Outline

- Introduce the CMB
- What can we squeeze out of the data
- Standard techniques – MCMC
- We want cosmological parameters
- Linear data transform
- Results and comparison to MCMC
The way forward

Usually we go from a sky map
The way forward

Express anisotropy as power spectrum
Cosmological Parameters

- Compare data to theory (Bayesian)
- MCMC is the work horse standard
- Set of marginalized estimates

\[ \Theta^{LCDM} = \left\{ \Omega_c h^2, \Omega_b h^2, \Lambda, n_s, A_s, \tau \right\} \]
MCMC
Instead...

Let us apply a matrix to the data, the Cls.

\[ x = C_l = \frac{1}{2l + 1} |a_{lm}|^2 \]

Carry this operation such that locally the Fisher Matrix is unchanged.
Fisher Matrix

\[ F_{ij} = \left\langle \frac{\partial^2 L}{\partial \theta_i \partial \theta_j} \right\rangle \]

\[ F_{ij}^{CMB} = \sum_l \sum_{XX,YY} \frac{\partial C_{l}^{XX}}{\partial \theta_i} (Cov)_{ij}^{-1} \frac{\partial C_{l}^{YY}}{\partial \theta_j} \]
Key components: Covariance

\[ \text{Cov}(C_l^{TT}, C_l^{TT}) = \frac{2}{(2l + 1) f_{\text{sky}}} (C_l^{TT} + B_{T,l}^{-2})^2 \]

\[ N_l = (\sigma_c \theta_c)^2 e^{l(l+1)/l_c^2} \]
Key components: Derivatives
How well can we recover the Fisher Matrix?
Recovering the Fisher Matrix

Ratio of full Fisher Matrix to model Fisher Matrix

\( \Lambda \)

\( F_{\text{CMB}} \)
Let’s use these on some data
We need some data: Mocks!

\[ a^T_{lm} = \sqrt{C^T_{lTT} + N^T_{lTT}} \ g_{lm} \]

\[ a^E_{lm} = \frac{C^E_{lTT}}{C^T_{lTT} + N^T_{lTT}} \sqrt{C^T_{lTT} + N_{lTT}} \ g_{lm} + \sqrt{(C^E_{lEE} + N^E_{lEE}) - \frac{(C^E_{lTE})^2}{(C^T_{lTT} + N^T_{lTT})}} \]

\[ C^T_{lTT} = \frac{1}{2l+1} \sum_{m=-l}^{m=l} \langle a^*_{lm} a^T_{lm} \rangle \]

\[ C^E_{lEE} = \frac{1}{2l+1} \sum_{m=-l}^{m=l} \langle a^*_{lm} a^E_{lm} \rangle \]

\[ C^T_{lTE} = \frac{1}{2l+1} \sum_{m=-l}^{m=l} \langle a^*_{lm} a^T_{lm} \rangle \]

\[ g_{lm} = \frac{1}{\sqrt{2}} (a + ib) \]

\[ h_{lm} = \frac{1}{\sqrt{2}} (c + id) \]
How well can we recover a single parameter?
1D marginalised Likelihood from TT data only
1D marginalised Likelihood from TT data only

\[ \Omega_{b} h^2 \]
1D marginalised Likelihood from TT data only
Chalk Talk
2D Results
This is the End... for now!