Probing the (an)-isotropy of expansion with weak gravitational lensing

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Probing the late time universe

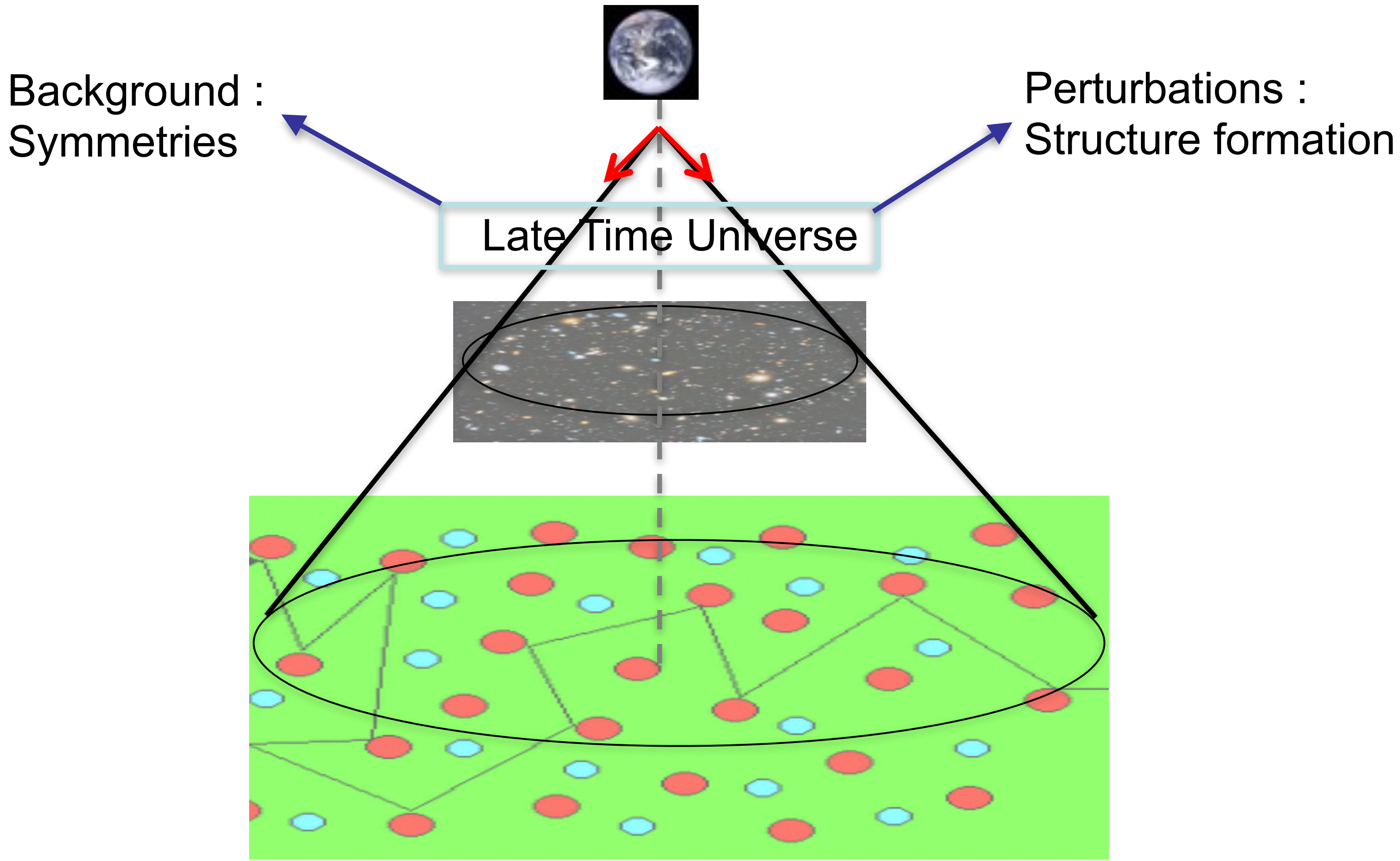
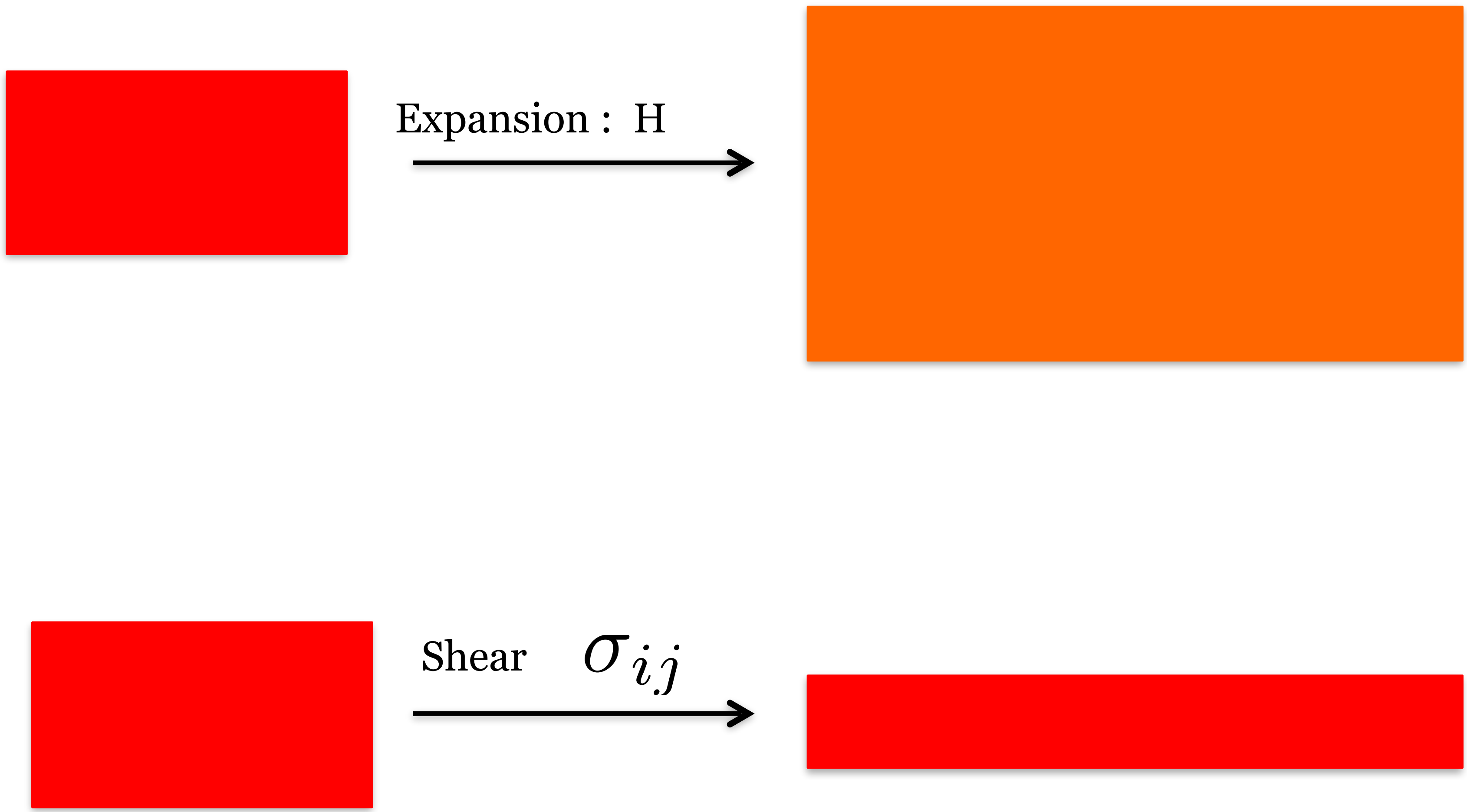


Illustration of shear and expansion

Expansion : H

Shear σ_{ij}

Illustration of shear and expansion



Shear evolution

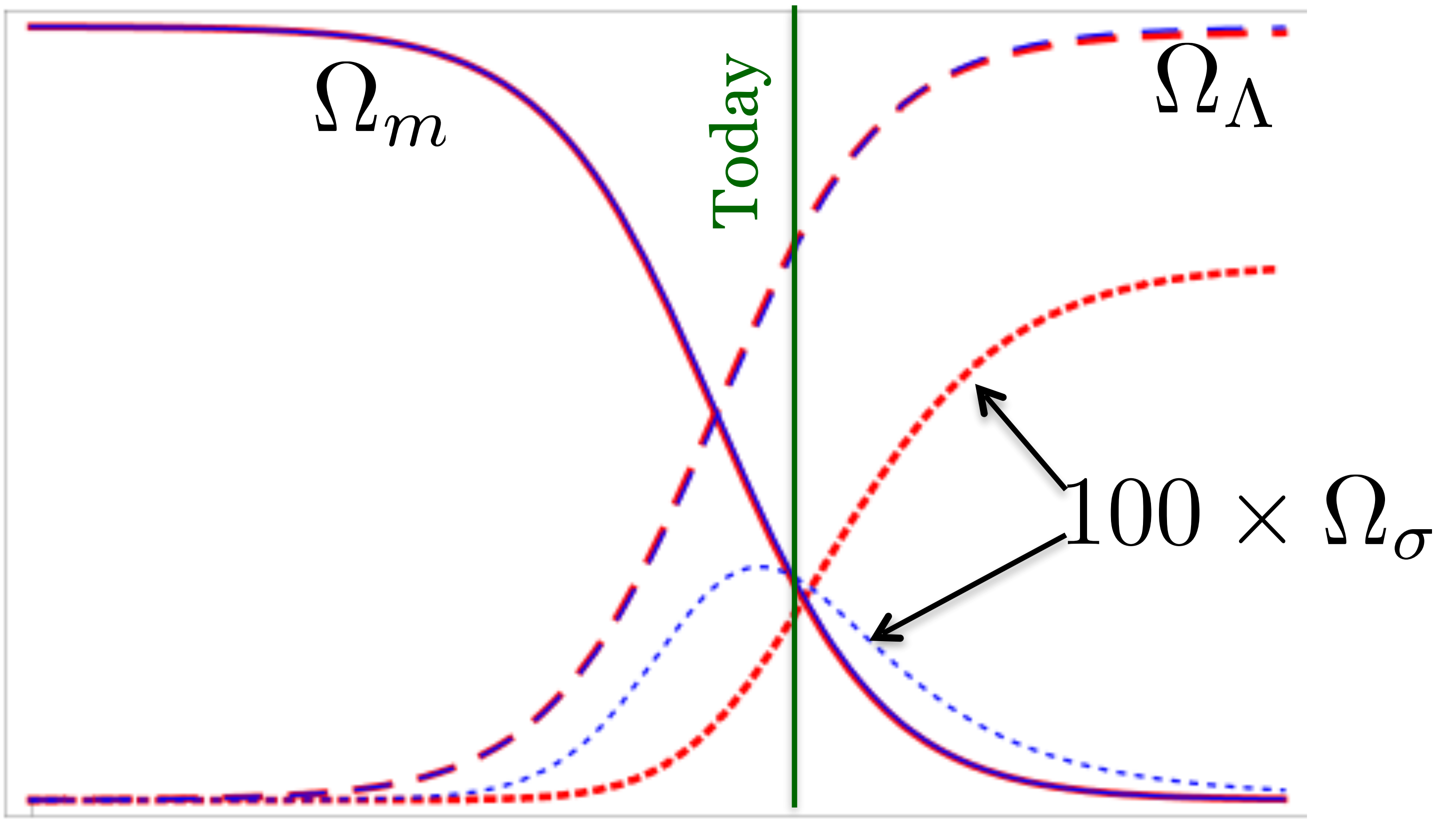
$$\sigma^2 = \sigma_{ij}\sigma^{ij}$$ Contributes as $1/a^6$

Shear effects relevant at early times (BBN, CMB)

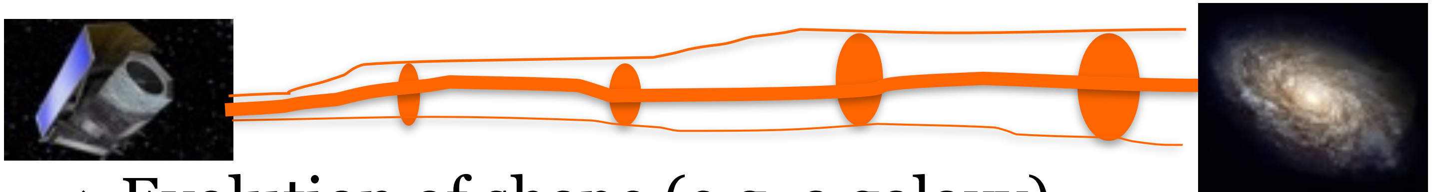
Unless there is an anisotropic stress

$$\sigma'_{ij} + 3H\sigma_{ij} = \Pi_{ij} \neq 0$$

Models of late time anisotropic-stress



Geodesic deviation (weak lensing) in FL



- Evolution of shape (e.g. a galaxy)

$$\frac{\mathrm{d}^2\mathcal{D}^a_b}{\mathrm{d}\lambda^2} = \mathcal{R}^a_c\mathcal{D}^c_b$$

Deformation Matrix

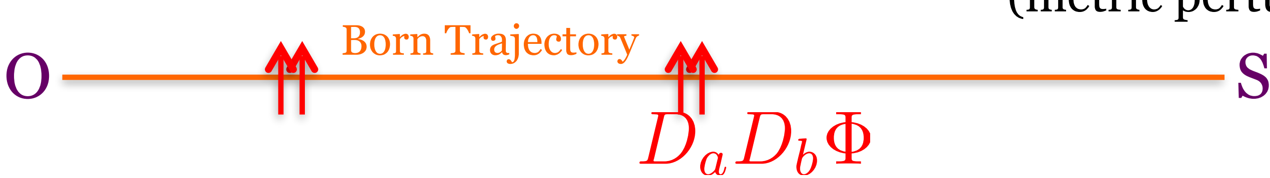
Derivative on central geodesic

Source related to curvature

- FL case : $\mathcal{R}_{ab} = 2D_aD_b\Phi$

Gradient orthogonal to line of sight

Gravitational potential (metric perturbation)

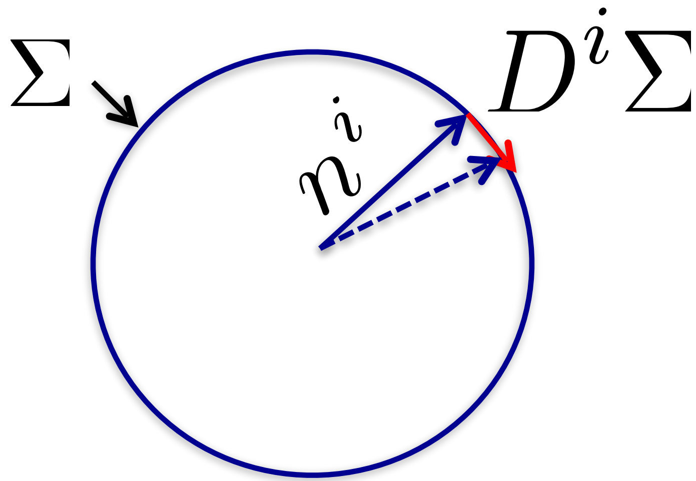


$$\gamma^{\mathrm{FL}}_{ab} \propto 2D_aD_b\Phi \quad \Rightarrow \quad \langle E_{\ell m}E_{\ell' m'}\rangle = \delta_{\ell\ell'}\delta_{mm'}C^E_\ell$$

Observation? Effects on geodesic

- Evolution of direction $\dot{n}^i = -D^i\Sigma$

Lensing Potential $$\Sigma = \frac{1}{2}\sigma_{ij}n^i n^j$$

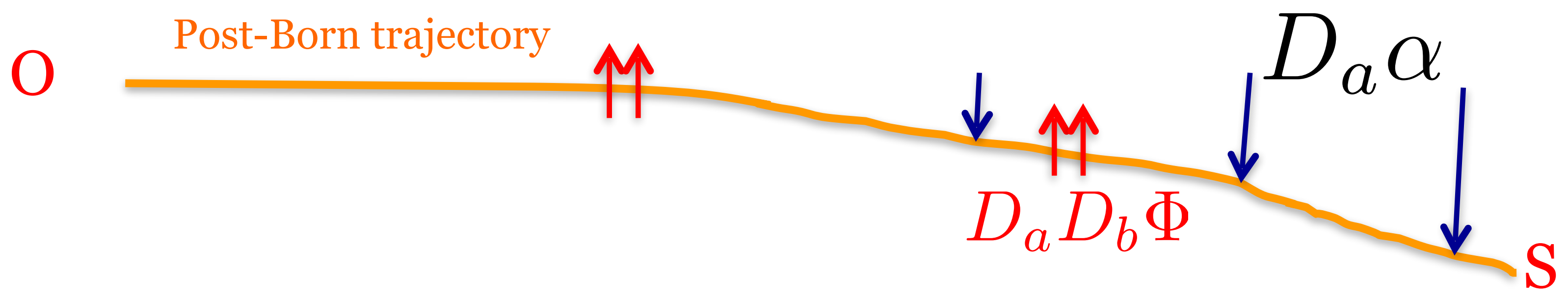


Geodesic deviation (weak lensing) with anisotropy

Anisotropic case. Dominant effect is

$$\gamma_{ab}^{\mathrm{Anis}} \propto D_c \alpha D^c \left(2 D_a D_b \Phi\right)$$

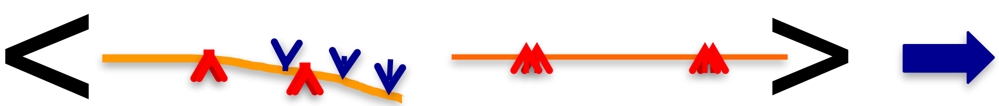
α is related to the shear



Anisotropy acts like a deflecting potential on the central geodesic

Correlations

$$\langle E_{\ell m} E_{\ell' m'} \rangle = \delta_{\ell\ell'} \delta_{mm'} C_\ell^E$$

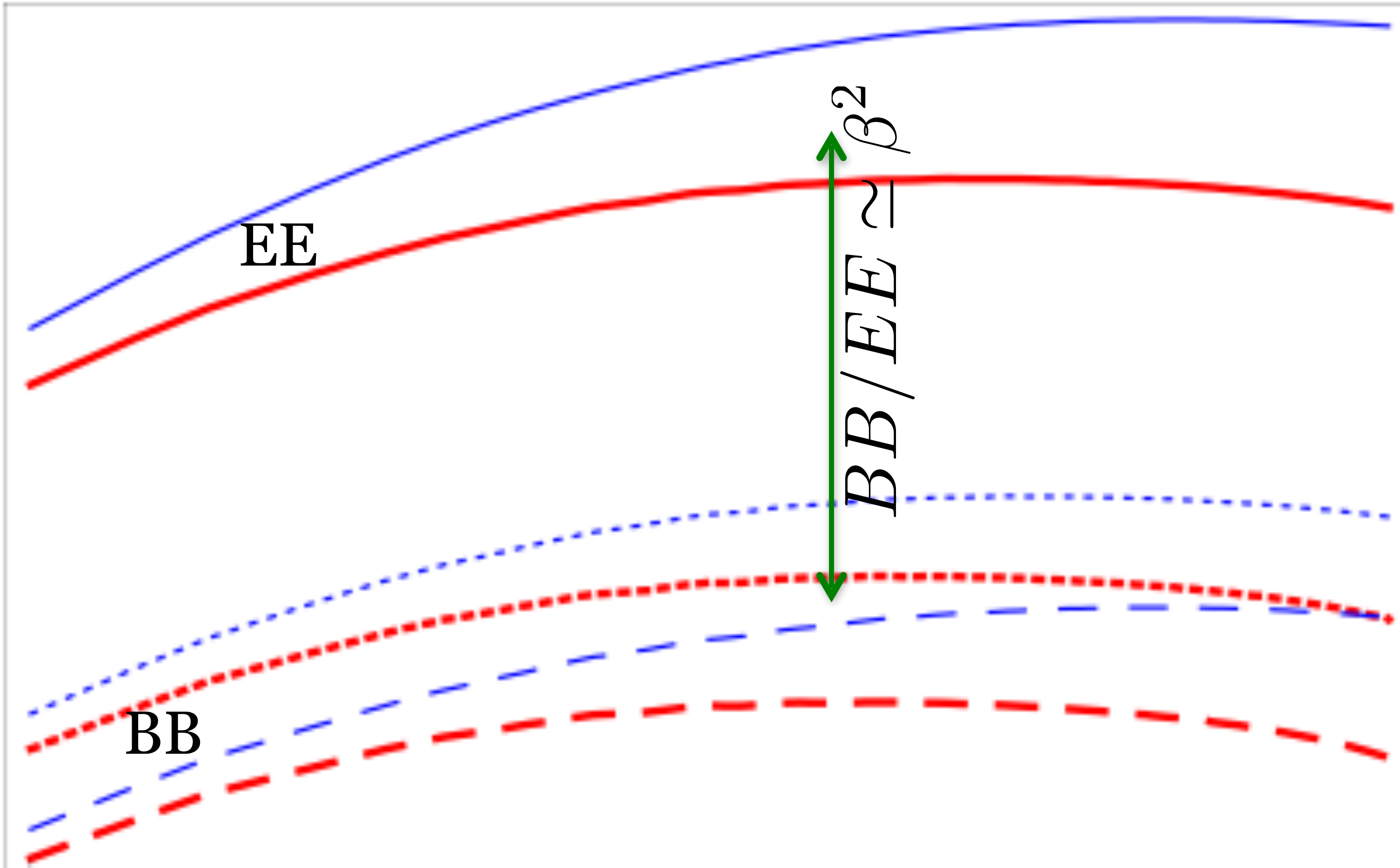


$$\langle B_{\ell m} E^\star_{\ell+1 m+M} \rangle \propto \alpha C_\ell^E$$

$$\langle B_{\ell m} B_{\ell' m'} \rangle = \delta_{\ell\ell'} \delta_{mm'} C_\ell^B$$

$$C_\ell^B \propto \alpha^2 C_\ell^E$$

BB correlations



$$C_\ell^{BB} \propto \alpha^2 C_\ell^{EE}$$