Effects of the local features in initial power spectrum on baryon acoustic oscillations

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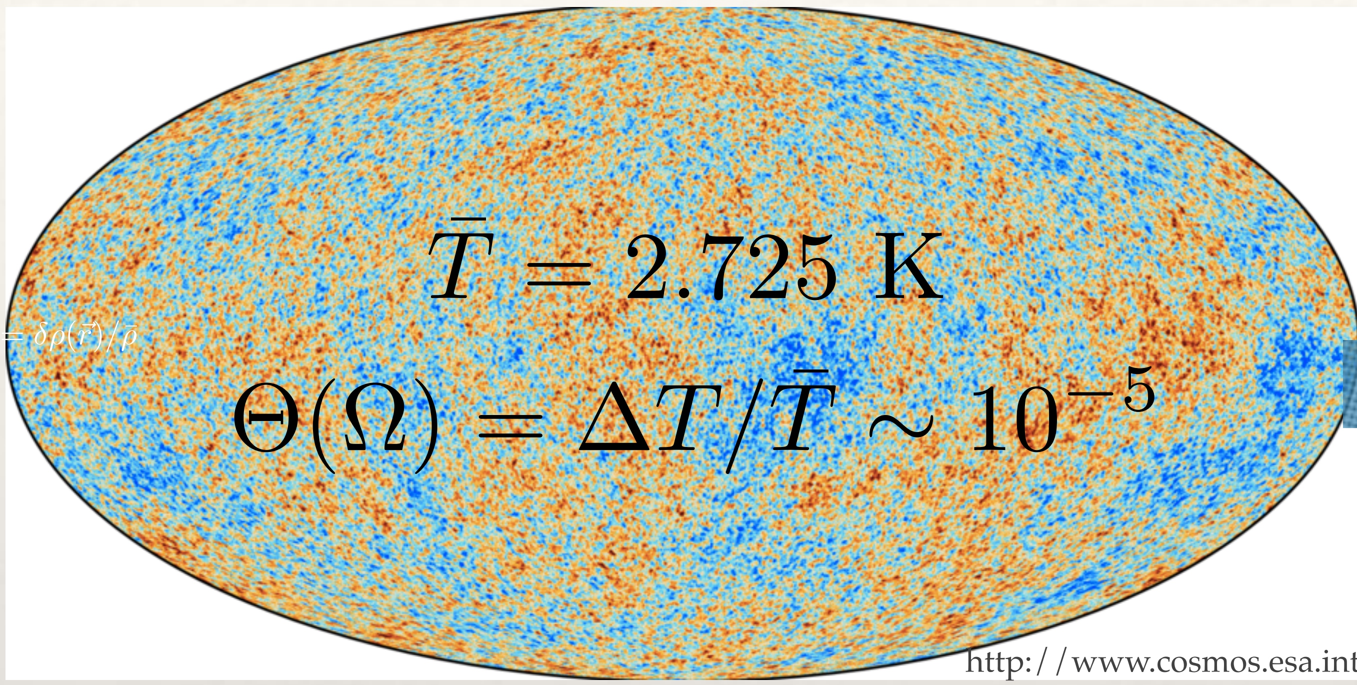
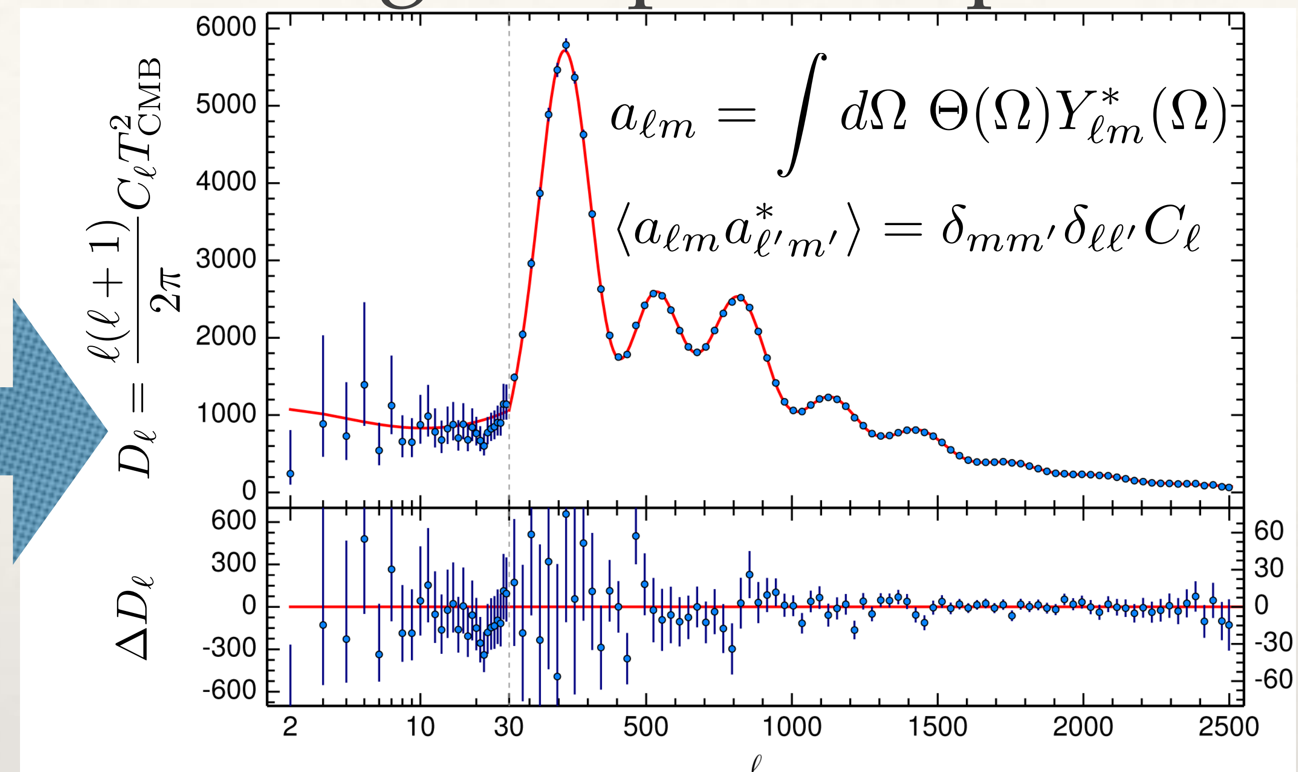
CMB vs BAO

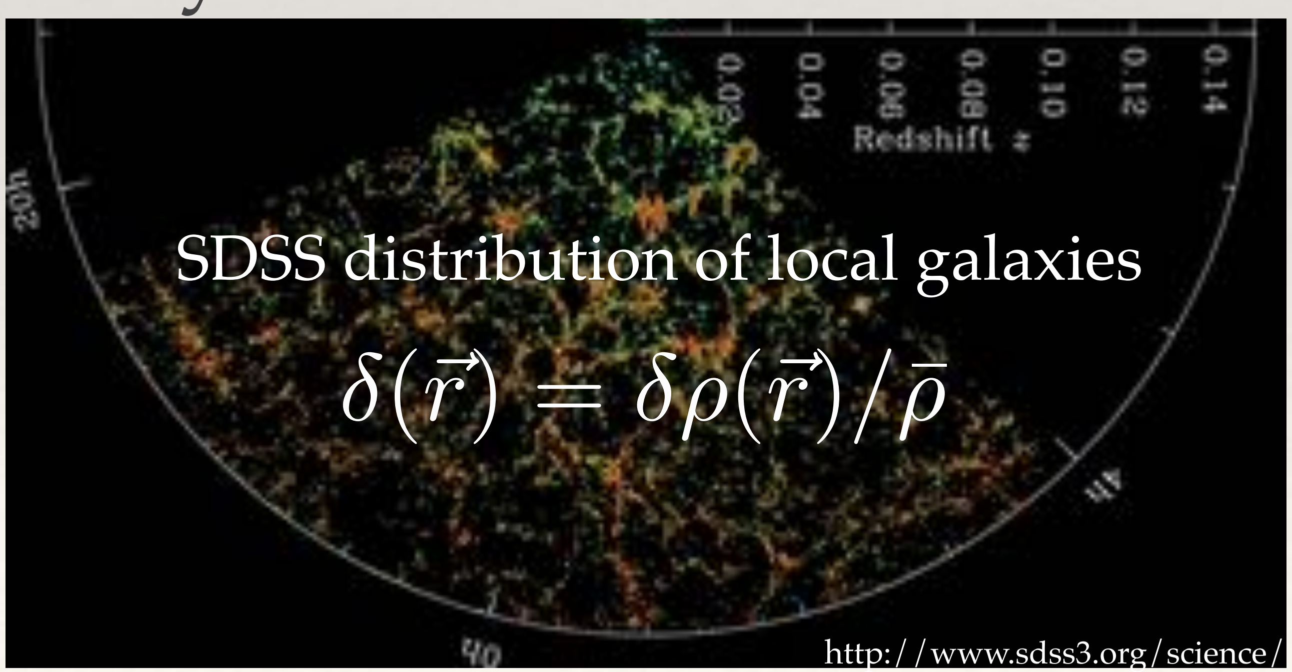
Cosmic Microwave Background



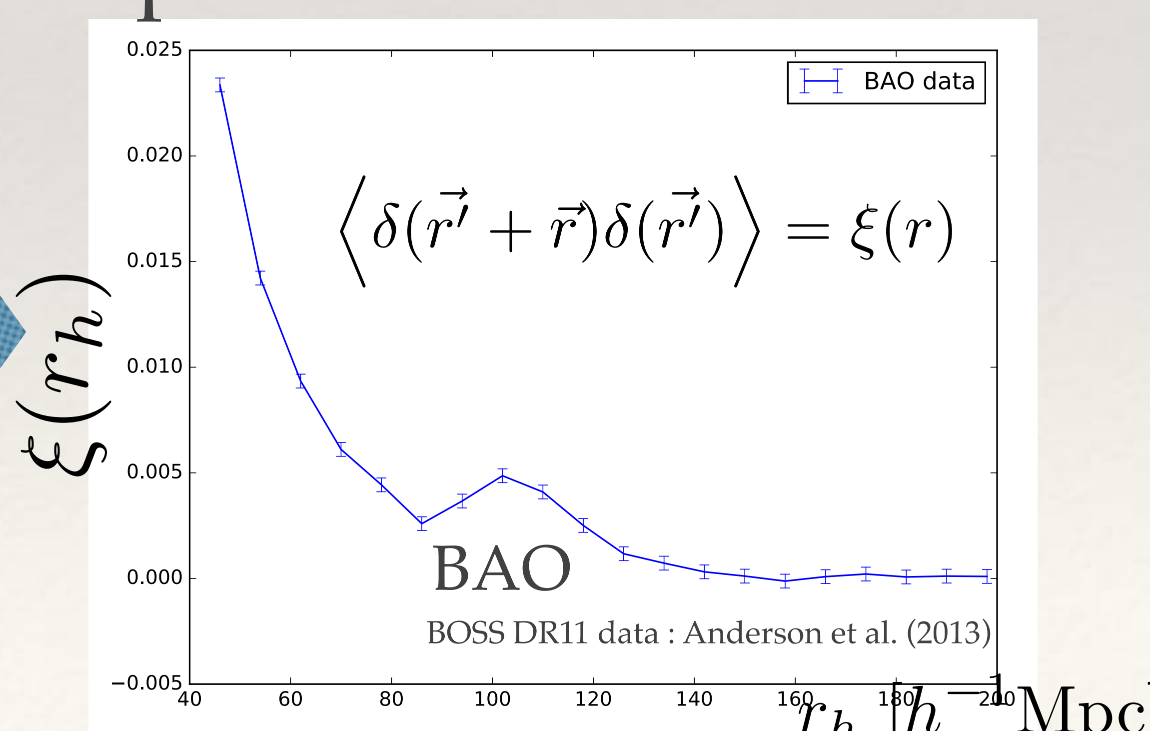
CMB angular power spectrum



Baryon Acoustic Oscillations

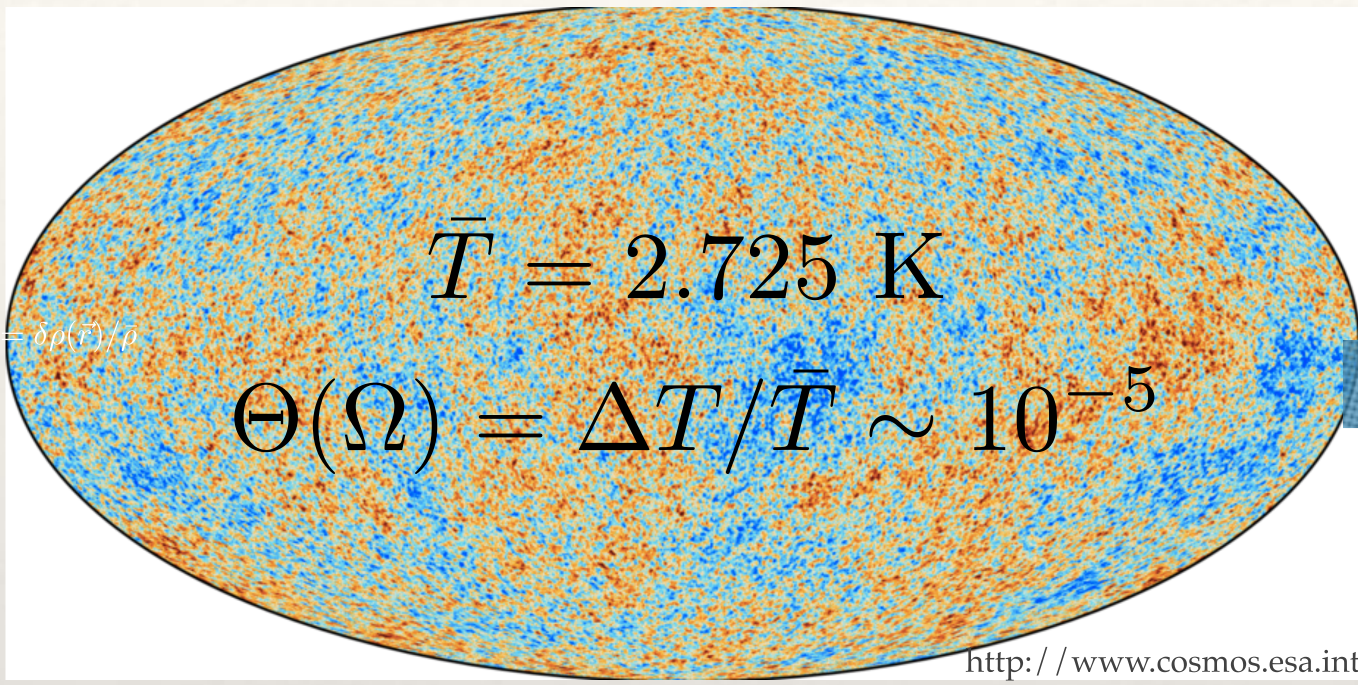


Two points correlation function

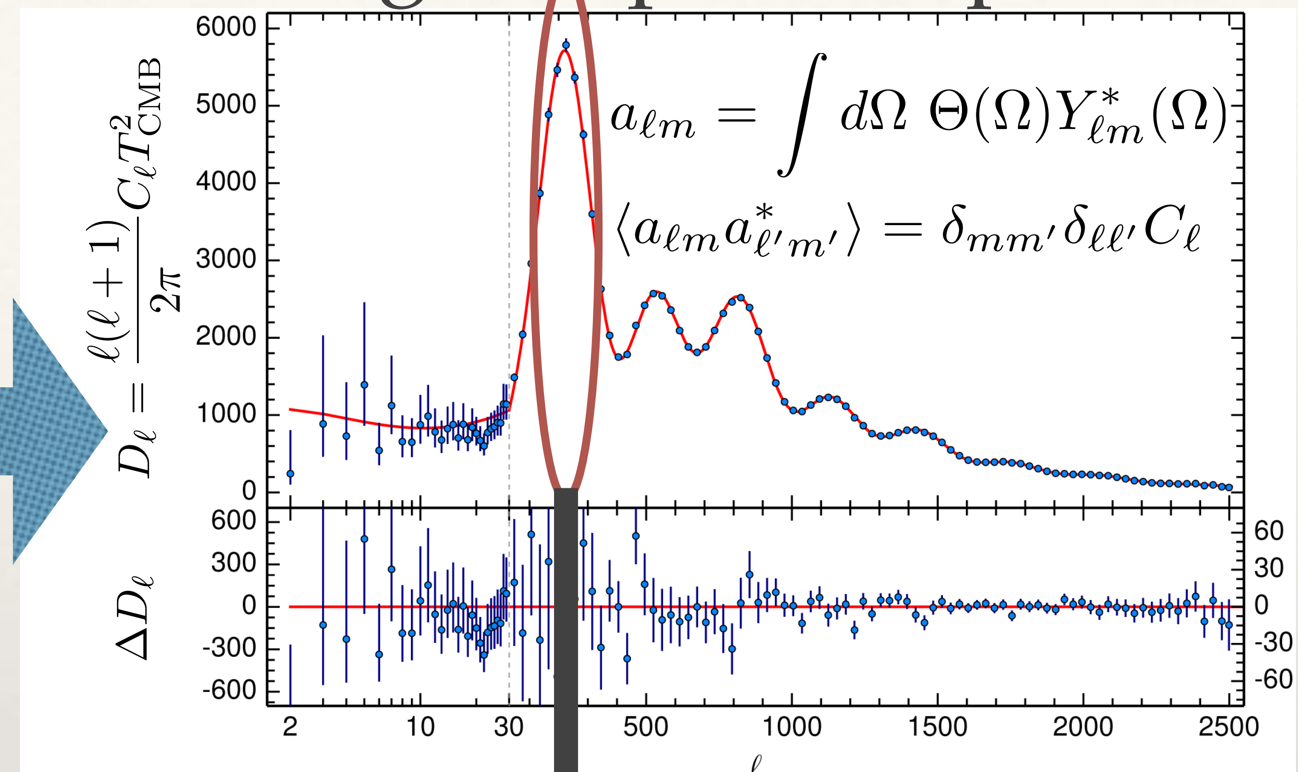


CMB vs BAO

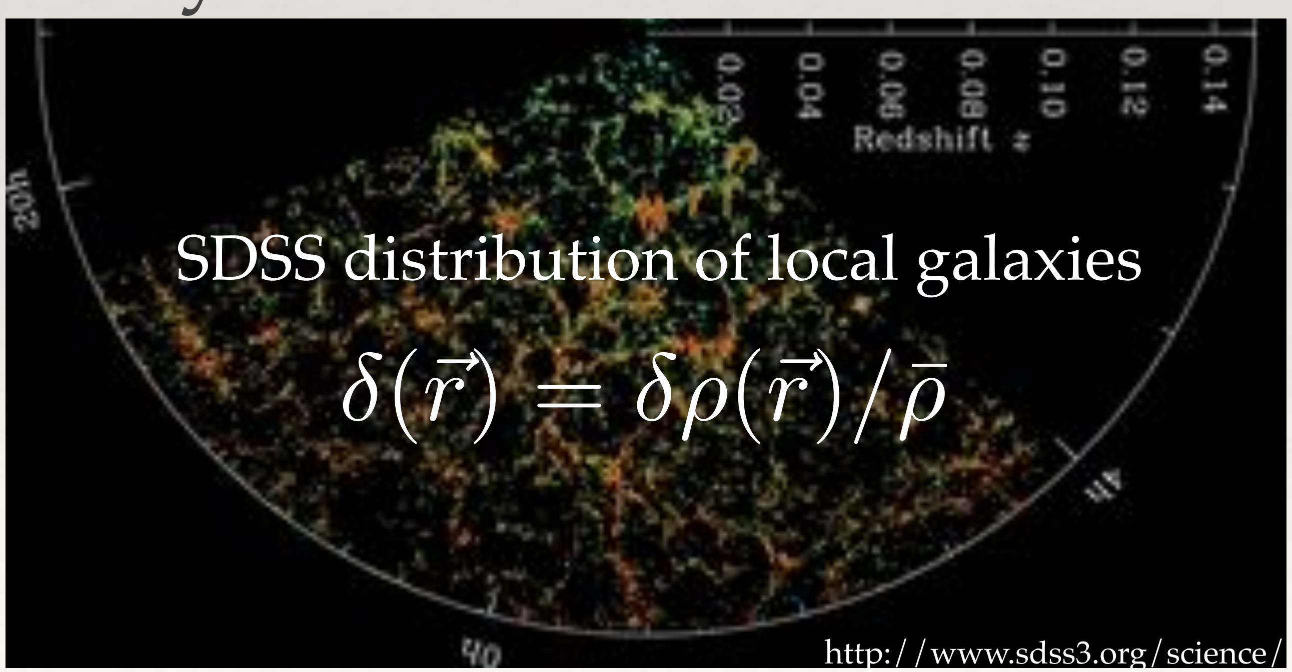
Cosmic Microwave Background



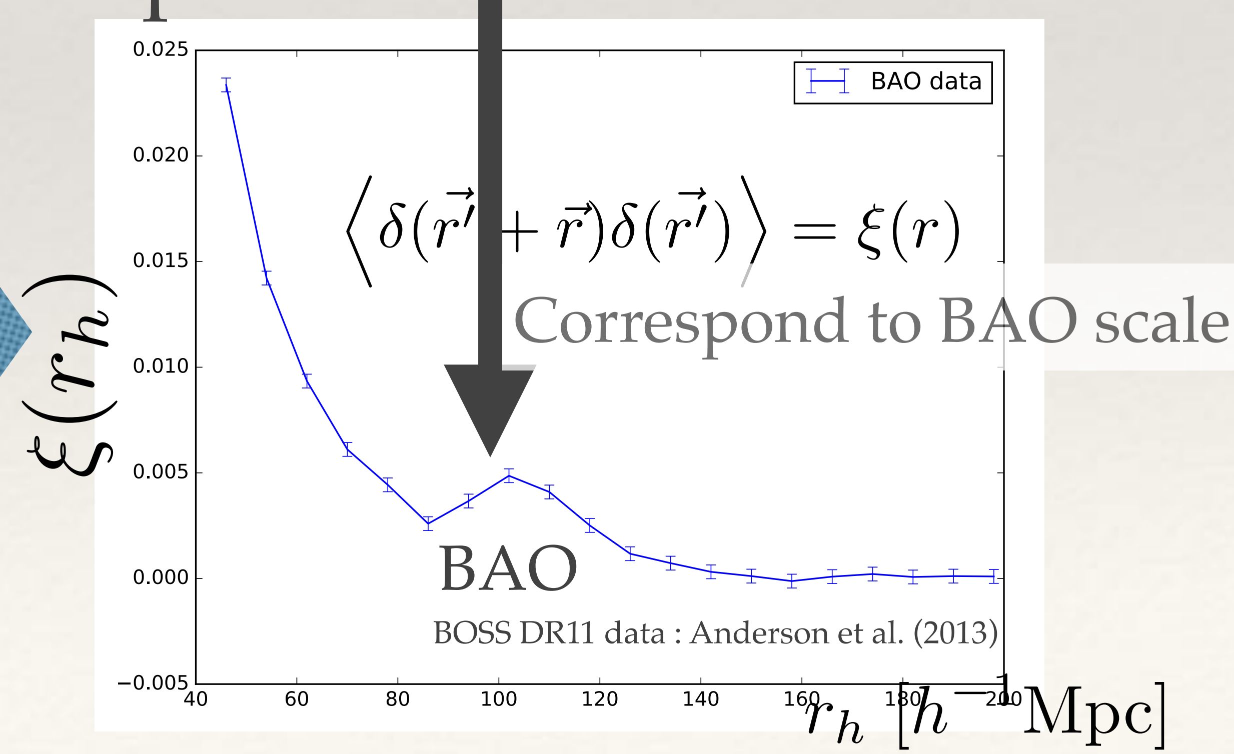
CMB angular power spectrum



Baryon Acoustic Oscillations

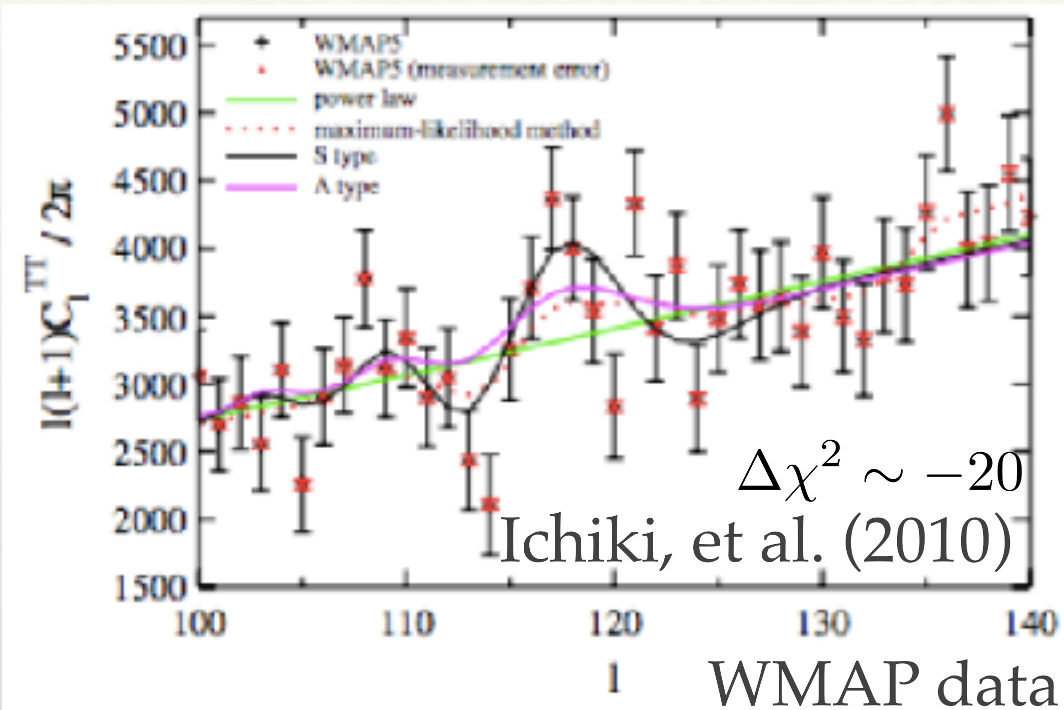


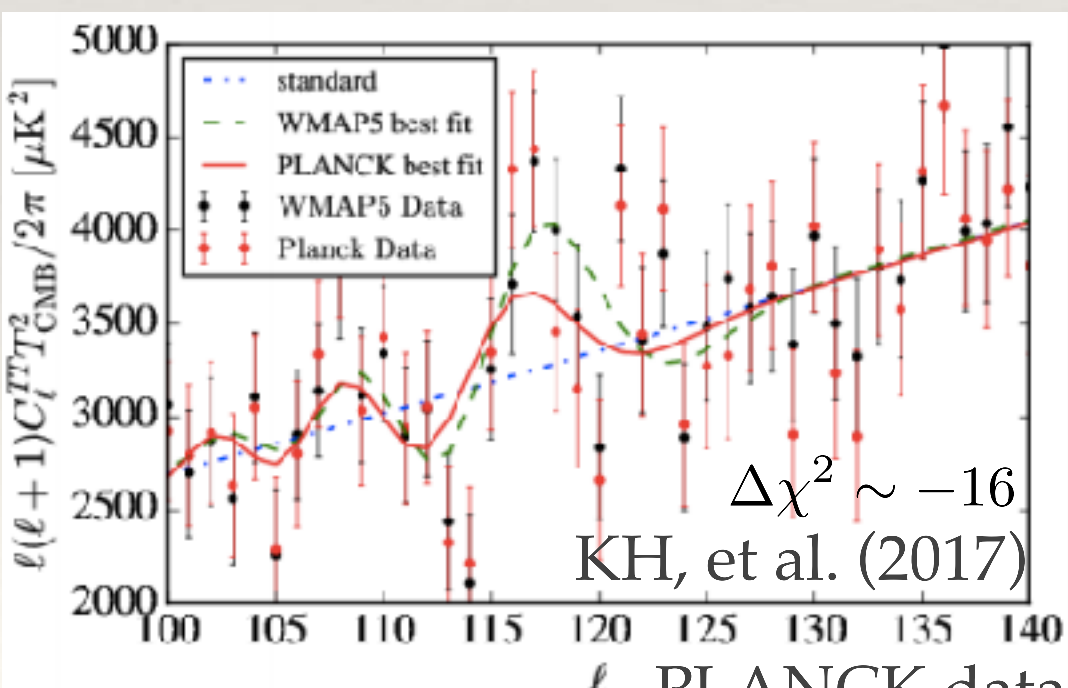
Two points correlation function



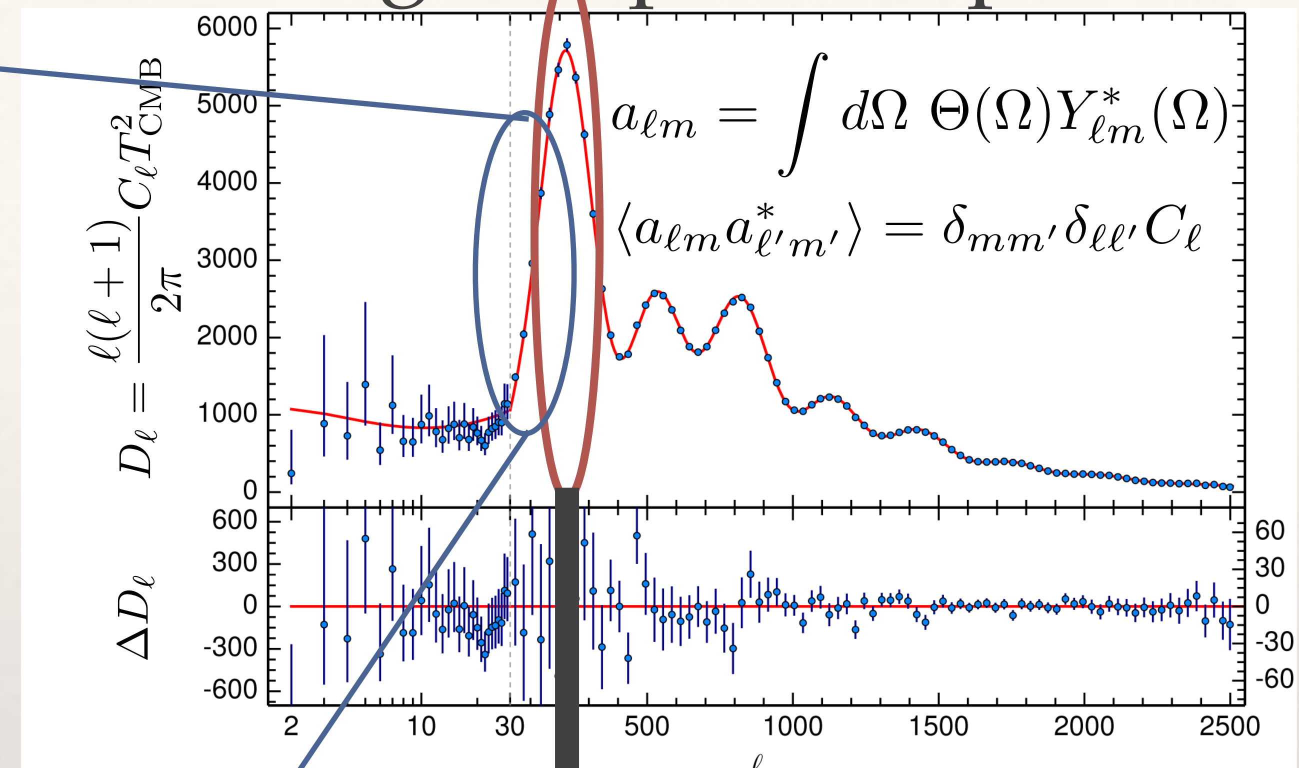
CMB vs BAO

Features at $\ell \sim 120$

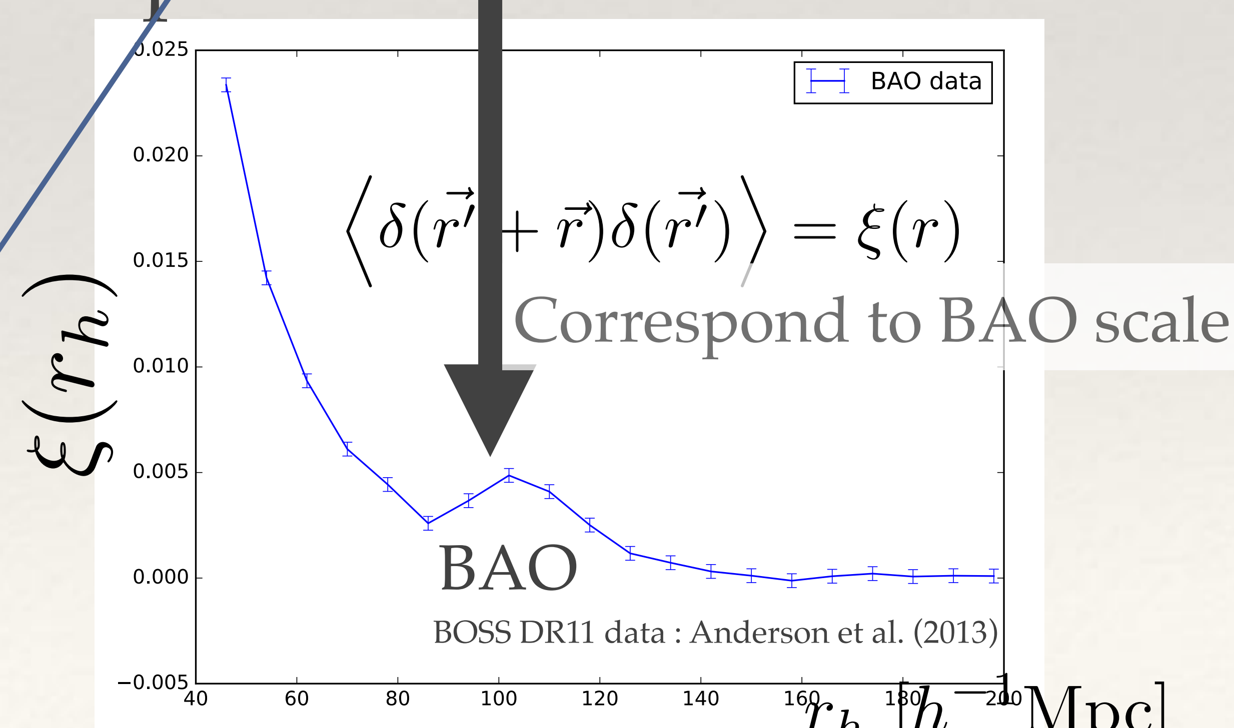




CMB angular power spectrum

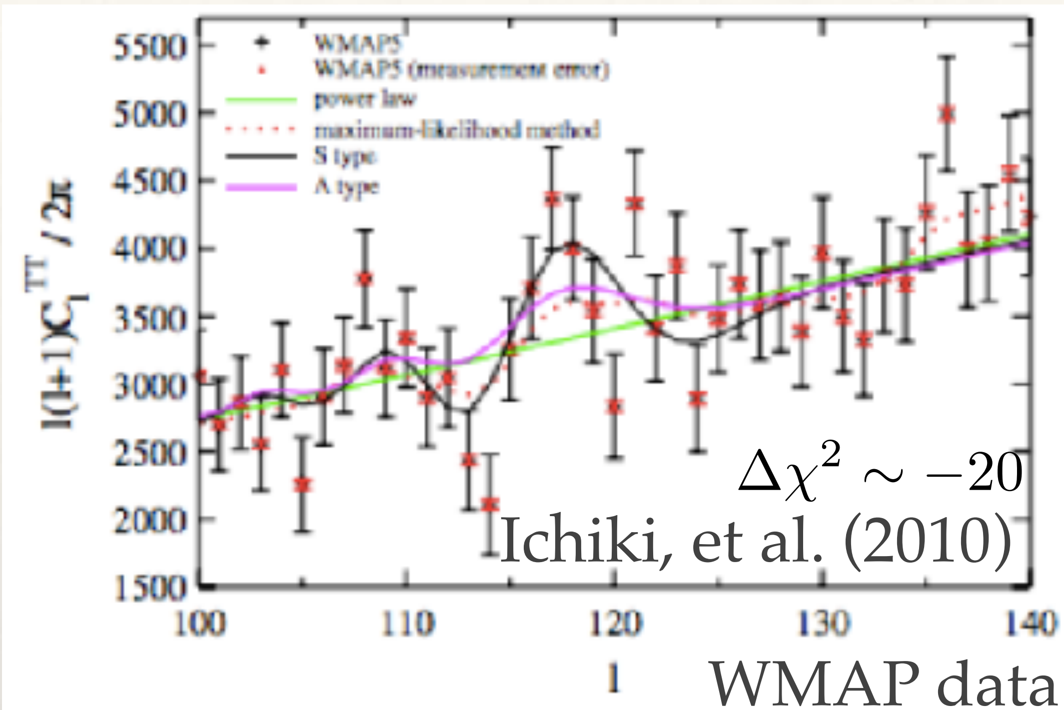


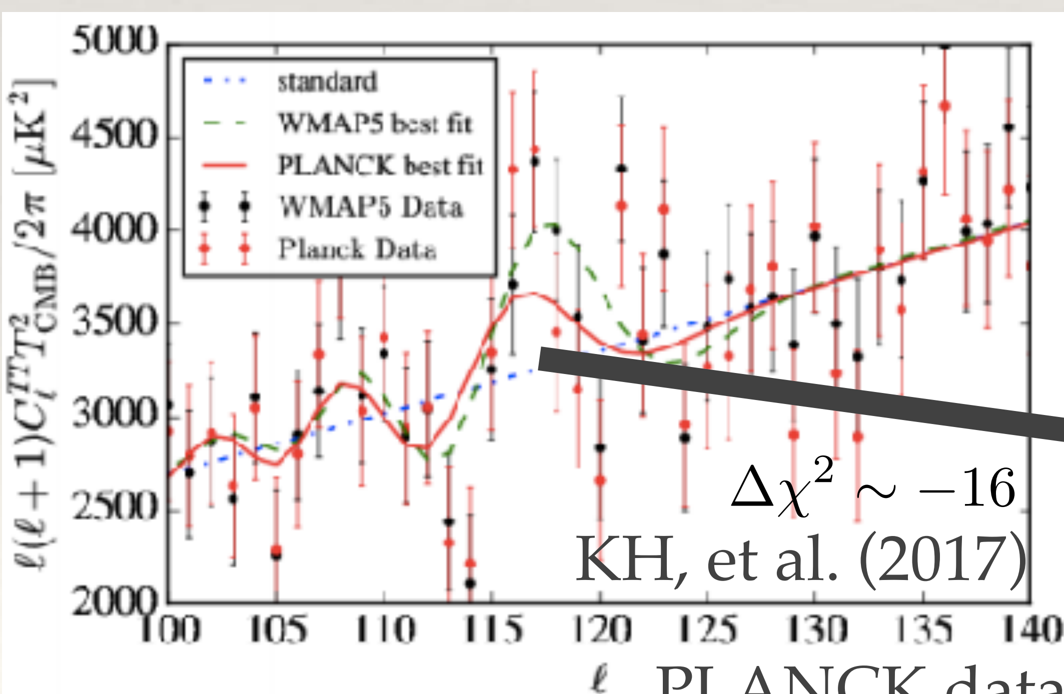
Two points correlation function



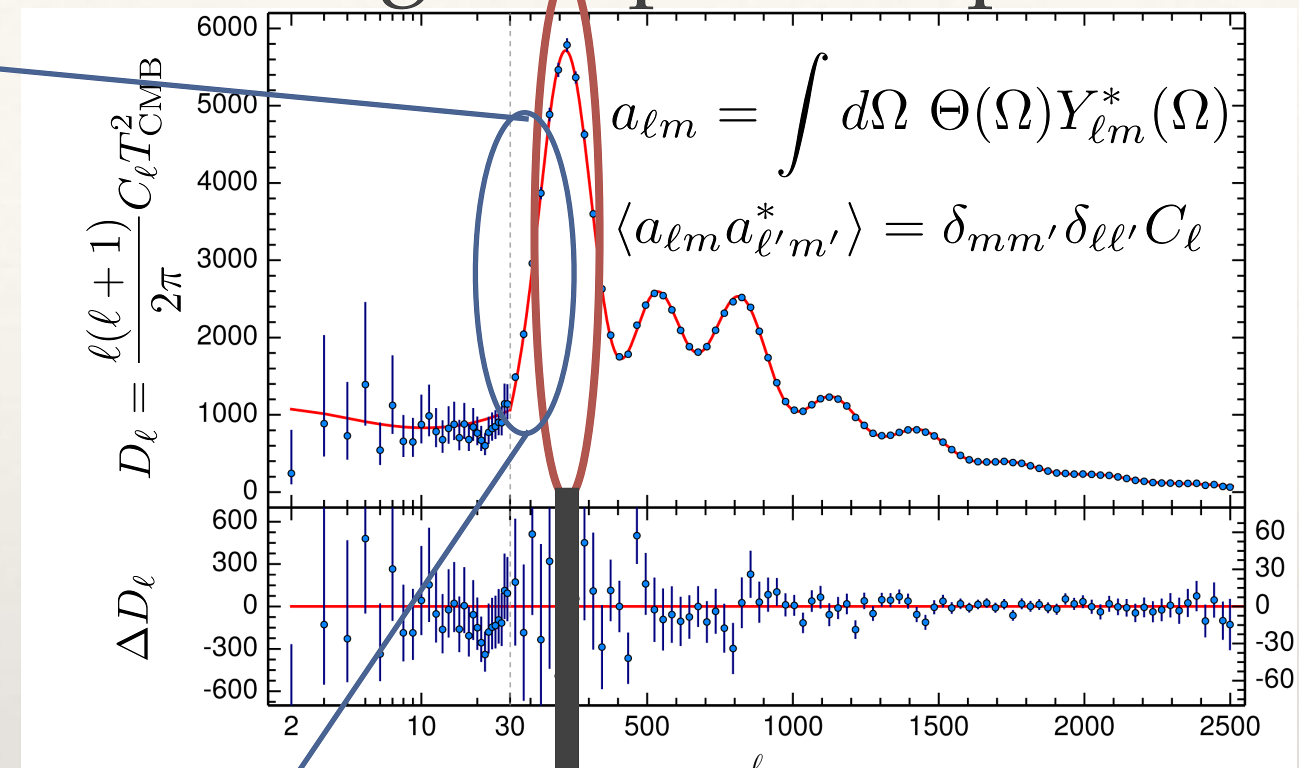
CMB vs BAO

Features at $\ell \sim 120$

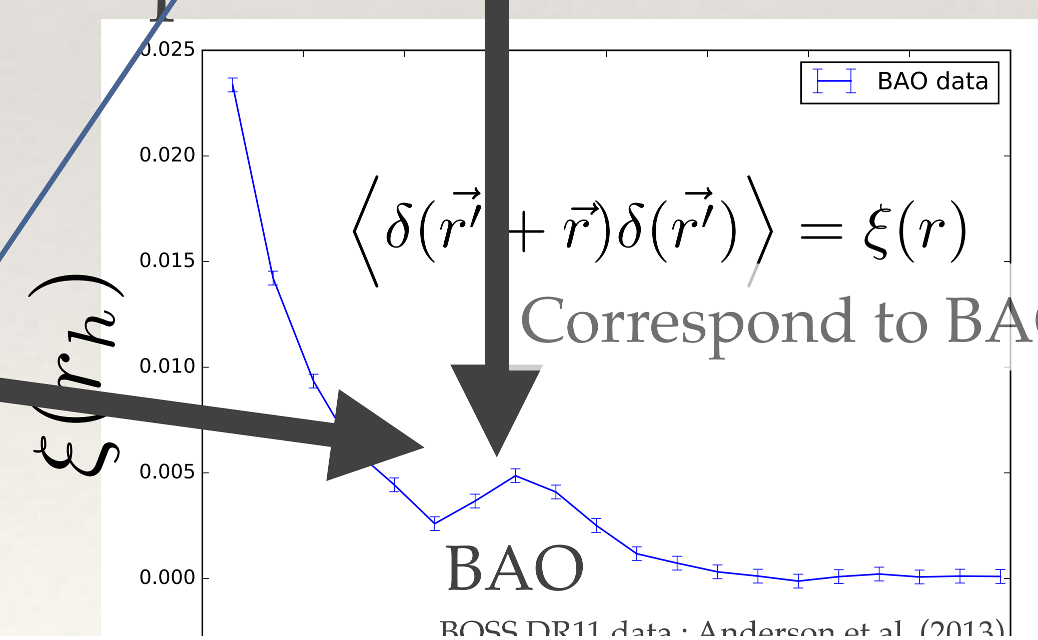




CMB angular power spectrum



Two points correlation function



We want to know the effects of these features on BAO

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Feature models in initial power spectrum

We assume that these features are originated from the initial power spectrum $P(k)$

$$C_\ell = \int T_\ell^2(k) P(k) \mathrm{dln}k$$

$$\xi(r) = \int T_B^2(k) P(k) \frac{\sin(kr)}{kr} \mathrm{dln}k$$

$$P(k) = P_s(k) + P_F(k)$$

$$P_s(k) = A \left(\frac{k}{k_0}\right)^{n_s - 1}$$

$$k_0 = 0.05\ [\mathrm{Mpc}^{-1}]$$

(i) Delta type feature

$$P_F(k) = Bk\delta(k - k_*)$$

(ii) Oscillating type feature

$$P_F(k) = B \left(\frac{k}{k_0}\right)^{n_s - 1} \times \cos\left(\frac{\pi(k - k_*)}{\kappa}\right) \exp\left(-\frac{(k - k_*)^2}{\kappa^2}\right)$$

(K.H. et al 2017)

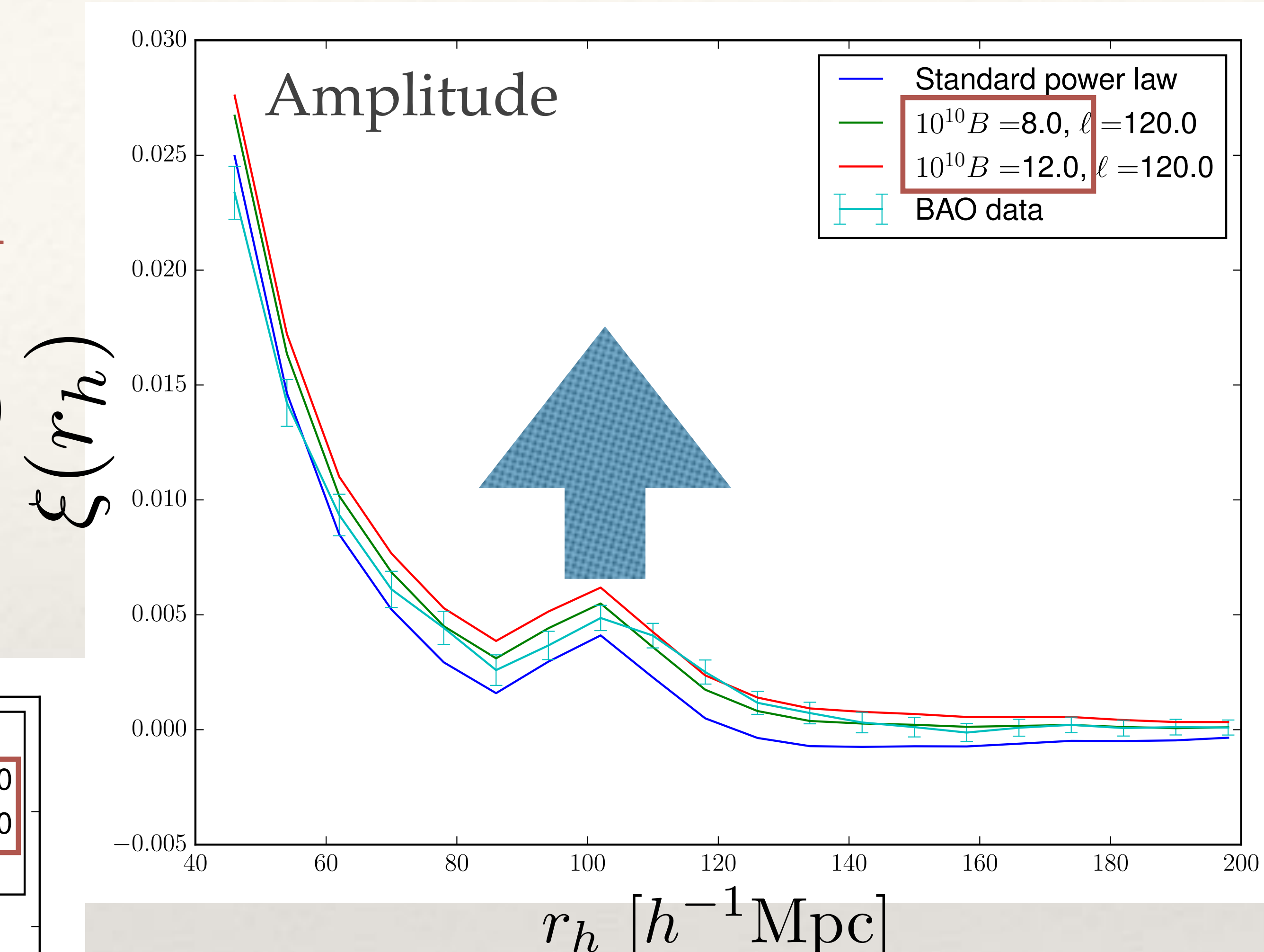
B : Amplitude κ : Width $[10^{-4}\mathrm{Mpc}^{-1}]$ k_* : Position

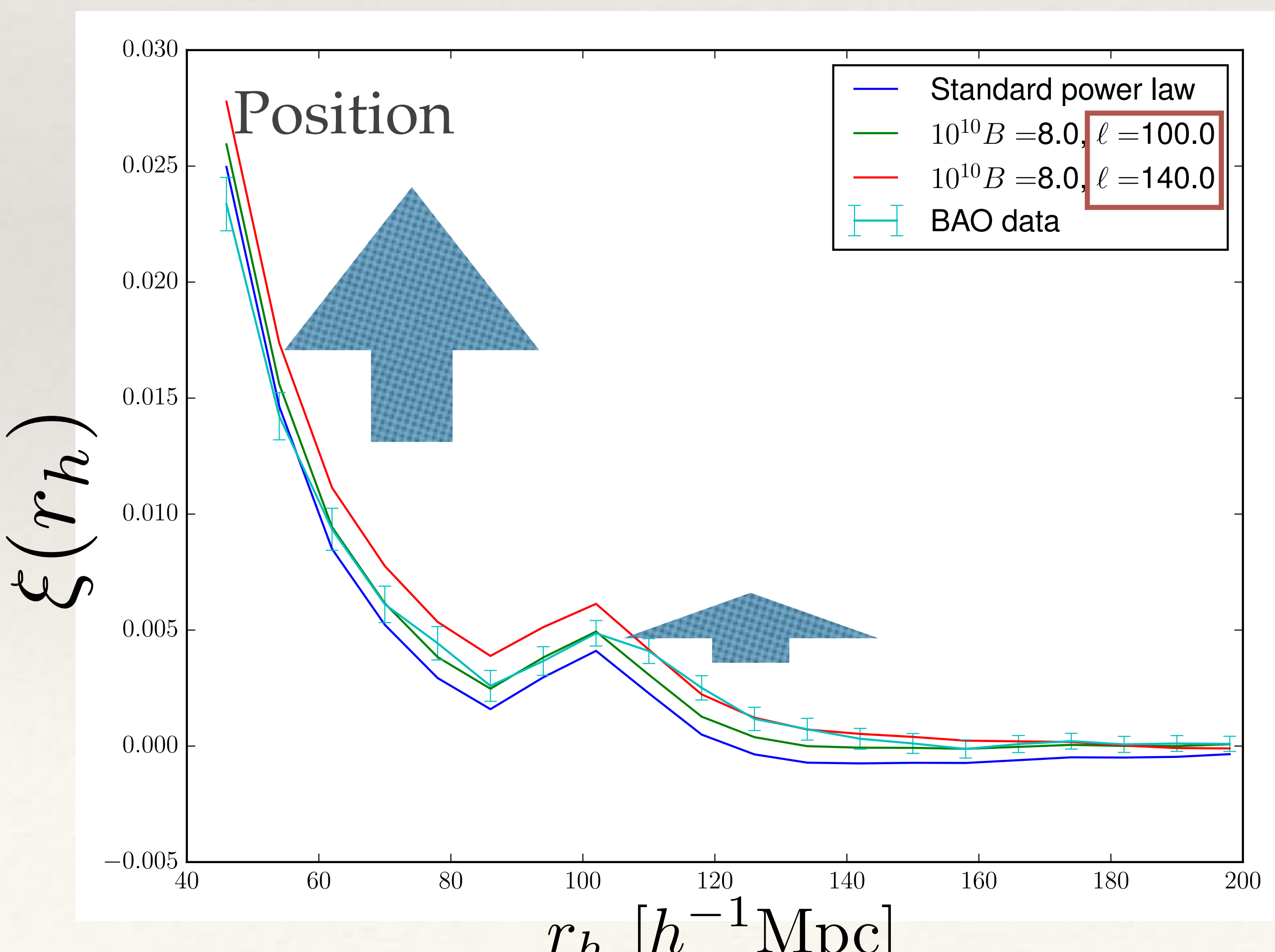
$k_* d_{ang} \sim \ell$ d_{ang} : Angular diameter distance to LSS

Effects of features on BAO : Delta type feature

(i) Delta type : Amplitude & Position

$$P_F(k) = A\left(\frac{k}{k_0}\right)^{n_s-1} + Bk\delta(k-k_*)$$





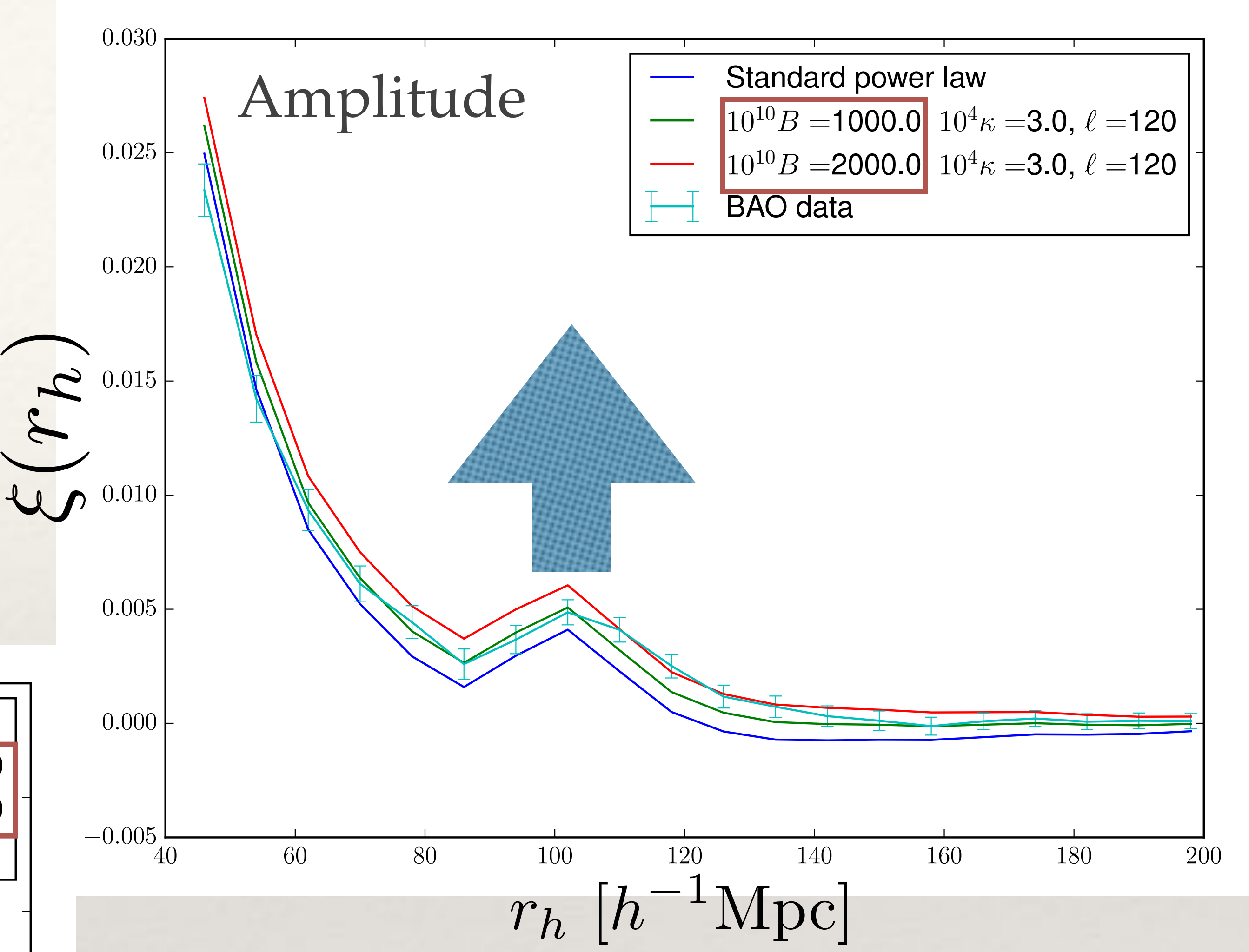
Center ell becomes larger

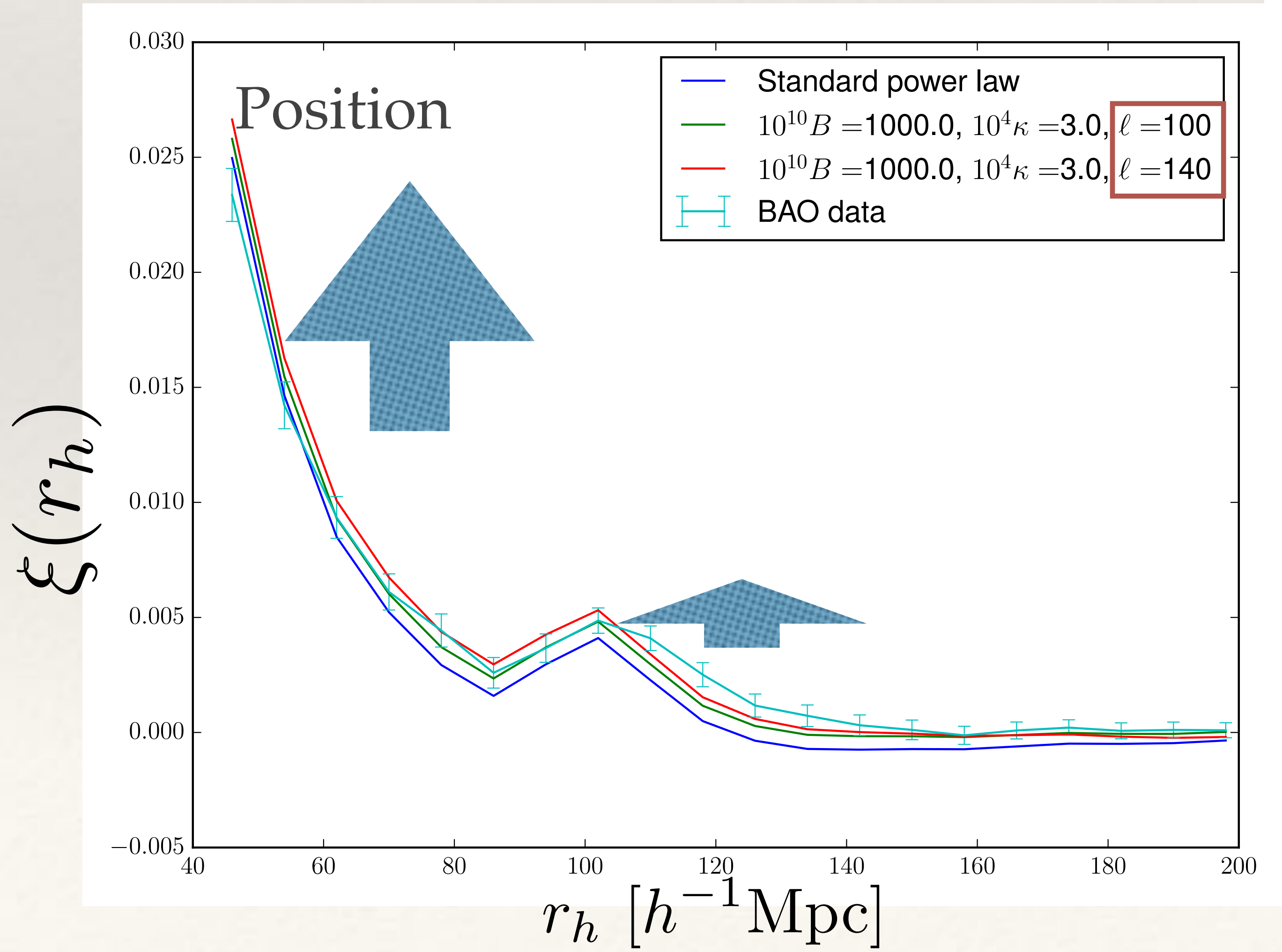
Amplitude at small scales becomes larger

Effects of features on BAO : Oscillating feature

(ii) Oscillating type : Amplitude & Position

$$P(k) = A\left(\frac{k}{k_0}\right)^{n_s-1} + B\left(\frac{k}{k_0}\right)^{n_s-1} \times \cos\left(\frac{\pi(k-k_*)}{\kappa}\right)\exp\left(-\frac{(k-k_*)^2}{\kappa^2}\right)$$





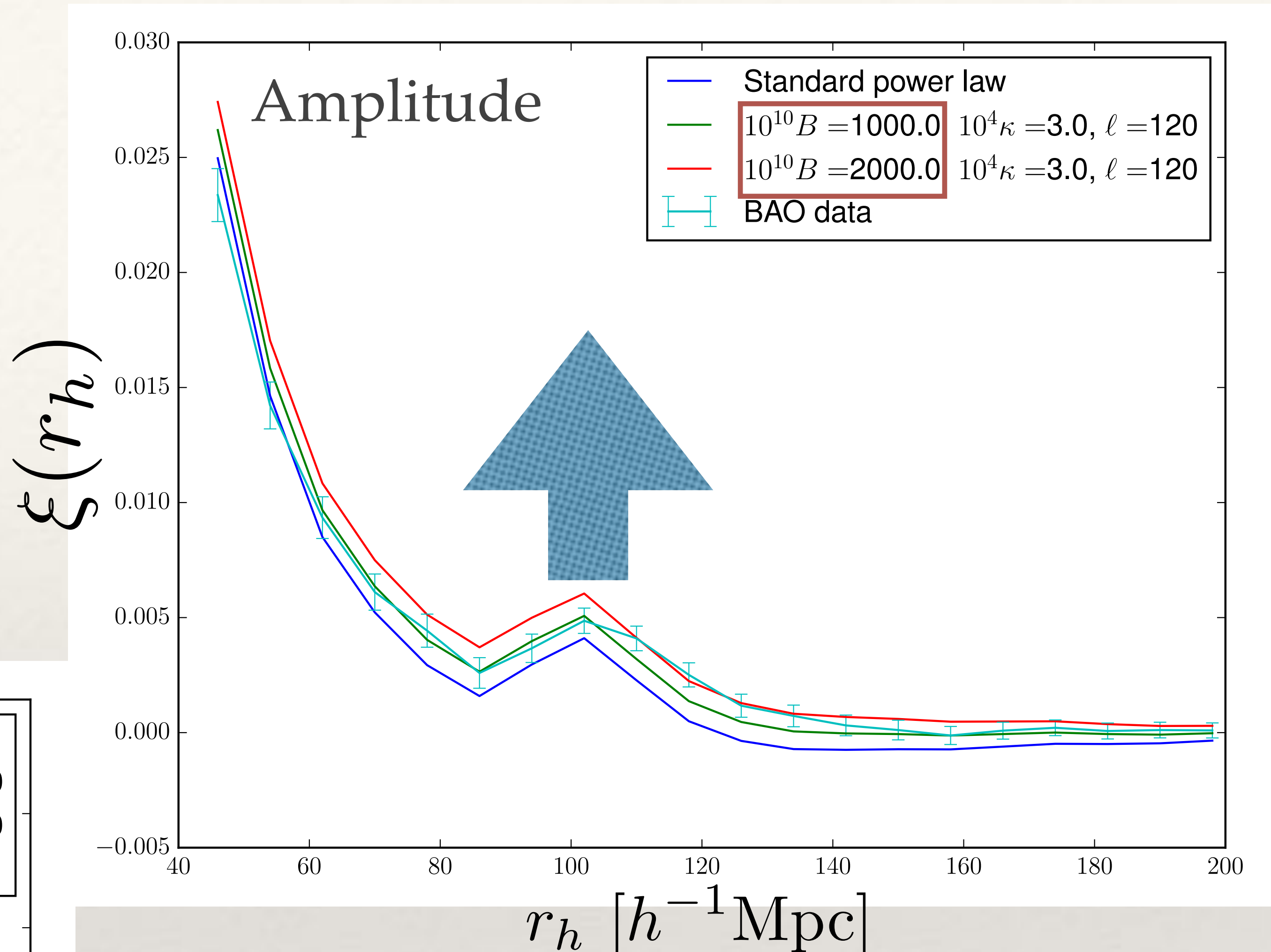
Center ell becomes larger

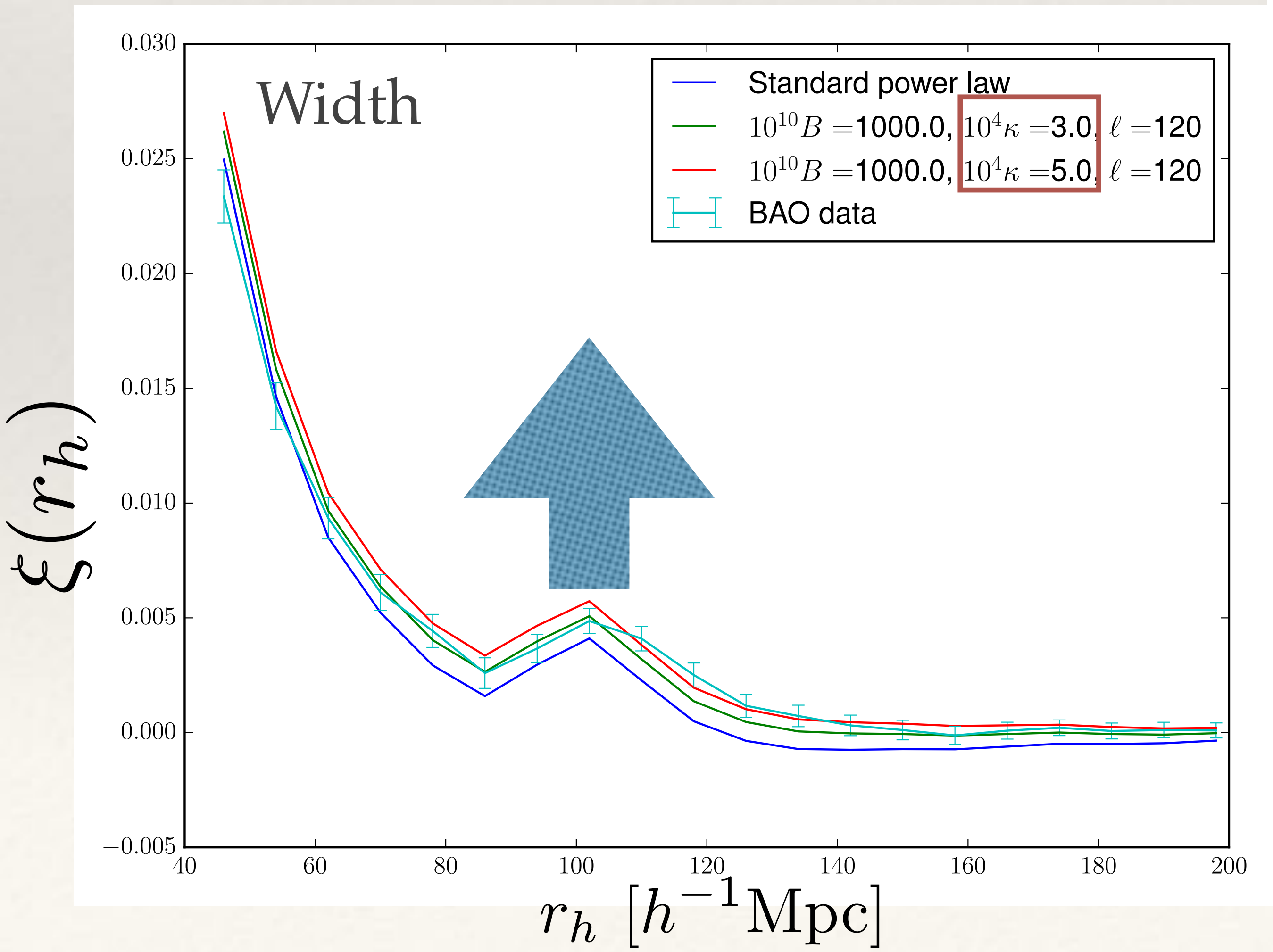
Amplitude at small scales becomes larger

Effects of features on BAO : Oscillating feature

(ii) Oscillating type : Amplitude & Width

$$P(k) = A\left(\frac{k}{k_0}\right)^{n_s-1} + B\left(\frac{k}{k_0}\right)^{n_s-1} \times \cos\left(\frac{\pi(k-k_*)}{\kappa}\right)\exp\left(-\frac{(k-k_*)^2}{\kappa^2}\right)$$





Almost the same effect

Amplitude A
Width κ
: larger

BAO amplitude : larger

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Markov-Chain Monte-Carlo (MCMC) analysis

We analyze the feature parameters
by performing MCMC analysis.
Cosmological parameters : Planck Best fits.

MCMC analysis

Data :

BAO : two-points correlation function data (Anderson 2013 : CMASS DR11)

+

(i) Delta type feature

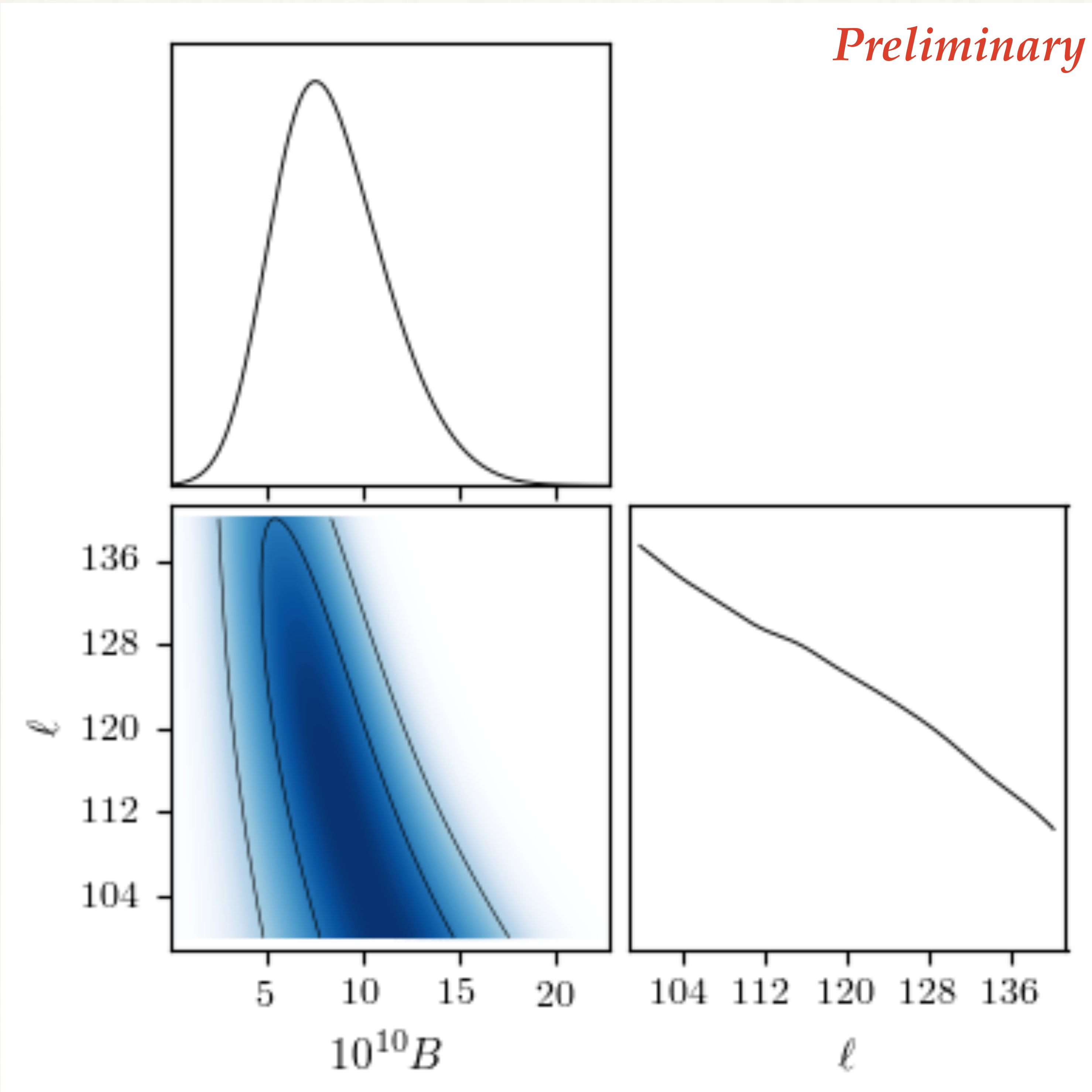
$$P_F(k) = Bk\delta(k - k_*)$$

(ii) Oscillating type feature

$$P_F(k) = B\left(\frac{k}{k_0}\right)^{n_s - 1} \times \cos\left(\frac{\pi(k-k_*)}{\kappa}\right)\exp\left(-\frac{(k-k_*)^2}{\kappa^2}\right)$$

Markov-Chain Monte-Carlo (MCMC) analysis

1. Delta type feature



Best fit parameters

$$10^{10}B = 8.03$$

$$k_* d_{ang} = 118.0$$

Best fit

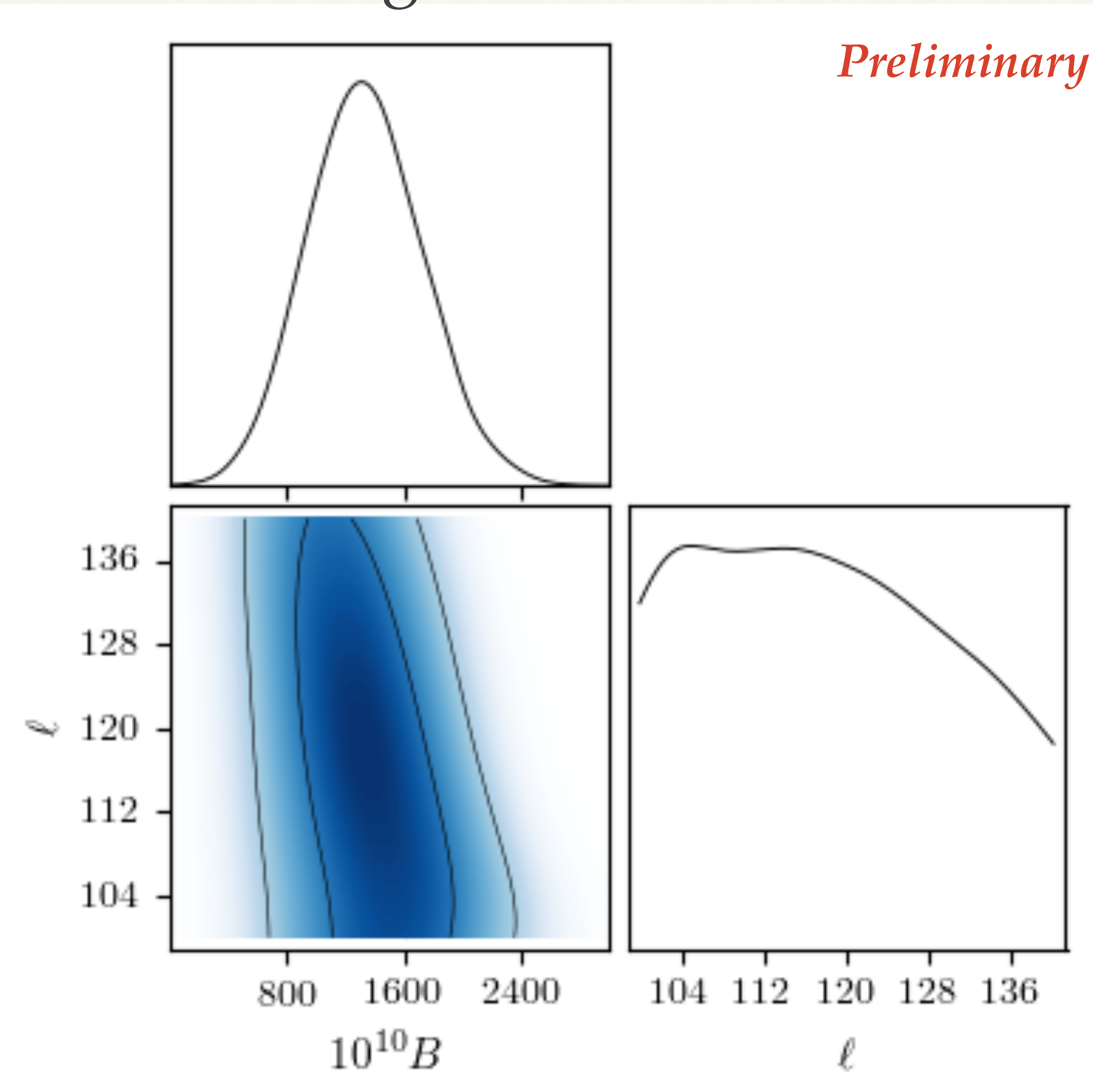
$$\chi^2 = 20.3$$

Ref :

Planck Best $\chi^2 = 32.8$

Markov-Chain Monte-Carlo (MCMC) analysis

2. Oscillating feature



Best fit parameters

$$10^{10}B = 1331$$

$$\kappa = 3.14$$ (Fixed)

$$k_* d_{ang} = 118.6$$

Best fit

$$\chi^2 = 20.3$$

Ref :

Planck Best $\chi^2 = 32.8$

Comments

$10^{10}B_{BAO} \sim 10^3 \gg 10^{10}B_{CMB} \sim 50$

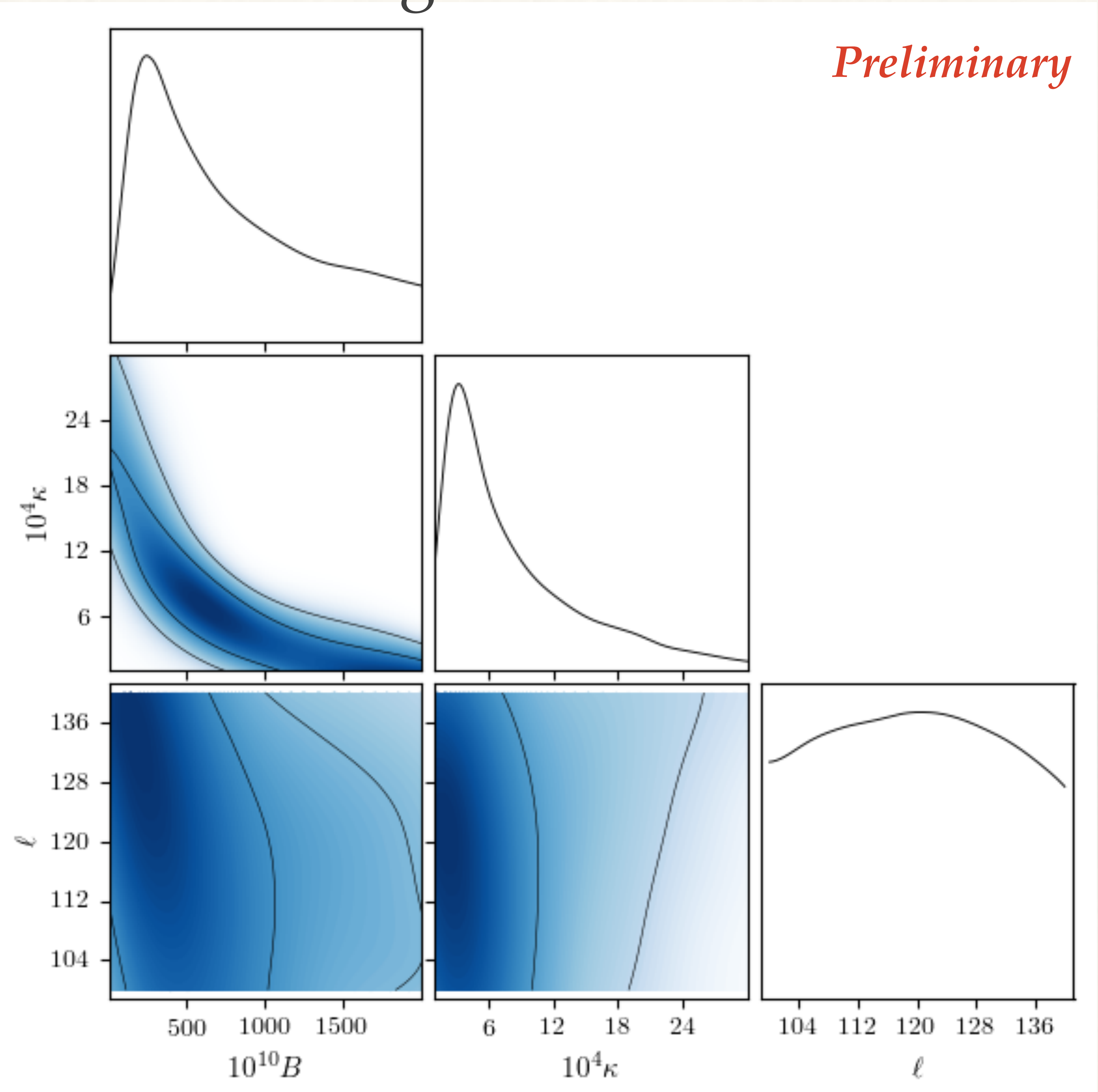
Ichiki, et al (2010)

KH, et al (2017)

From CMB

Markov-Chain Monte-Carlo (MCMC) analysis

2. Oscillating feature



Best fit parameters

$$10^{10}B = 2000$$

$$\kappa = 2.11$$

$$k_* d_{ang} = 118.3$$

Best fit

$$\chi^2 = 20.3$$

Ref :

Planck Best $\chi^2 = 32.8$

Comments

$$10^{10}B_{BAO} \sim 10^3 \gg 10^{10}B_{CMB} \sim 50$$

Ichiki, et al (2010)
KH, et al (2017)
From CMB

Contents

Summary

- The effects of features in initial power spectrum on BAO
- Delta and oscillating type initial power spectrum models
- MCMC analysis using BAO data : features are preferred

Resulting parameters

Delta type	Oscillating type (fixed width)
$10^{10}B = 8.03$	$10^{10}B = 1331 (\gg 10^{10}B_{CMB} \sim 50)$
$k_* d_{ang} = 118.0$	$k_* d_{ang} = 118.6$

Next, we will focus on galaxy bias $P(k) \to (1 + b(k))P(k)$
and we will analyze the spectrum with the bias parameters