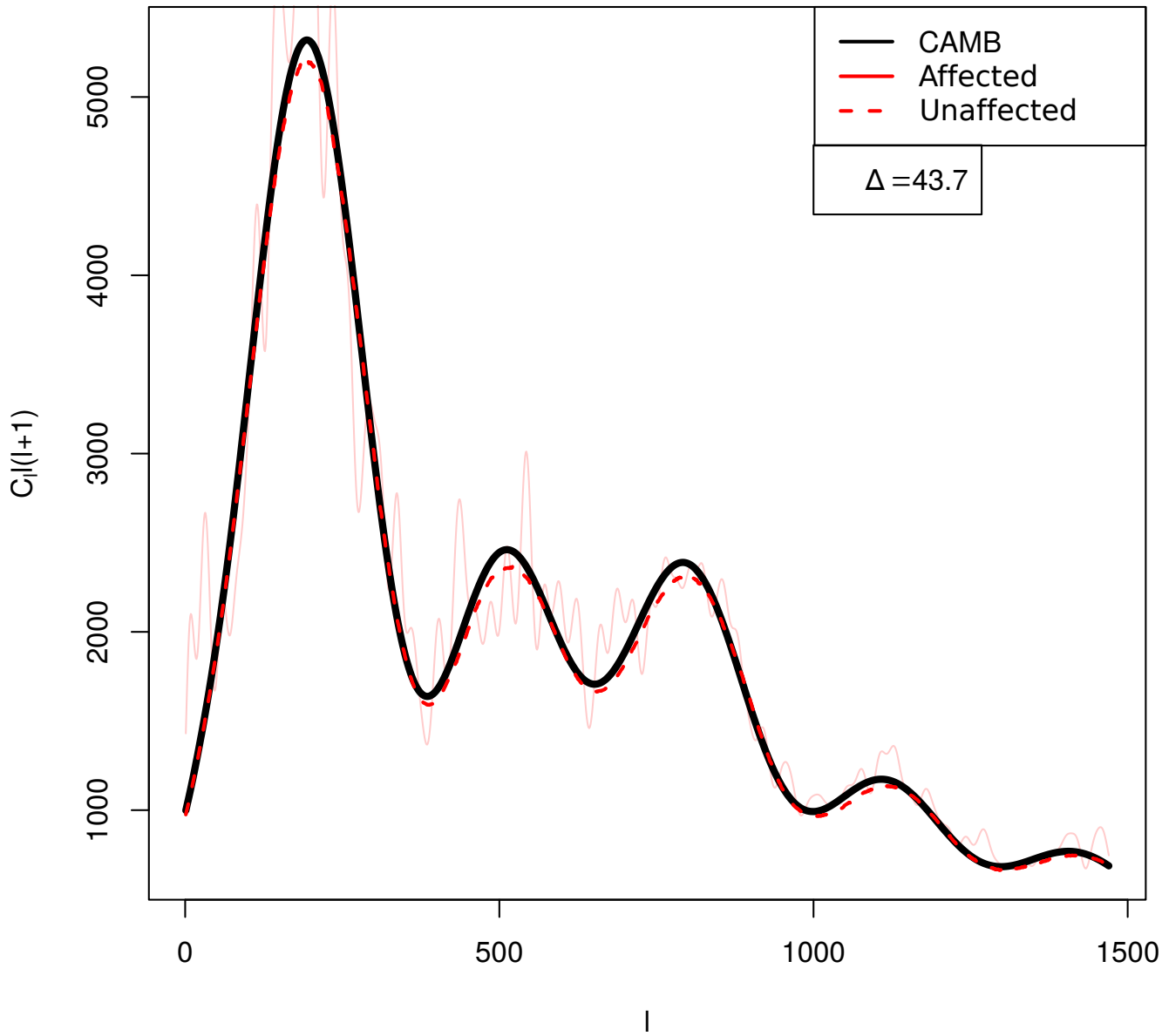


Measuring the cosmological parameters angular distributions.



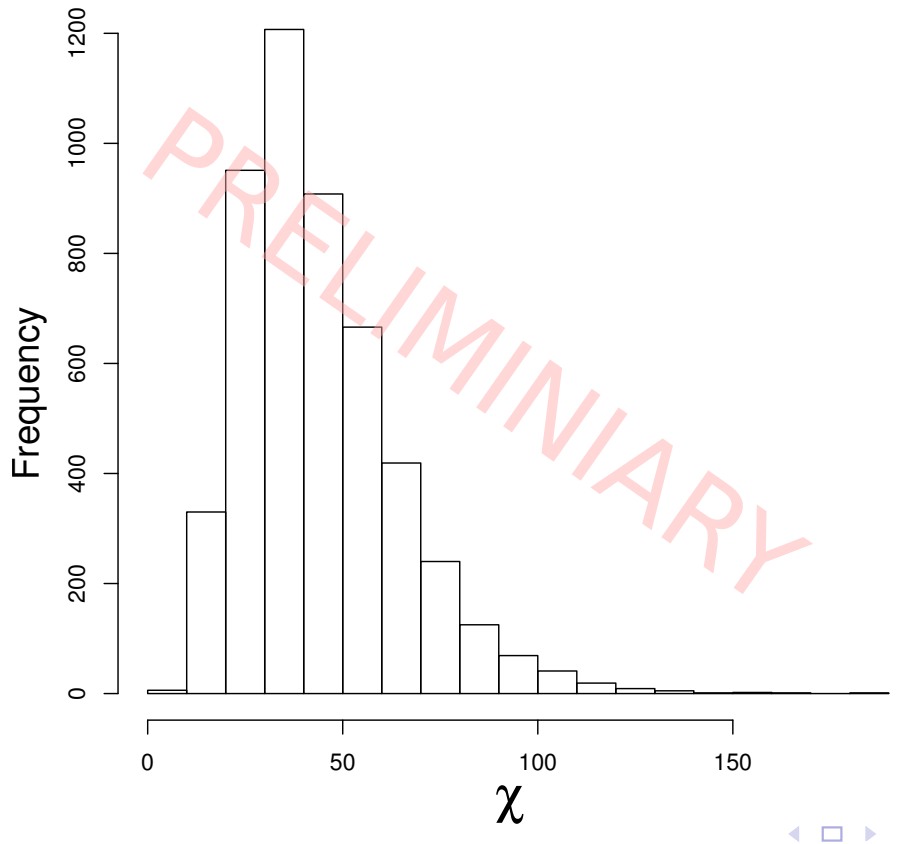
Denoising Autoencoders

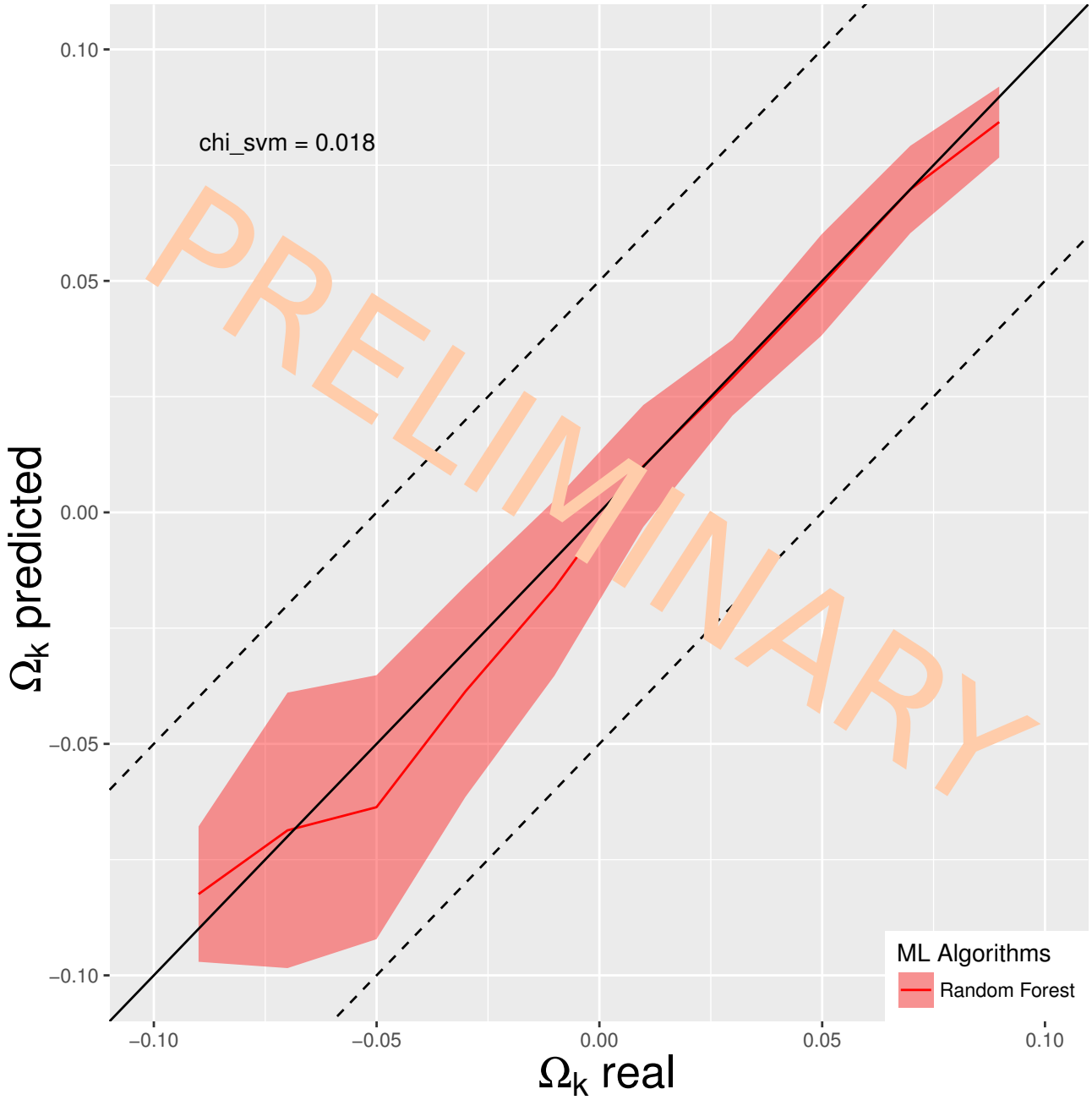


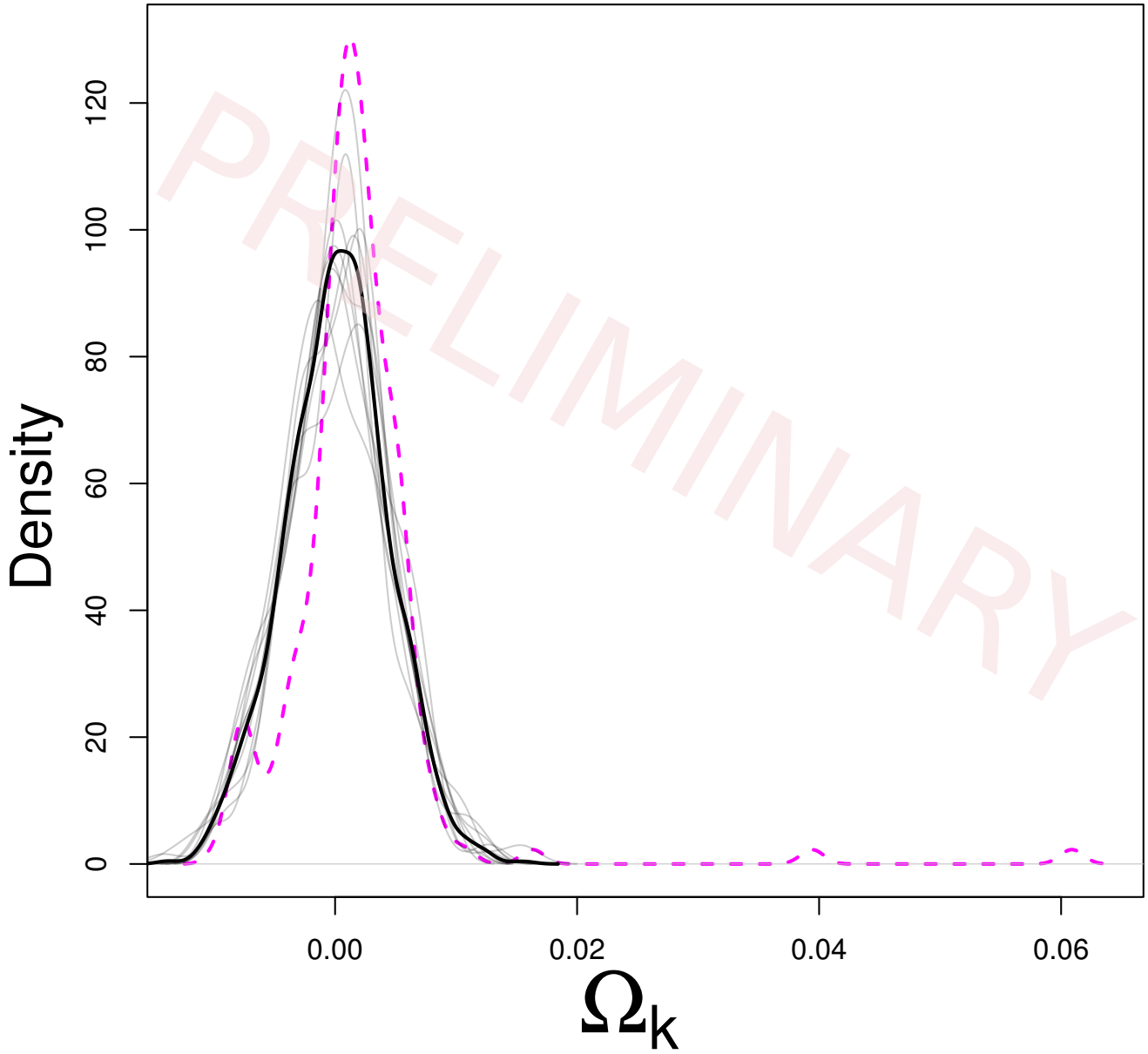

CAMB
Affected
Unaffected
Δ =43.7
$C_l(l+1)$
1000
2000
3000
4000
5000
0
500
1000
1500
l

Measuring the cosmological parameters angular distributions.

$$\chi = \frac{\sum_{i=1}^{npix} |C_{l,real} - C_{l,rec}|}{npix}$$




chi_svm = 0.018
PRELIMINARY
0.10
0.05
0.00
−0.05
−0.10
Ω_k predicted
−0.10
−0.05
0.00
0.05
0.10
Ω_k real
ML Algorithms
Random Forest


PRELIMINARY
Density
0
20
40
60
80
100
120
0.00
0.02
0.04
0.06
Ω_k

Final Remarks

- We developed a machine learning technique that estimate the cosmological parameters using CMB information.
- This technique can be easily extended to use more cosmological information as features (BAO, correlation function, SZ emission, etc.).
- As a first application we are studying the angular distribution of the cosmological parameters.
- We developed a machine learning technique that reconstructed the power spectra from pixels.
- We do not found any significant curvature departure from what is expected in an homogeneous and isotropic universe, with the exception of some pixels that are in the galactic plane.
- We will extend the parameters space and add polarization information.


THANK YOU!!

Changing the minimum mutipole.