Probing Weak Lensing Cosmology with Scattering Transform

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Scattering Transform

wavelet :

operation:

$$I' = |I \star \psi^{j,l}|$$

$J = 8, j = 0,1 \ldots, 7$

$L = 4, l = 0,1,2,3$

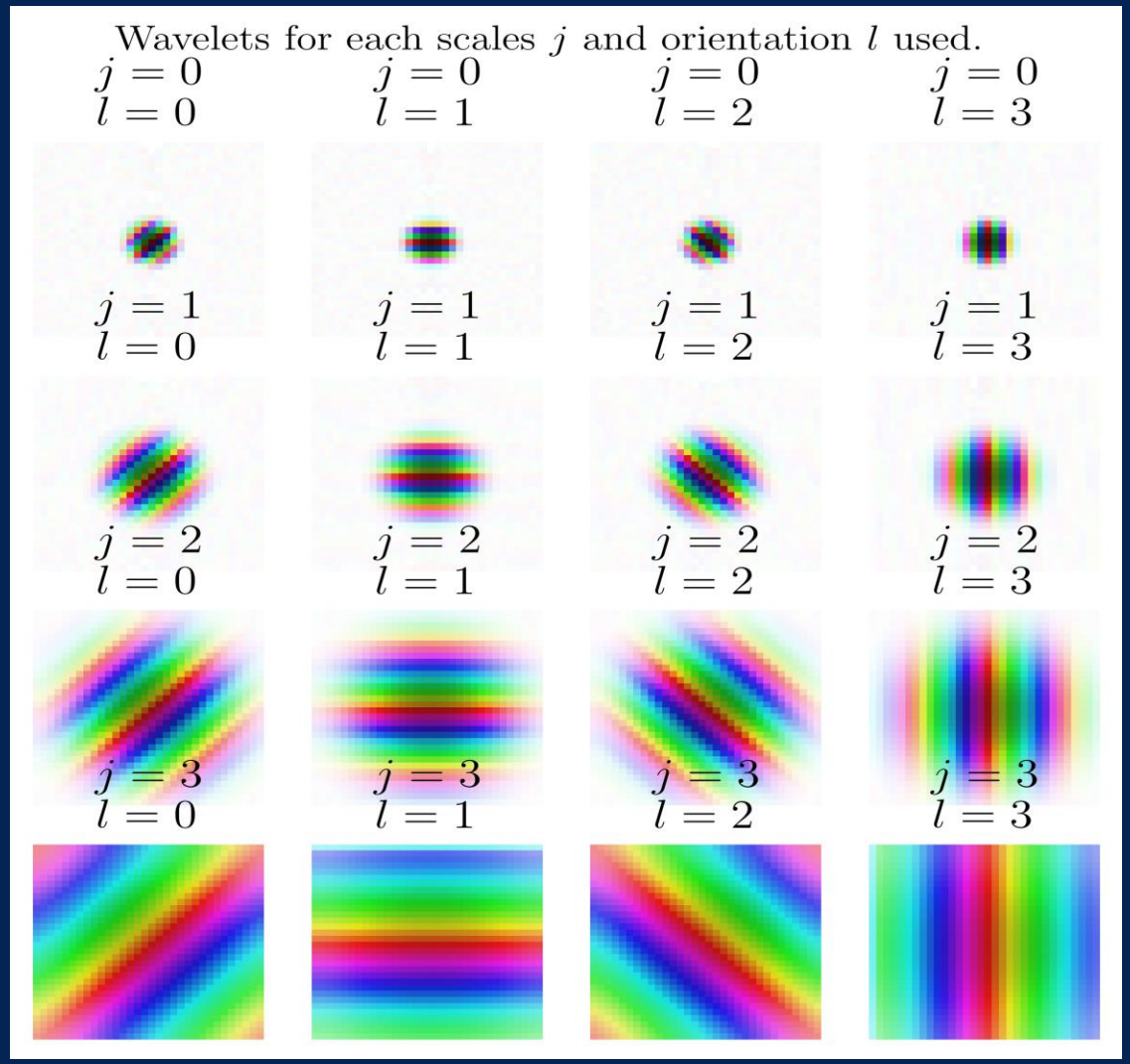
Scattering transform=

wavelet convolution

+ modulus

+ mean

- j : size (logarithmic spacing)
- l : orientation



Kymatio

Scattering Transform

Input field I_0

Coefficients: $S_0 \equiv < I_0 >$

operation:

$$I' = |I \star \psi^{j,l}|$$

Fields: $I_1 \equiv |I_0 \star \psi_1|$

Coefficients: $S_1 \equiv < I_1 >$

Scattering transform=

wavelet convolution

+ modulus

+ mean

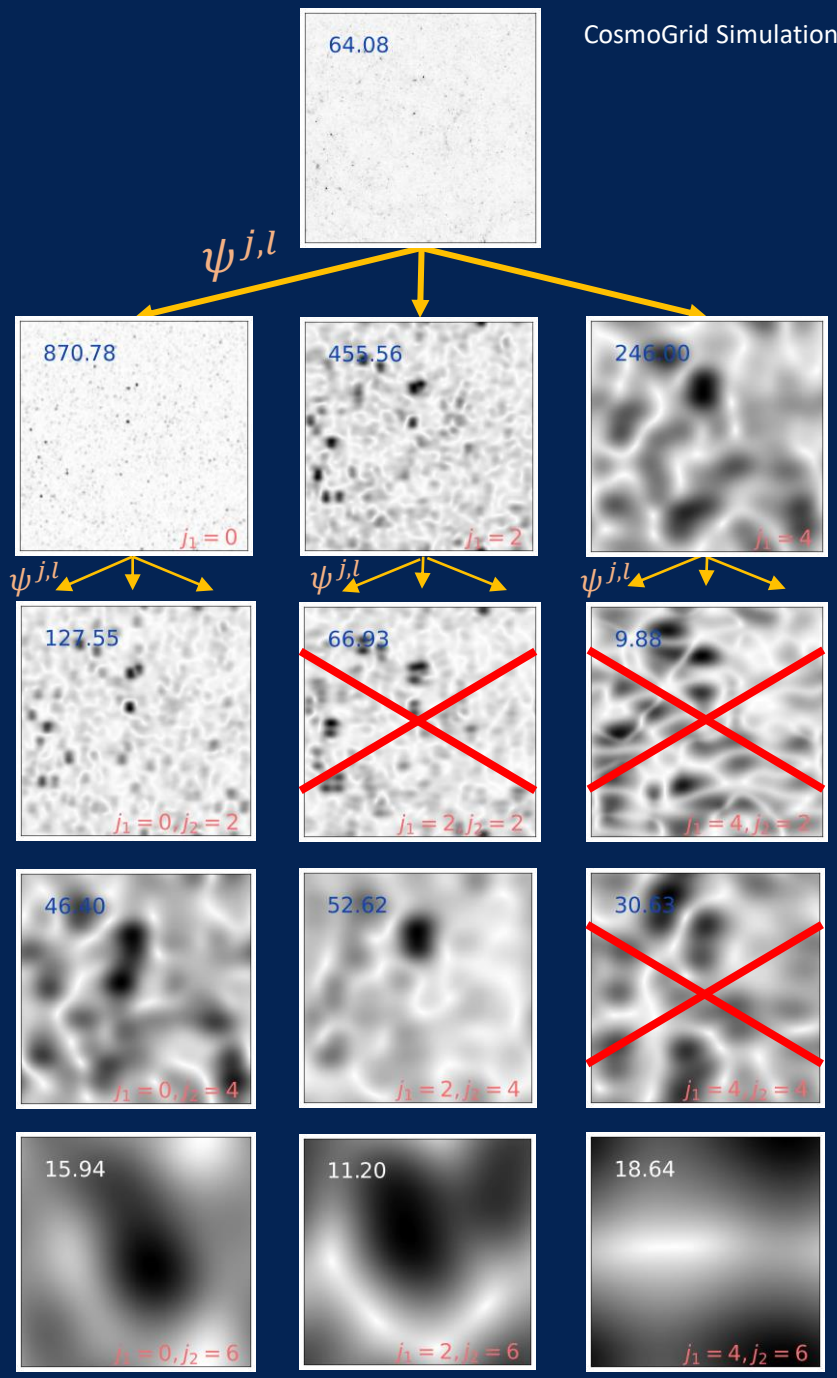
When doing second order convolution, choose filter ψ^{j_2,l_2} with $j_2 > j_1$, since structures of particular size, say j_2, do not have any meaningful

Fields $I_2 \equiv ||I_0 \star \psi_1| \star \psi_2|$

Coefficients: $S_2 \equiv < I_2 >$

(all convolved fields shown has orientation index $l_1 = 1, l_2 = 1$)

(All numbers shown are 10^6 times the real coefficients)



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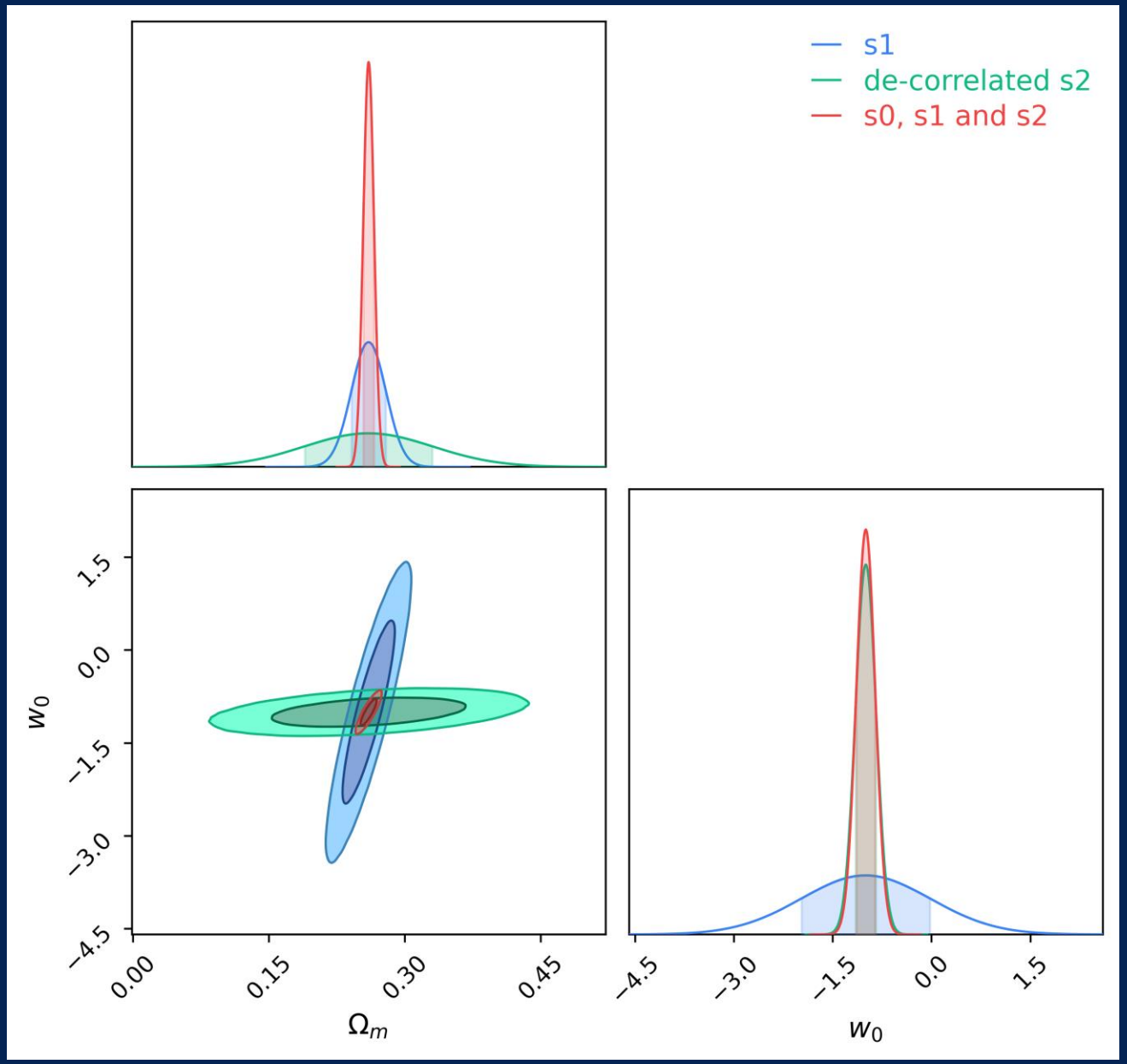
Fisher Forecast

$$s_1 \equiv <S_1^{j_1,l_1}>_{l_1}$$

$$s_2 \equiv <S_2^{j_1,l_1,j_2,l_2}>_{l_1,l_2}$$

De-correlated 2nd –order coefficients:
s_2/s_1

with a noiseless 20x20 $\deg^2$ weak lensing map



Future Work

- Emulation
  - Emulate the scattering coefficients using 2500 cosmology from CosmoGridV1 simulation set
  - A fast emulator based on Neural Network (CosmoPower, Spurio-Mancini et al 2021)

- MCMC
  - Covariance estimated from simulations at fiducial cosmology
  - Sample the posterior with the fast emulator in multi-dimensional space
  - Obtaining cosmological parameter constraints with scattering transform