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ABSTRACT

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1 COSMIC SHEAR

1.1 Power spectra

We compute the shear cross correlation between 2 tomographic bins as

$$
\begin{aligned}
C_\ell^{ij} = \langle \gamma_i \gamma_j^* \rangle =& \frac{1}{N} \int dz_{p_i} p(z_{p_i}) \int dz_{s_i} p(z_{s_i}|z_{p_i}) \mathcal{W}(z_{p_i}, z_{s_i}) \int dz_{p_j} p(z_{p_j}) \int dz_{s_j} p(z_{s_j}|z_{p_j}) \mathcal{W}(z_{p_j}, z_{s_j}) \\
& \int dz_l \frac{c}{H(z_l)} \frac{\overline{\rho}_m}{\Sigma_c(z_l, z_{s_i})} \frac{\overline{\rho}_m}{\Sigma_c(z_l, z_{s_j})} \frac{1}{f_k(\chi_l)^2} P_{mm}(z_l) \qquad (1)
\end{aligned}
$$

$$
N = \int dz_{p_i} p(z_{p_i}) \int dz_{s_i} p(z_{s_i}|z_{p_i}) \mathcal{W}(z_{p_i}, z_{s_i}) \int dz_{p_j} p(z_{p_j}) \int dz_{s_j} p(z_{s_j}|z_{p_j}) \mathcal{W}(z_{p_j}, z_{s_j}) \qquad (2)
$$

Our notation is slightly different from many lensing papers. z_{p_i} denotes the photo-z distribution for sample i, z_{s_i} denotes the true redshift for these source galaxies. $p(z_{p_i})$ is the photometric redshift distribution for these galaxies and $p(z_{s_i}|z_{p_i})$ is the distribution of true redshift for galaxies with photo-z z_{p_i}. We will use subscript l to denote quantities related to the matter (such as z_l) that is lensing the source galaxies. We use $d\chi_l = dz_l \frac{c}{H(z_l)}$, lensing weight $W_L = \frac{\overline{\rho}_m}{\Sigma_c(z_l, z_{s_2}) f_k(\chi_l)}$ where $f_k(\chi_l)$ is the transverse separation to redshift z_l. $P_{mm}(z_l)$ is the matter power spectrum at redshift z_l. We use the normalization factor N to correctly normalize the computed power spectra. $\mathcal{W}(z_{p_i}, z_{s_i})$ are the weights that are applied to the source galaxies.

SS: In the code, we assume that z_{p_i} is the true redshift for now and hence there is not integral over dz_{s_i}

1.2 Gaussian Covariance

1.2.1 Shape Noise

We begin by writing the estimator for shear-shear correlations, under the assumption that there is no cosmological signal, only the shape noise, which is un-correlated across different galaxies

$$
\langle \gamma\gamma \rangle = \frac{\sum_i \sum_j \mathcal{W}_i \mathcal{W}_j \gamma_i \gamma_j \delta_D(i,j)}{(\sum_i \mathcal{W}_i)(\sum_j \mathcal{W}_j)} \qquad (3)
$$

where the summations is carried over the galaxy samples, i, j and the dirac delta $\delta_D(i,j)$, imposes the condition that the shape noise is only correlated when γ_i, γ_j is from the same galaxy. Thus the shape noise is

$$
\begin{aligned}
\langle \gamma\gamma \rangle =& \frac{\sum_i \mathcal{W}_i \mathcal{W}_i \gamma_i^2}{(\sum_i \mathcal{W}_i)(\sum_j \mathcal{W}_j)} \qquad (4) \\
=& \sigma_e^2 \frac{\sum_i \mathcal{W}_i \mathcal{W}_i}{(\sum_i \mathcal{W}_i)(\sum_j \mathcal{W}_j)} \qquad (5) \\
=& \sigma_e^2 \frac{n}{n^2} = \frac{\sigma_e^2}{n} \qquad (6)
\end{aligned}
$$

where σ_e is the ensemble average of the ellipticities and in the last equality we assumed $W_i = 1$ to get the usual shape noise expression. We can also write the shape noise as integral over redshift distributions as

$$
\langle \gamma\gamma \rangle = \frac{\sigma_e^2}{n} \frac{\int dz_p p(z_p) \int dz_s p(z_s|z_p) W_i(z_s) W_j(z_s)}{N} \qquad (7)
$$

where N is the normalization constant defined earlier. Note that here we have assumed that $p(z_p)$ are normalized and hence we can take the number density of galaxies n outside of the integrals ($n(z_p) = np(z_p)$).

1.3 Super Sample Covariance

1.3.1 Tidal SSC

1.4 Trispectrum Covariance