Error Analysis in LSS-CMB crosscorrelation

Enrique Gaztañaga
Pablo Fosalba, Anna Cabre, Mark Manera & Francisco Castander

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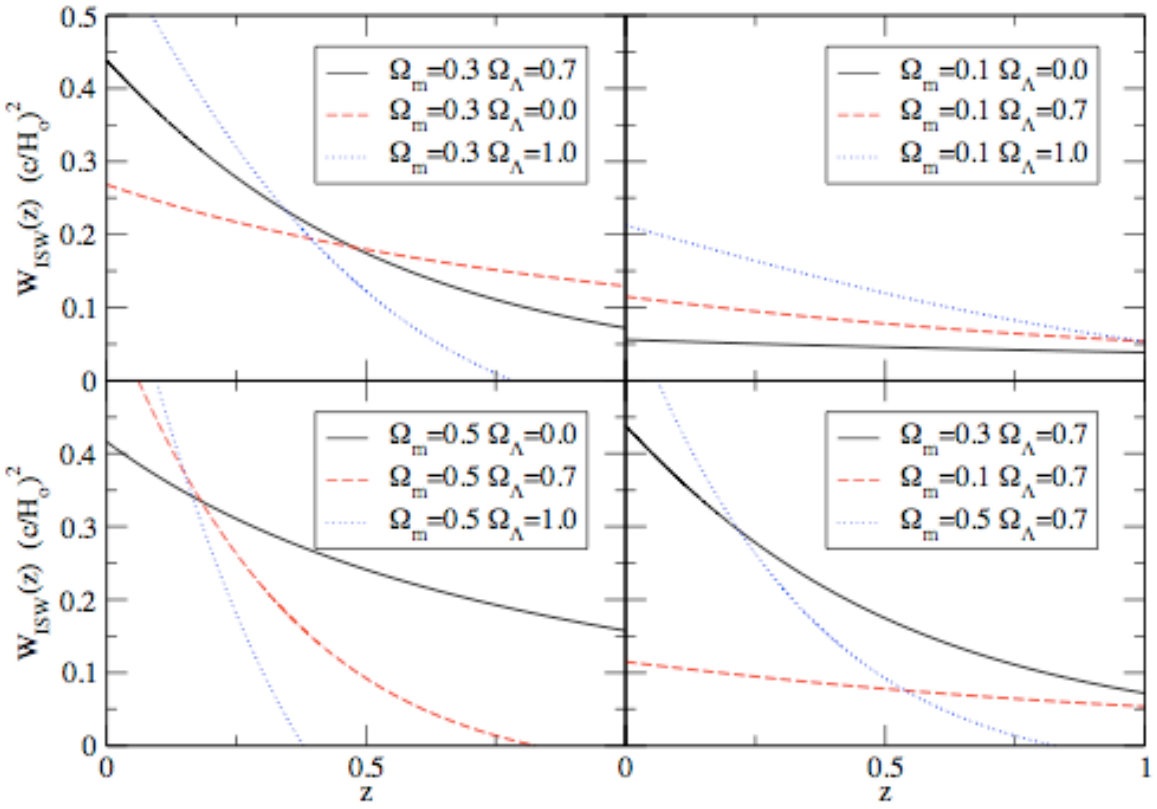
Institut d'Estudis Espacials de Catalunya, IEEC/CSIC
Instituto de Ciencias del Espacio, CSIC

- *Errors: theory vs simulations*
- *S/N predictions (SDSS & DES)*
- *Harmonic vs configuration space*
- *Combined data*

$$
\begin{aligned}
w_{TG}^{ISW}(\theta) &= \sum_l \frac{2l+1}{4\pi} p_l(\cos\theta)\, C_{GT}^{ISW}(l) \\
C_{GT}^{ISW}(l) &= \frac{4}{(2l+1)^2} \int dz\, W_{ISW}(z) W_G(z) \frac{H(z)}{c} P(k) \\
W_{ISW}(z) &= 3\Omega_m (H_0/c)^2 \frac{d[D(z)/a]}{dz} \qquad (6) \\
W_G(z) &= b(z)\phi_G(z)D(z),
\end{aligned}
$$

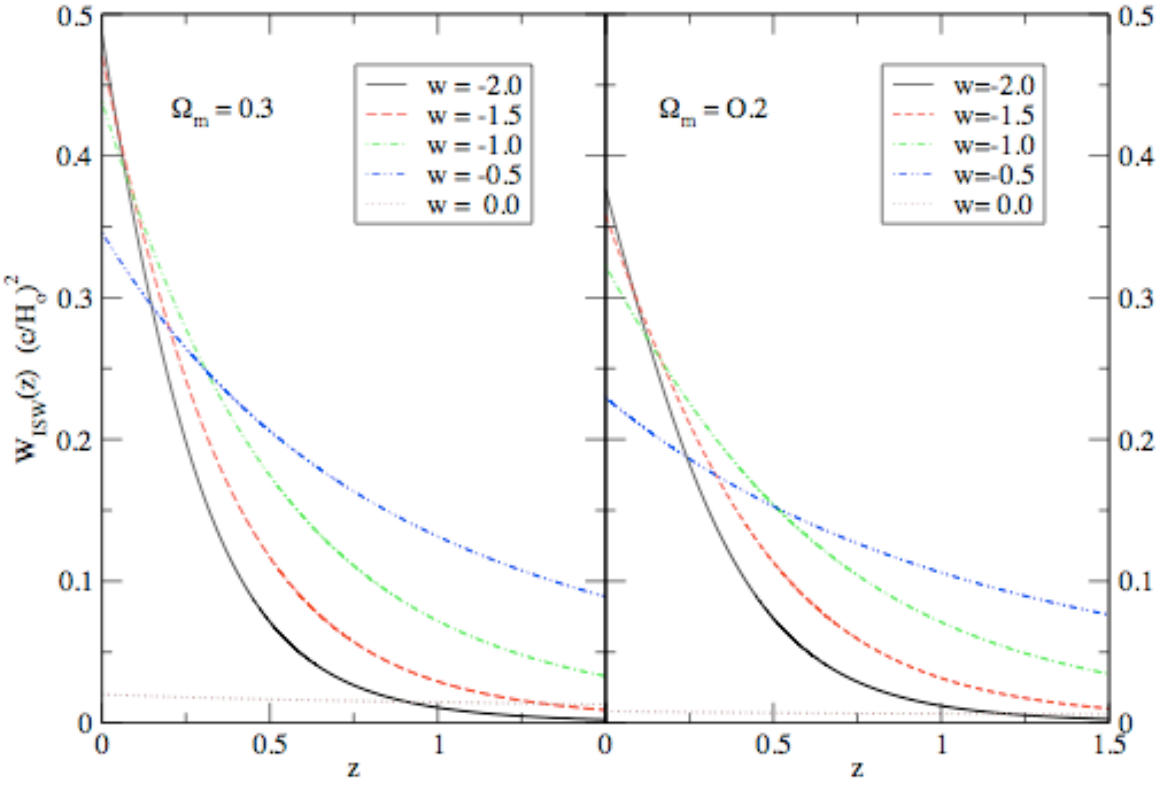


$$w_{TG}^{ISW}(\theta) = \sum_l \frac{2l+1}{4\pi} p_l(\cos\theta)\, C_{GT}^{ISW}(l)$$

$$C_{GT}^{ISW}(l) = \frac{4}{(2l+1)^2} \int dz\, W_{ISW}(z) W_G(z) \frac{H(z)}{c} P(k)$$

$$W_{ISW}(z) = 3\Omega_m (H_0/c)^2 \frac{d[D(z)/a]}{dz} \qquad (6)$$

$$W_G(z) = b(z)\phi_G(z)D(z),$$



All sky Montecarlo simulations

Simulate both CMB and LSS as gaussian fields with the corresponding c_l spectrum for TT, GG and also TG:

$$a_{lm}^T = \sqrt{C_l^T}\,\xi_{1,m}$$
$$a_{lm}^X = \frac{C_l^{XT}}{\sqrt{C_l^T}}\xi_{1,m} + \left(C_l^X - \frac{[C_l^{XT}]^2}{C_l^T}\right)^{1/2}\xi_{2,m}$$

Boughn, Crittenden & Turok 1998

->Compare to theory: effects of cross-correlation TG? fsky?
->Compare to JK

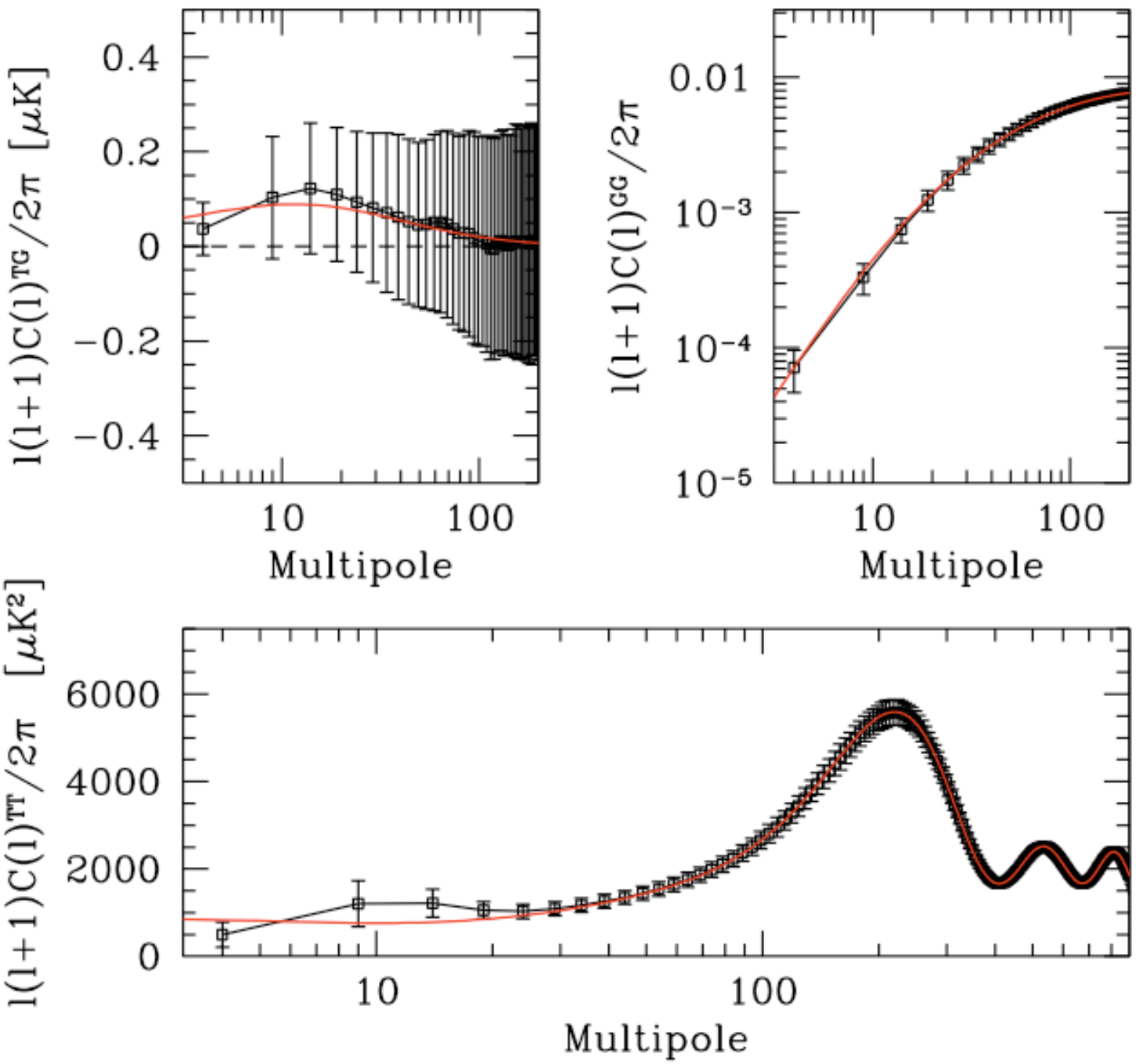
Both for variance
and covariance

$$Cov(\omega_1,\omega_2) = \sum_l \frac{(2l+1)}{f_{sky}(4\pi)^2}\, p_l(\cos(\theta_1))p_l(\cos(\theta_2)) \left[C_{gT}(l)^2 + C_{TT}(l)C_{gg}(l)\right],$$

Theory:
-diagonal gaussian errors in c_l transfer to w2
-gaussian configurational (real space) errors in w2

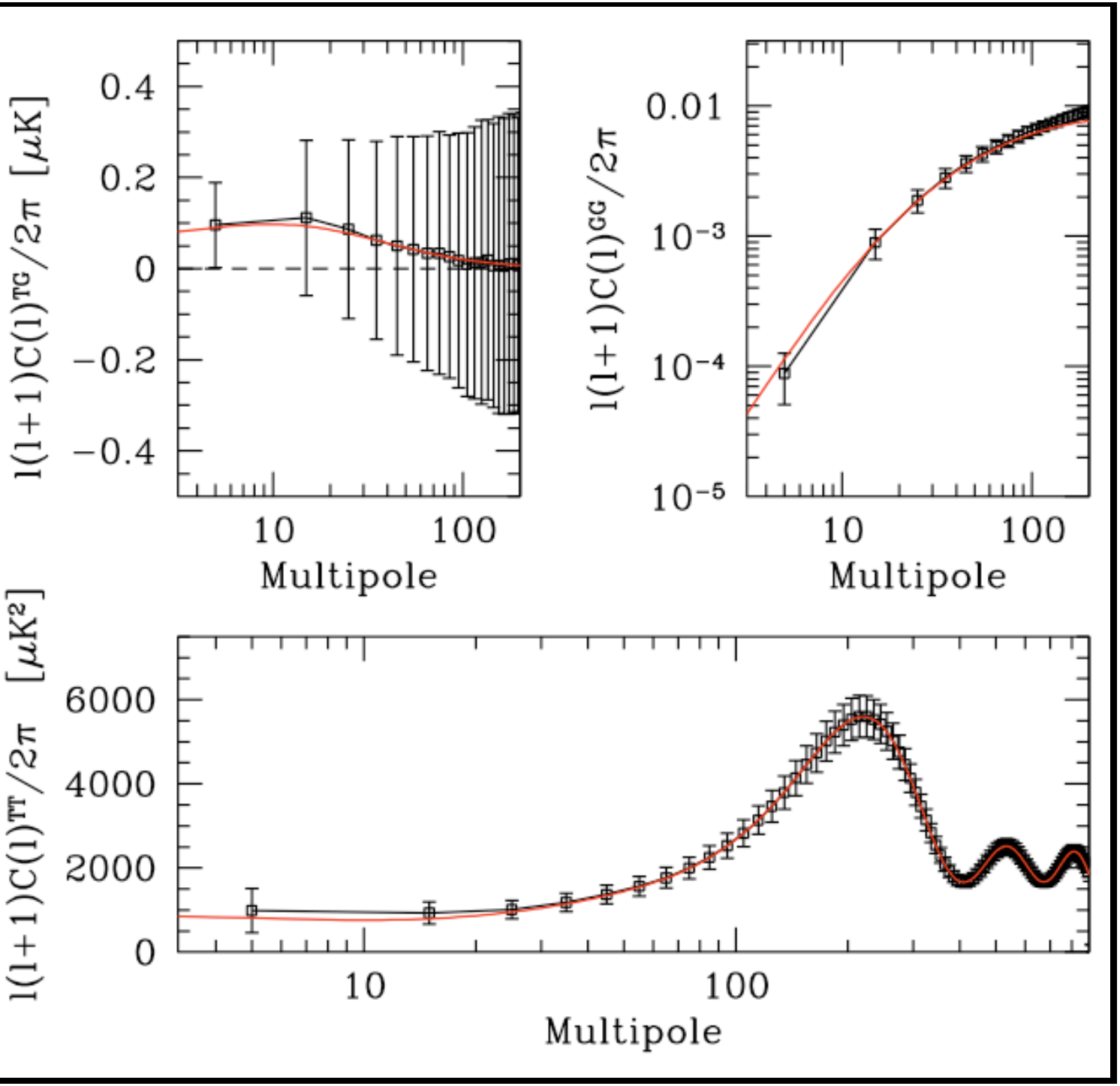
All sky
z=0.33

Input
vs
1000 sim



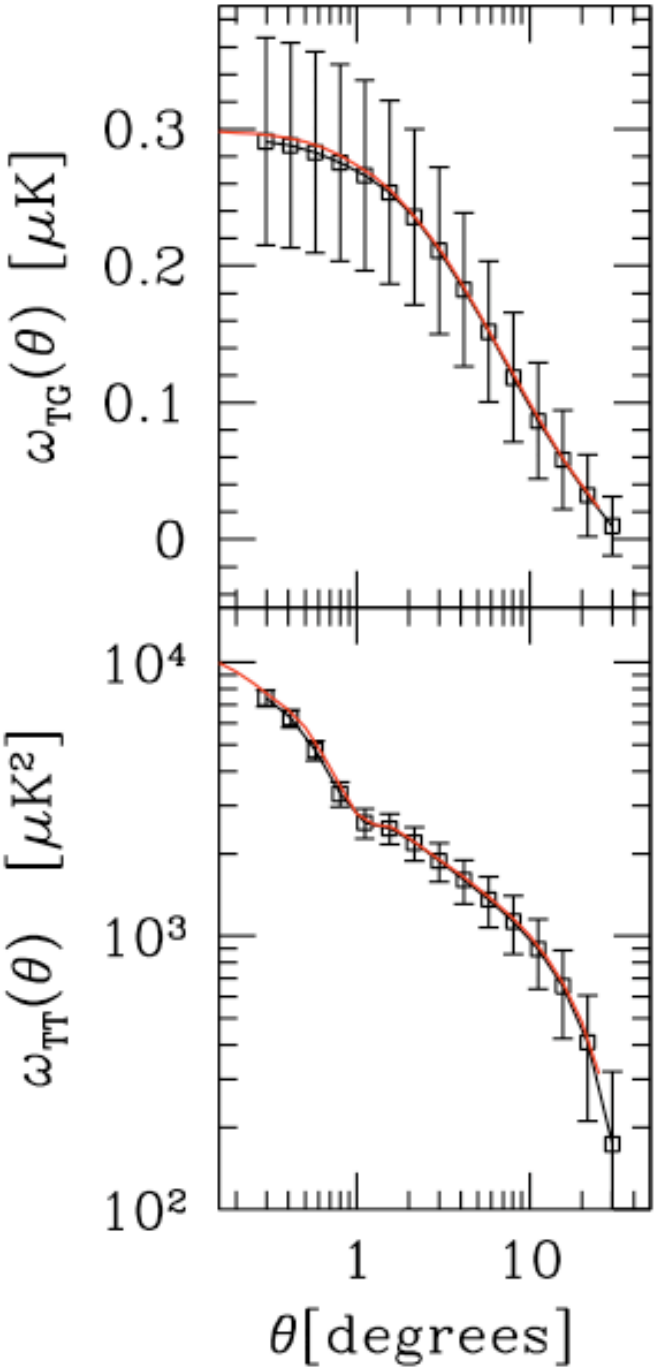
10% sky
z=0.33

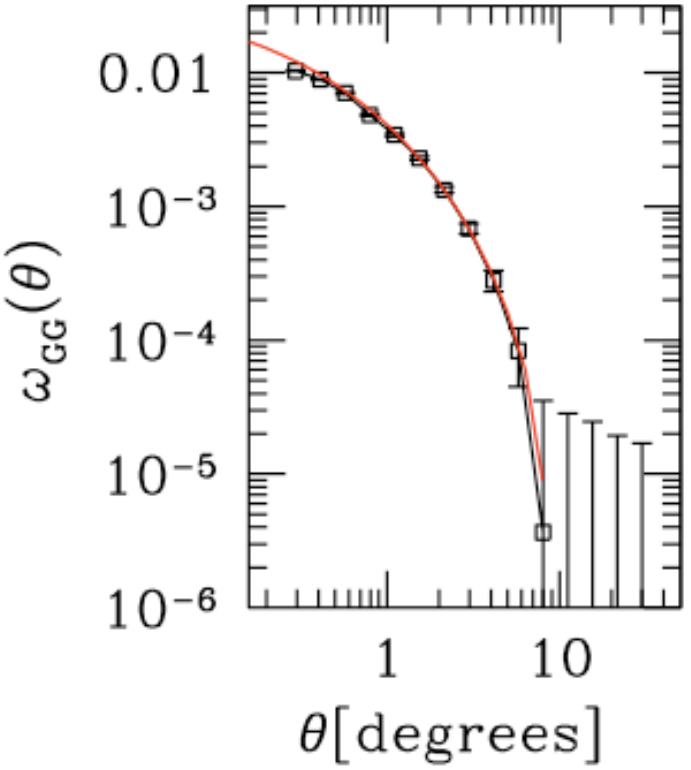
Input
vs
sim



All sky
z=0.33

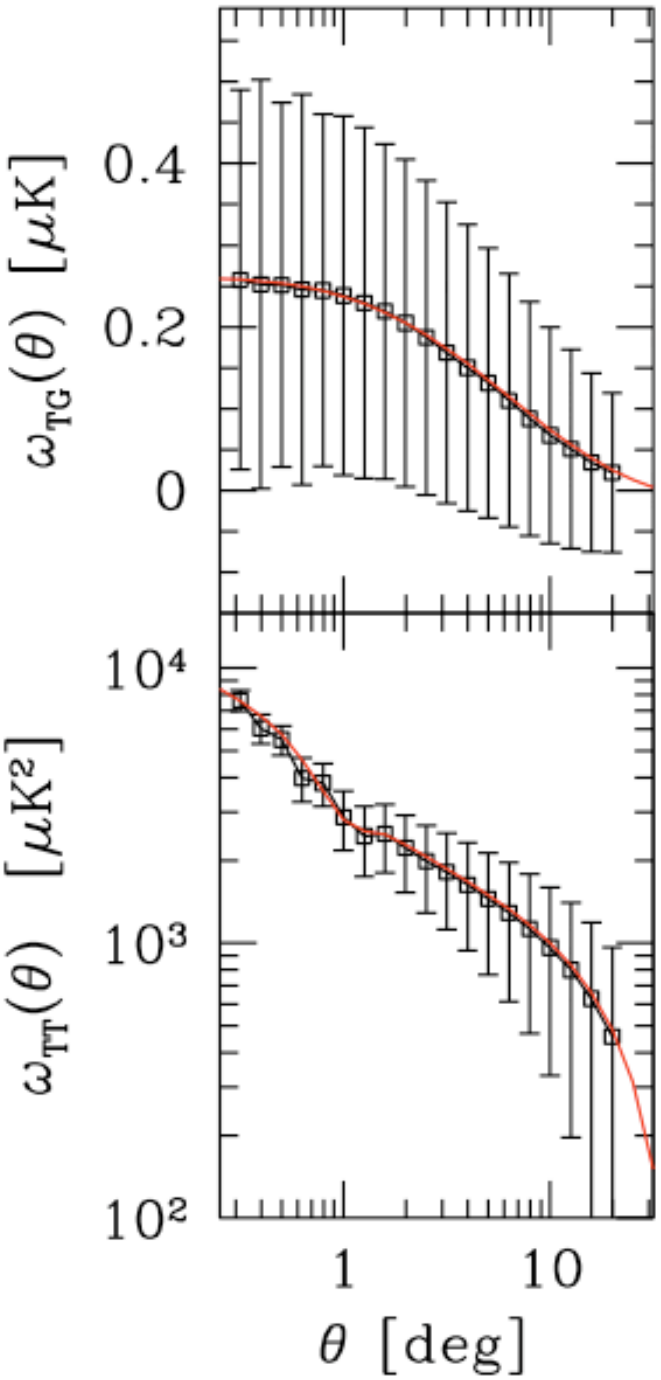
Input
vs
sim

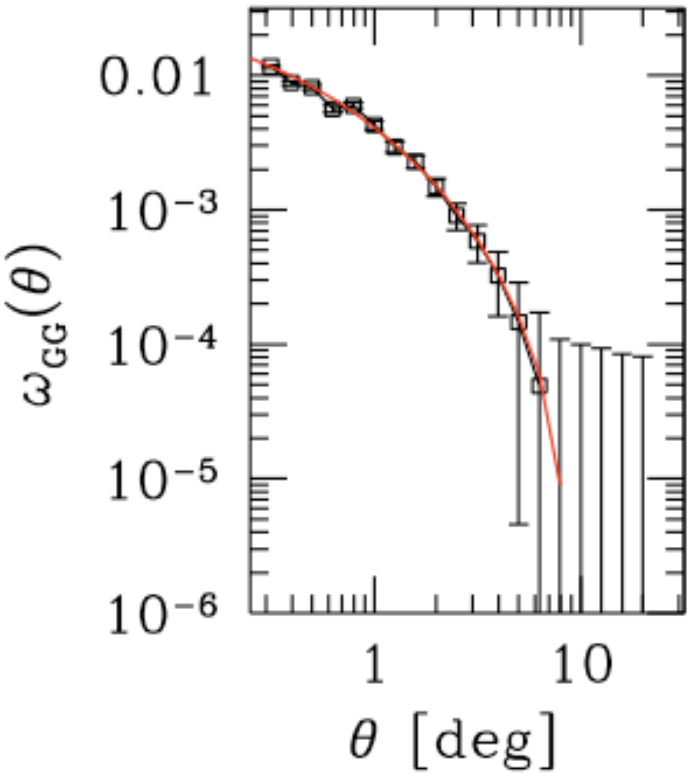




10% sky
z=0.33

Input
vs
sim

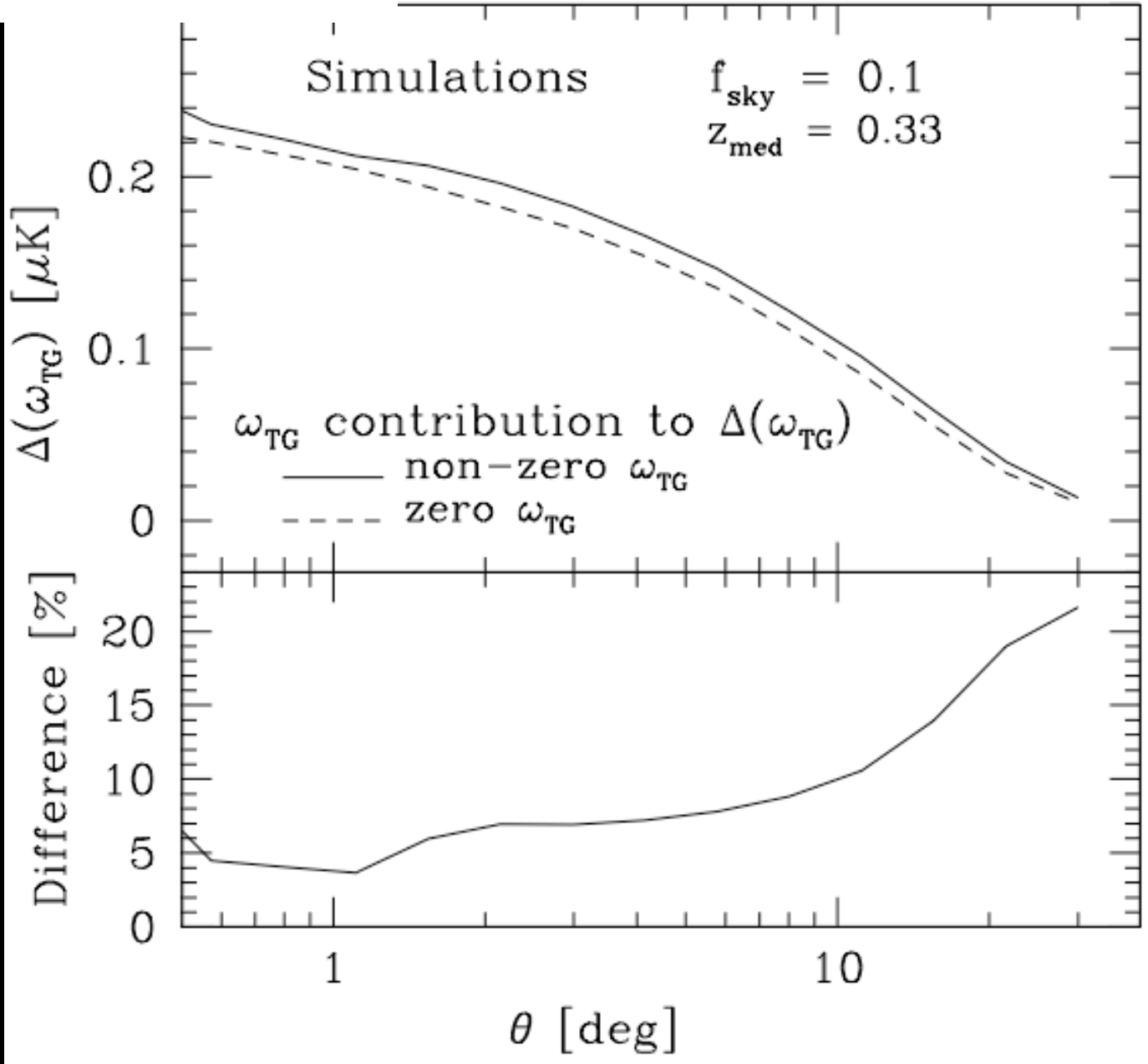




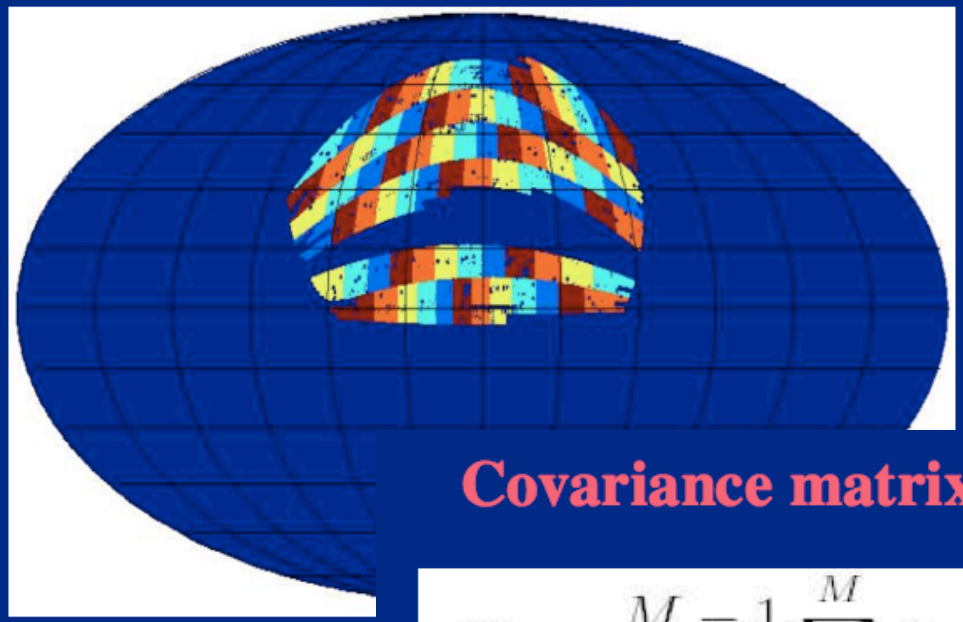
$$\Delta^2\tilde{C}_{gT}(l) = \frac{1}{2l+1}\,[C_{gT}^2(l) + C_{TT}(l)C_{gg}(l)].$$

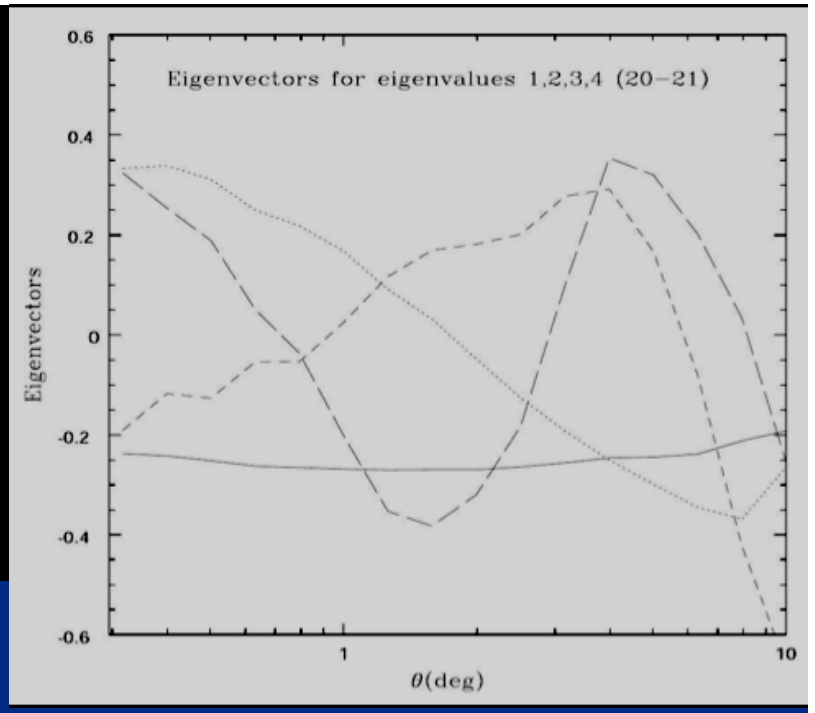
[redacted]

[redacted]



Jack-knife errors





Covariance matrix

$$C_{ij} = \frac{M-1}{M}\sum_{k=1}^{M}\Delta\omega^k(\theta_i)\Delta\omega^k(\theta_j)$$

$$\Delta\omega^k(\theta) = \omega^k(\theta) - \bar{\omega}^k(\theta)$$

Singular Value Decomposit (SVD)

$$\widehat{C_{ij}} = (U_{ik})^{+} W_{kl} V_{lj}$$

$$W_{ij} = \lambda_i^2 \delta_{ij}$$

χ^2 distribution

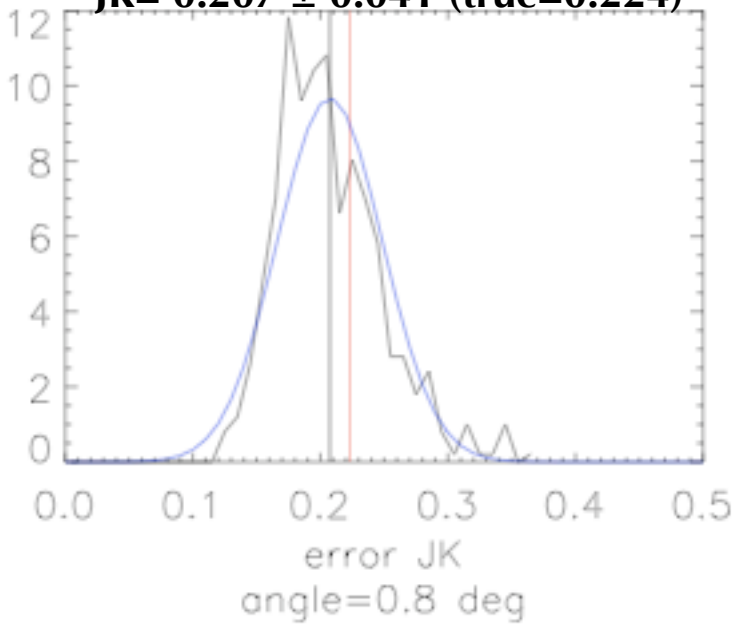
$$\chi^2 = \sum_{i=1}^{nbin}\sum_{j=1}^{nbin}\Delta_i C_{ij}^{-1}\Delta_j$$

$$\Delta_i = \omega^{obs}(i) - \omega^{model}(i)$$

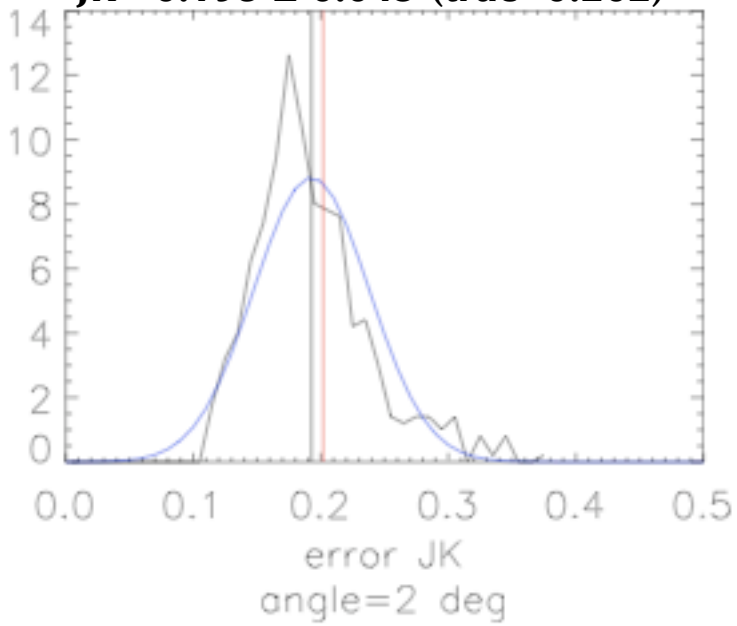
Poor-man Boostrap?

Comparison of JK errors with MC errors

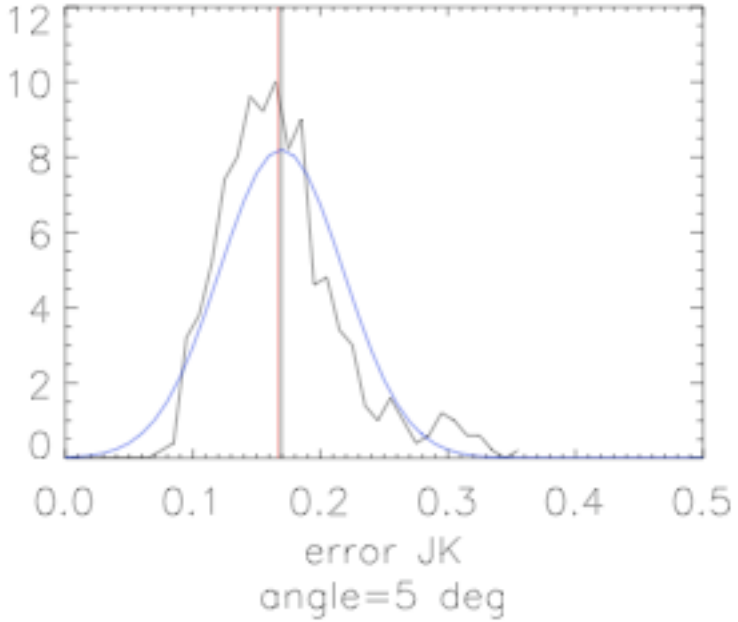
JK= 0.207 ± 0.041 (true=0.224)



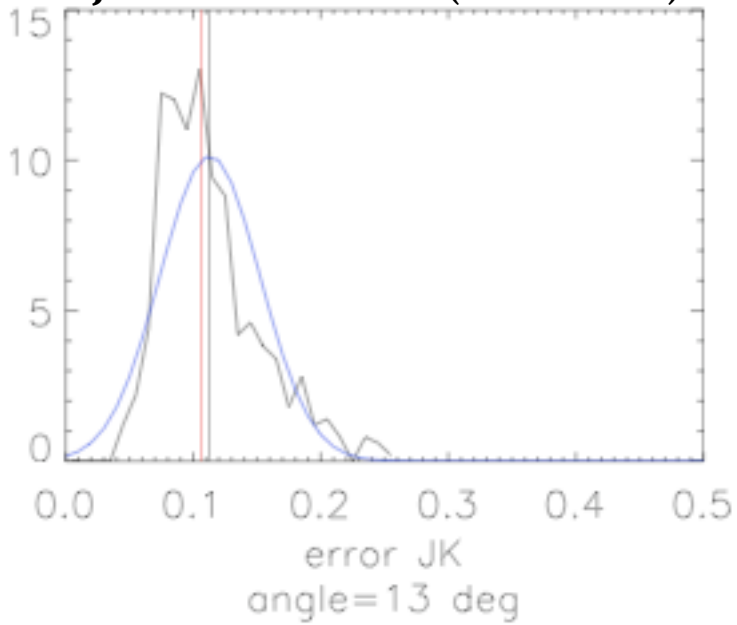
JK= 0.193 ± 0.045 (true=0.202)

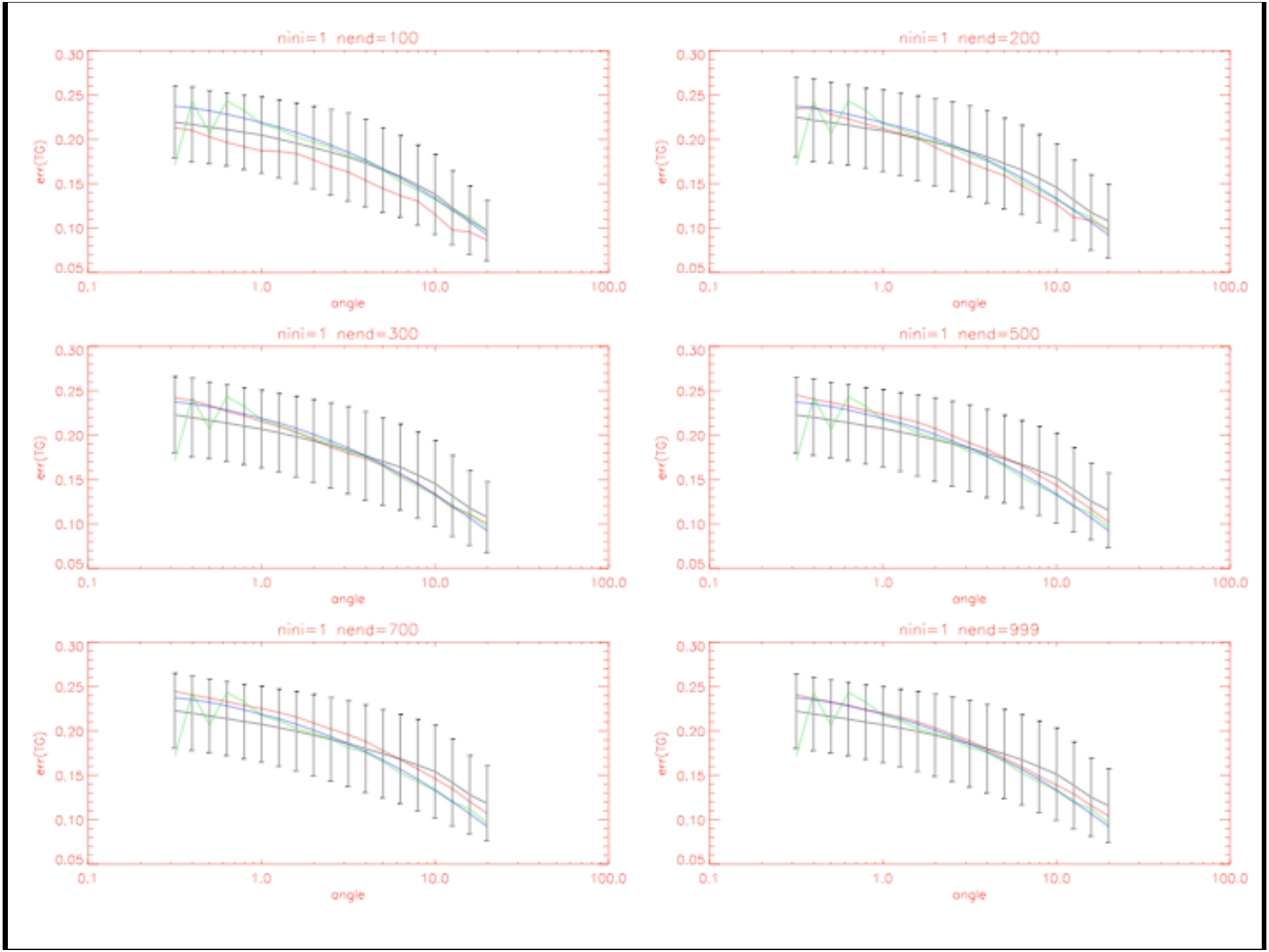


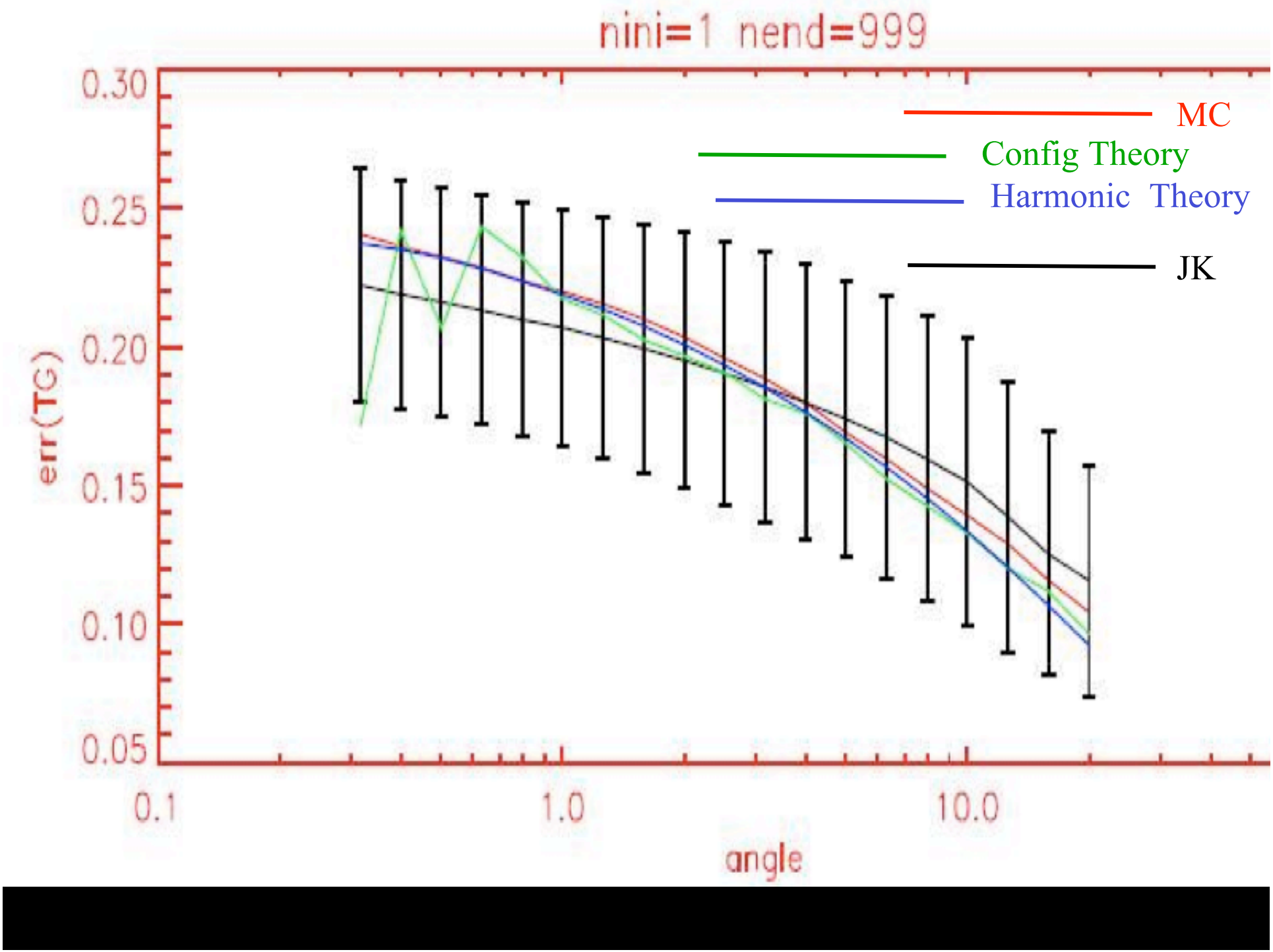
JK= 0.170 ± 0.049 (true=0.167)

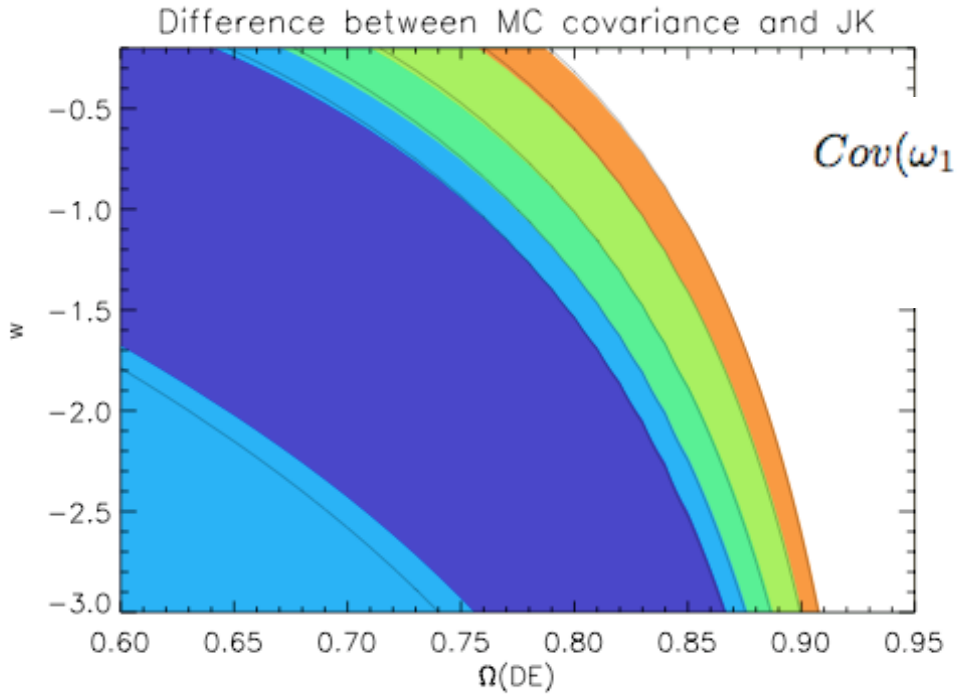


JK= 0.113 ± 0.039 (true=0.107)

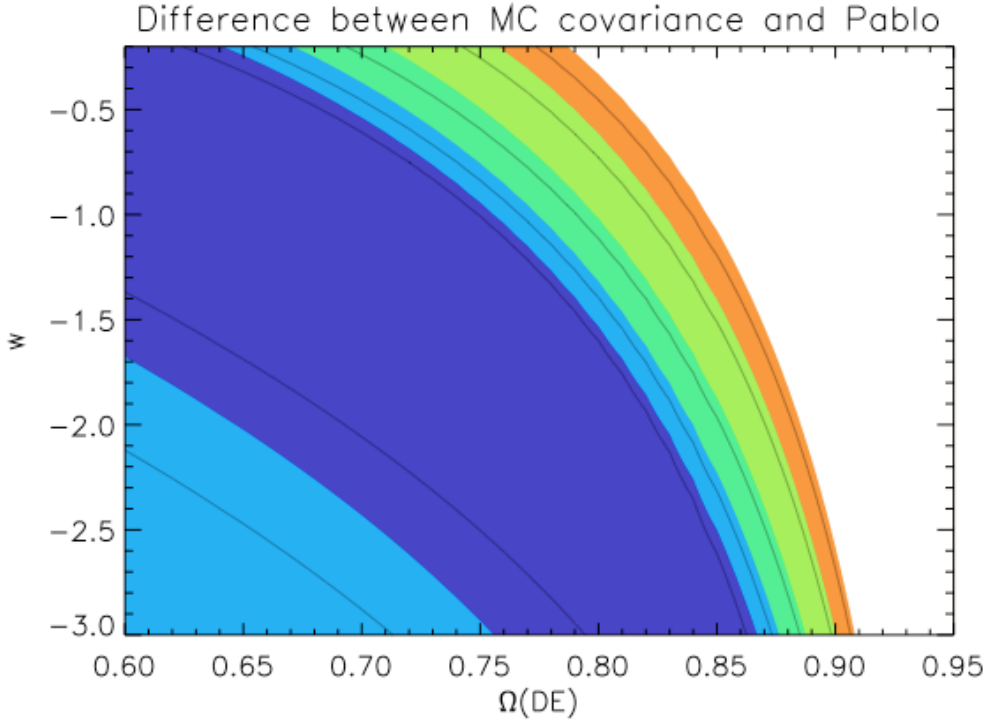


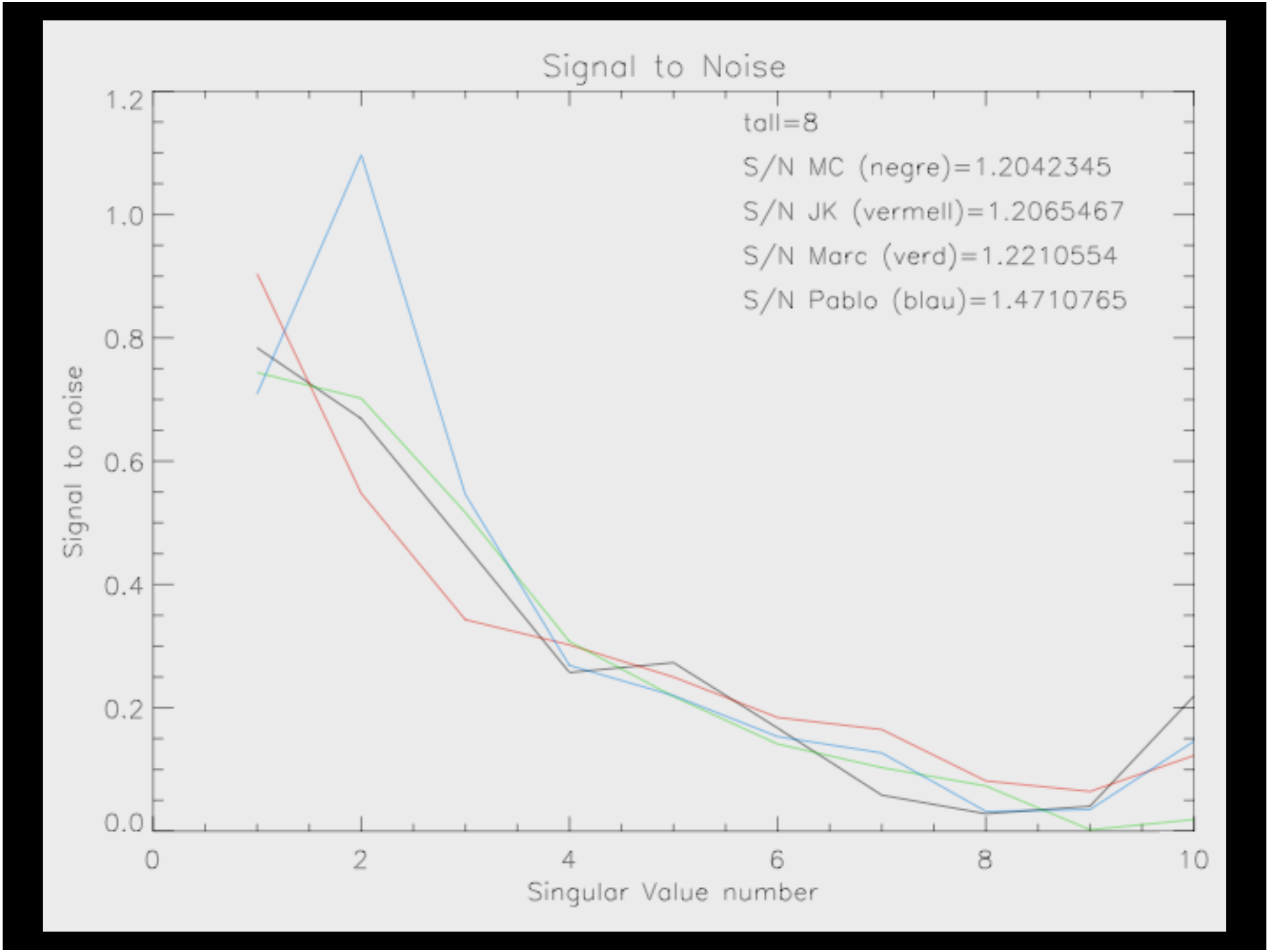

nini=1 nend=100
nini=1 nend=200
nini=1 nend=300
nini=1 nend=500
nini=1 nend=700
nini=1 nend=999
err(TG)
angle
0.30
0.25
0.20
0.15
0.10
0.05
0.1
1.0
10.0
100.0

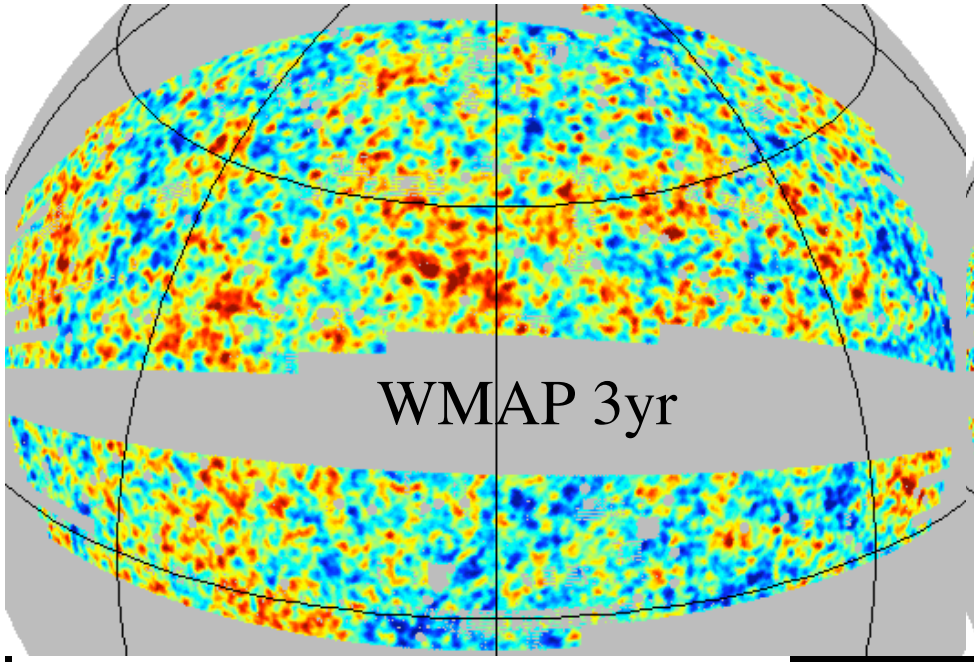

nini=1 nend=999
0.30
0.25
0.20
0.15
0.10
0.05
err(TG)
0.1
1.0
10.0
angle
MC
Config Theory
Harmonic Theory
JK

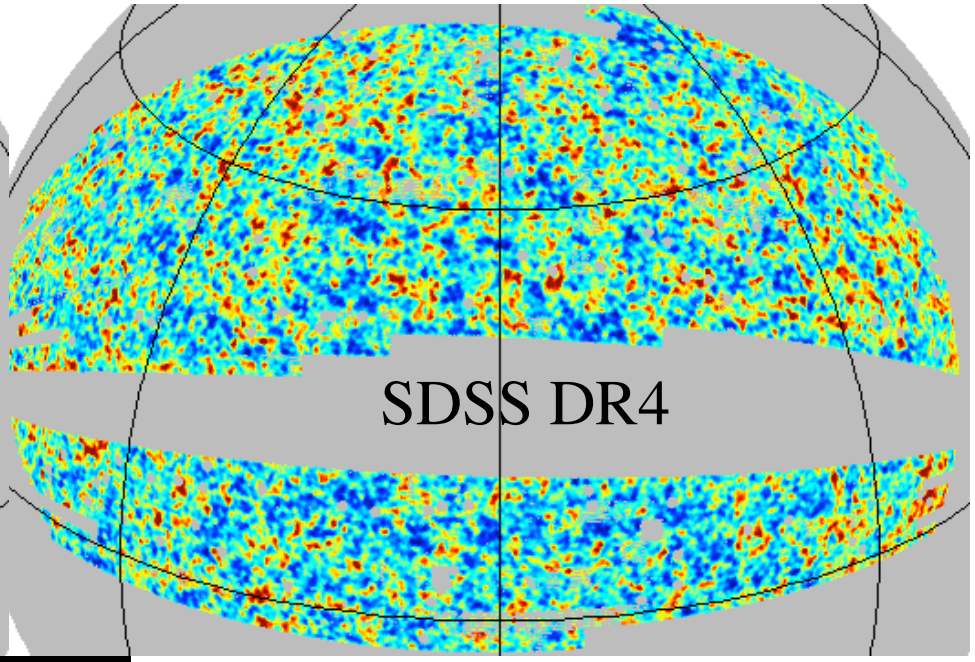


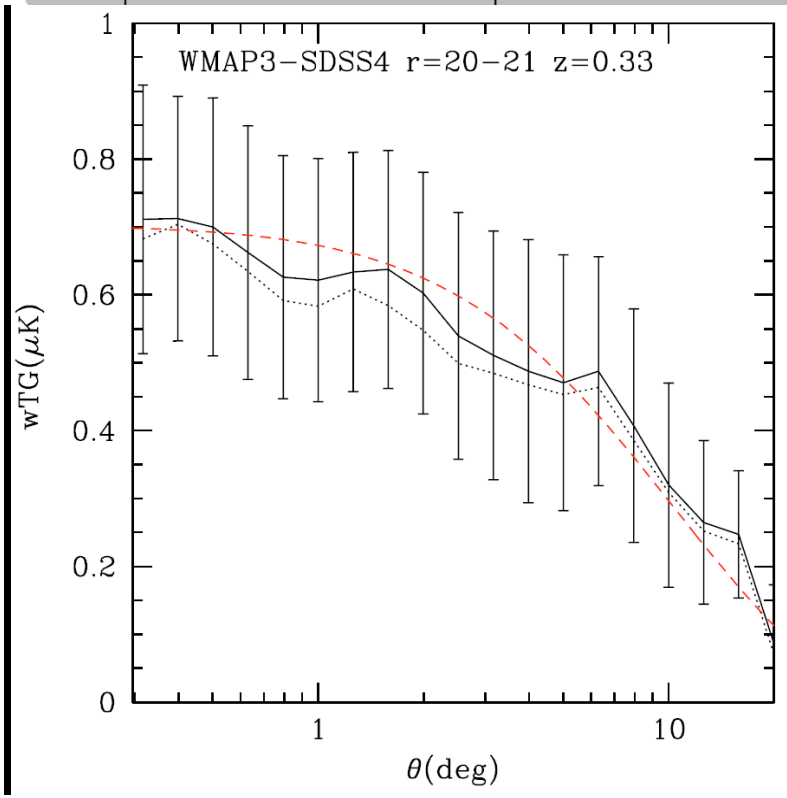
$$Cov(\omega_1, \omega_2) = \sum_l \frac{(2l+1)}{f_{sky}(4\pi)^2} p_l(\cos(\theta_1)) p_l(\cos(\theta_2)) \left[C_{gT}(l)^2 + C_{TT}(l) C_{gg}(l)\right],$$




Signal to Noise
tall=8
S/N MC (negre)=1.2042345
S/N JK (vermell)=1.2065467
S/N Marc (verd)=1.2210554
S/N Pablo (blau)=1.4710765
Signal to noise
Singular Value number
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
2
4
6
8
10

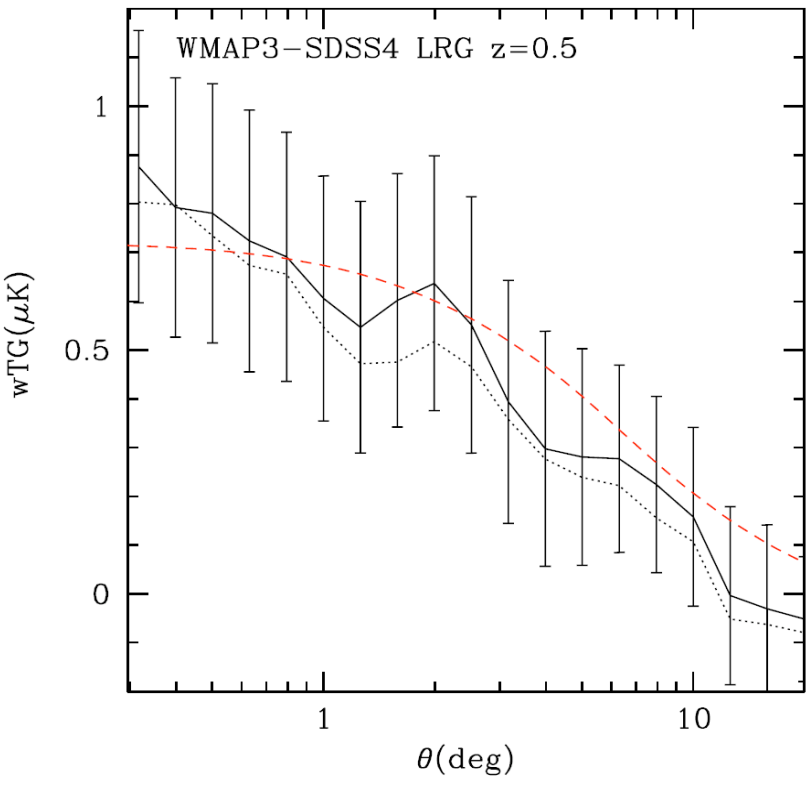

WMAP 3yr

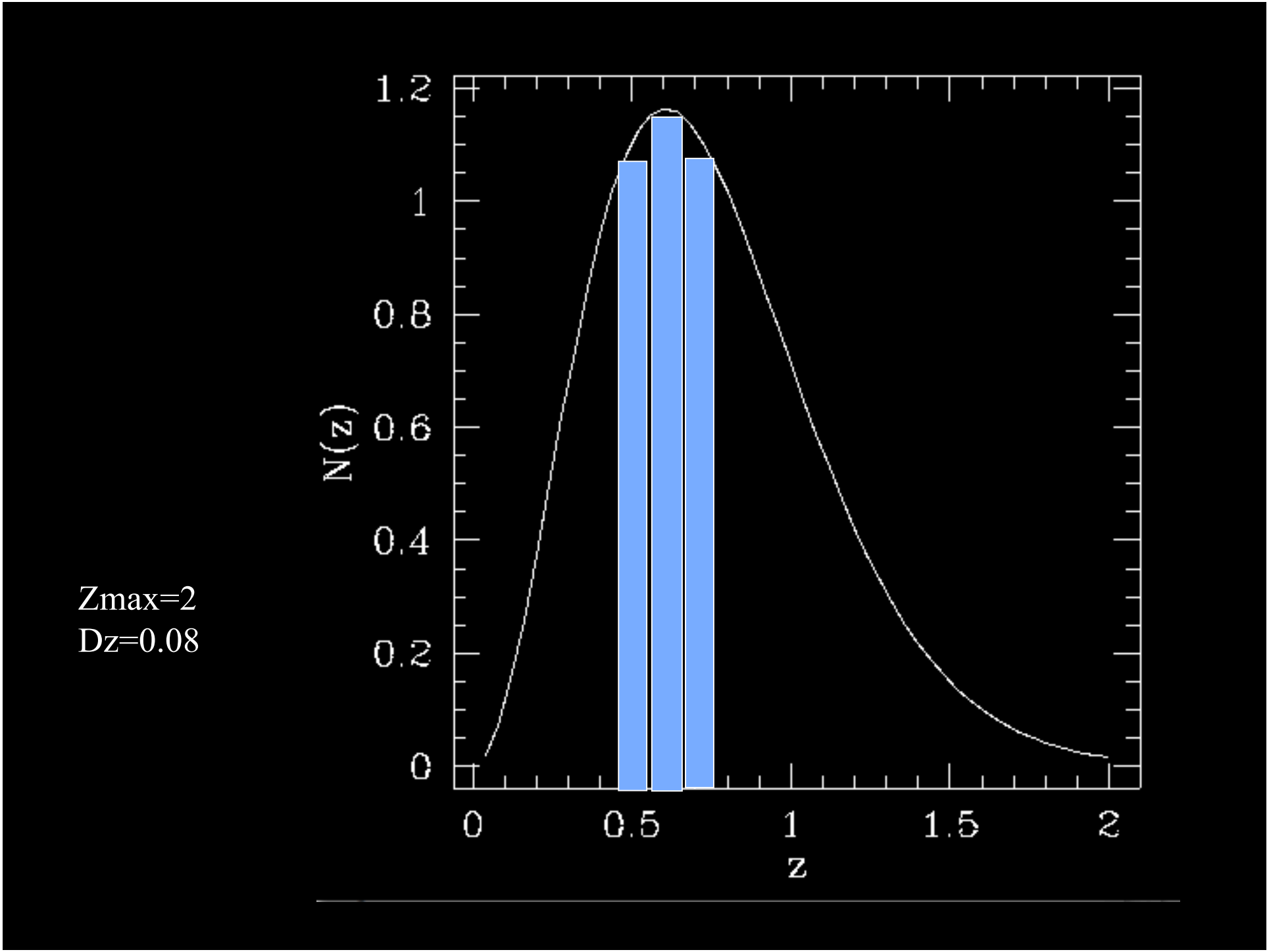

SDSS DR4


WMAP3−SDSS4 r=20−21 z=0.33
wTG(μK)
θ(deg)
1
0.8
0.6
0.4
0.2
0
1
10

High?

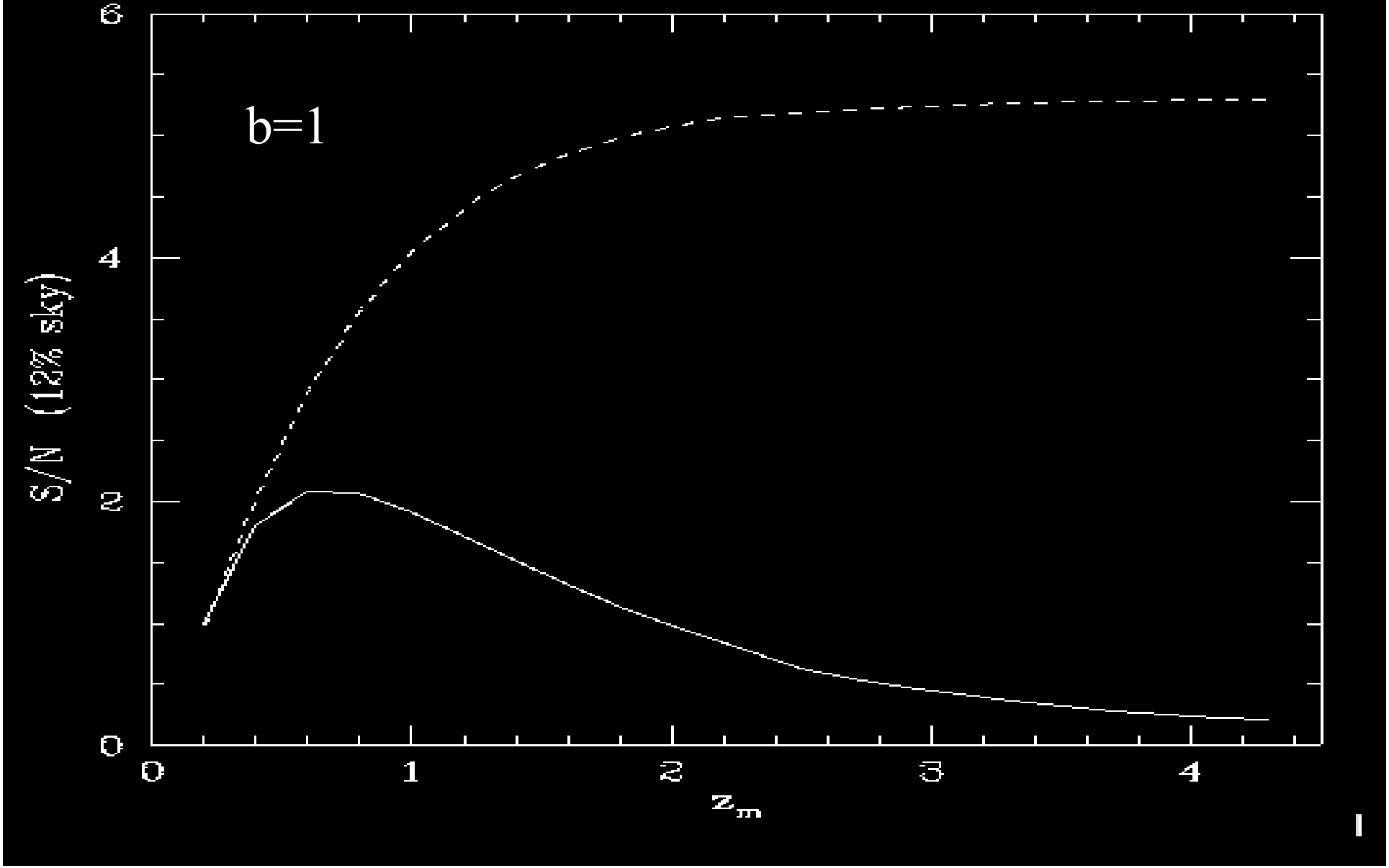
S/N~4.7

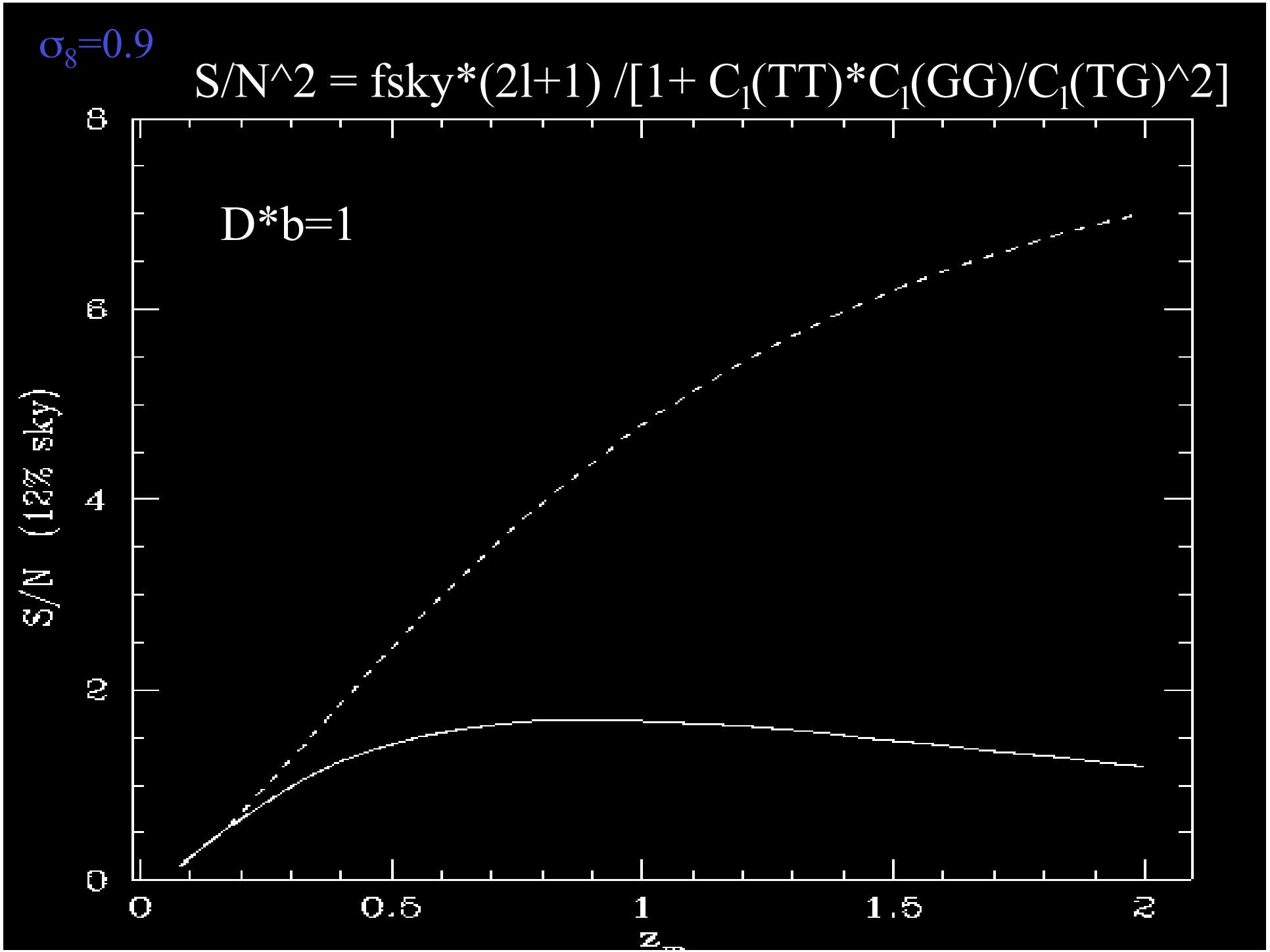

WMAP3−SDSS4 LRG z=0.5
wTG(μK)
θ(deg)
1
0.5
0
1
10


1.2
1
0.8
0.6
0.4
0.2
0
N(z)
0
0.5
1
1.5
2
z
Zmax=2
Dz=0.08

σ_8=0.9

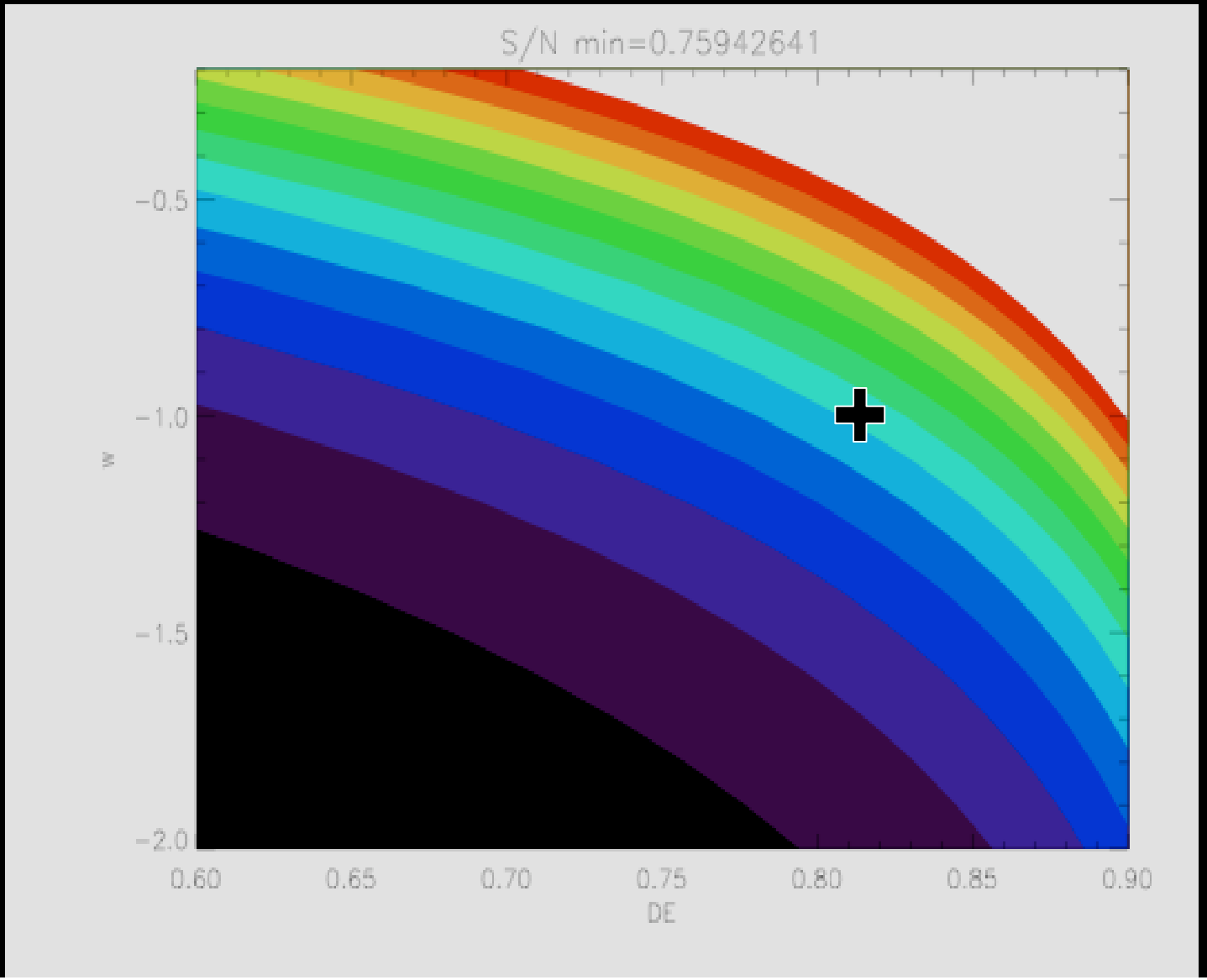
$$S/N^2 = fsky*(2l+1) /[1+ C_l(TT)*C_l(GG)/C_l(TG)^2]$$




σ_8=0.9
S/N^2 = fsky*(2l+1) /[1+ C_l(TT)*C_l(GG)/C_l(TG)^2]
D*b=1
S/N (12% sky)
0
2
4
6
8
0
0.5
1
1.5
2
z_m

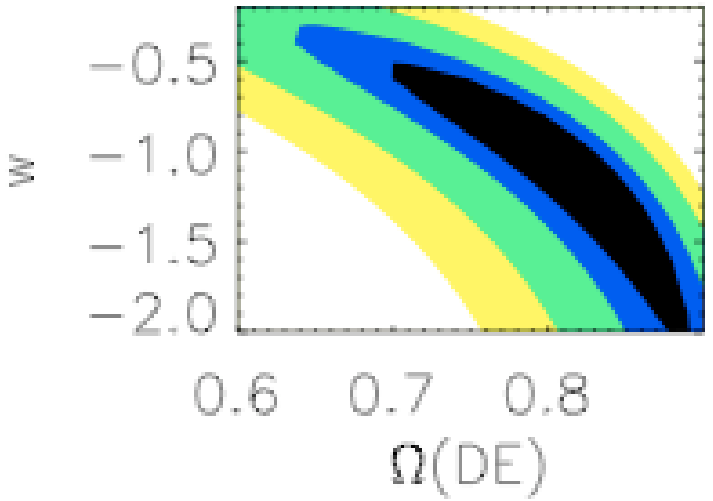
$S/N^2 = fsky*(2l+1) /[1+ C_l(TT)*C_l(GG)/C_l(TG)^2]$

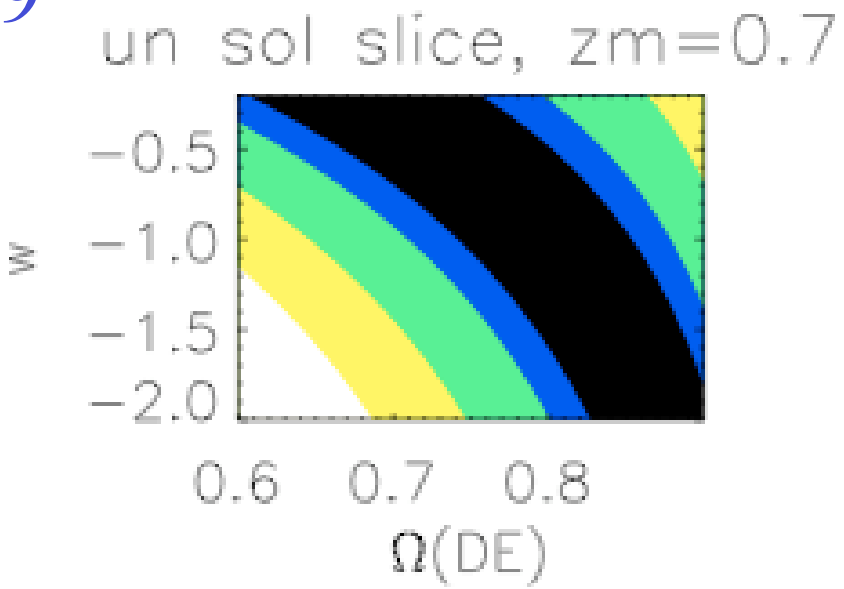
$\sigma_8=0.9$



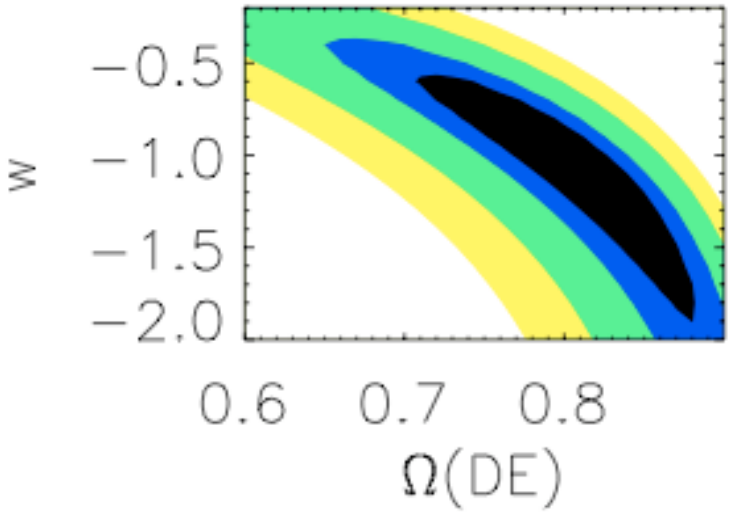
D*b=1
Zmax=2
Dz=0.08

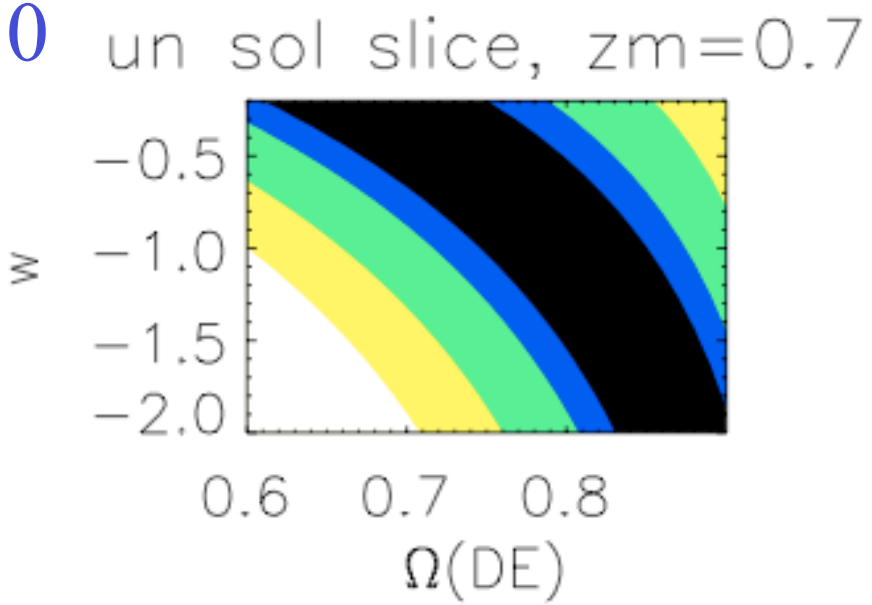
σ_8=0.9

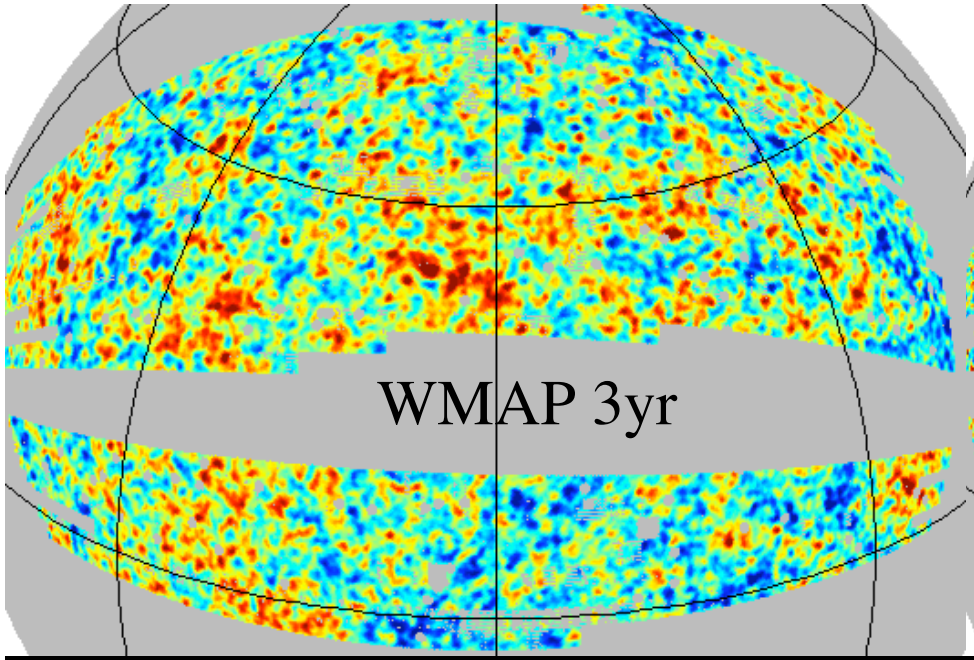


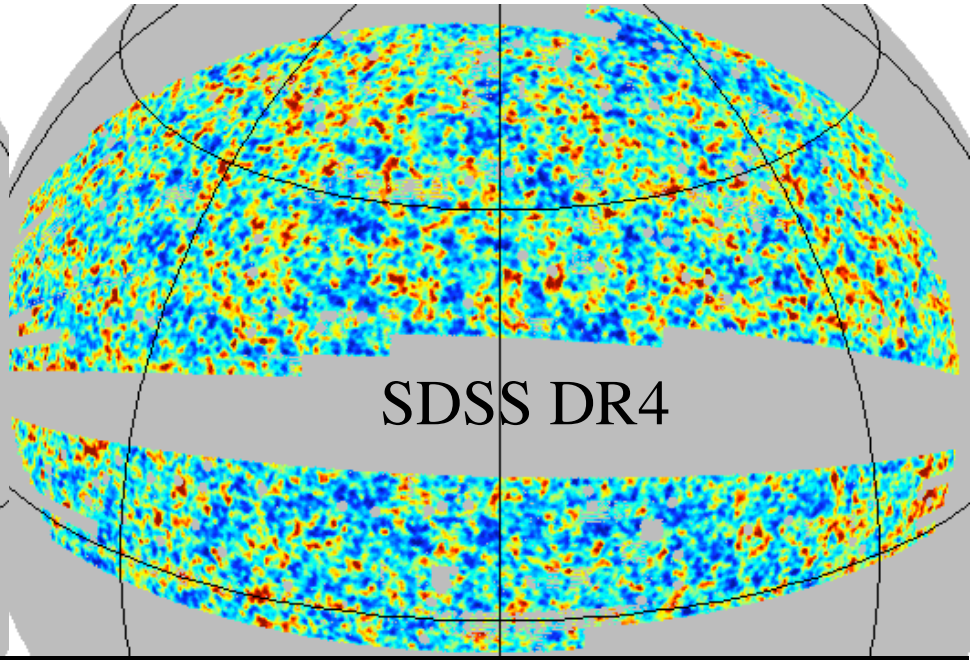


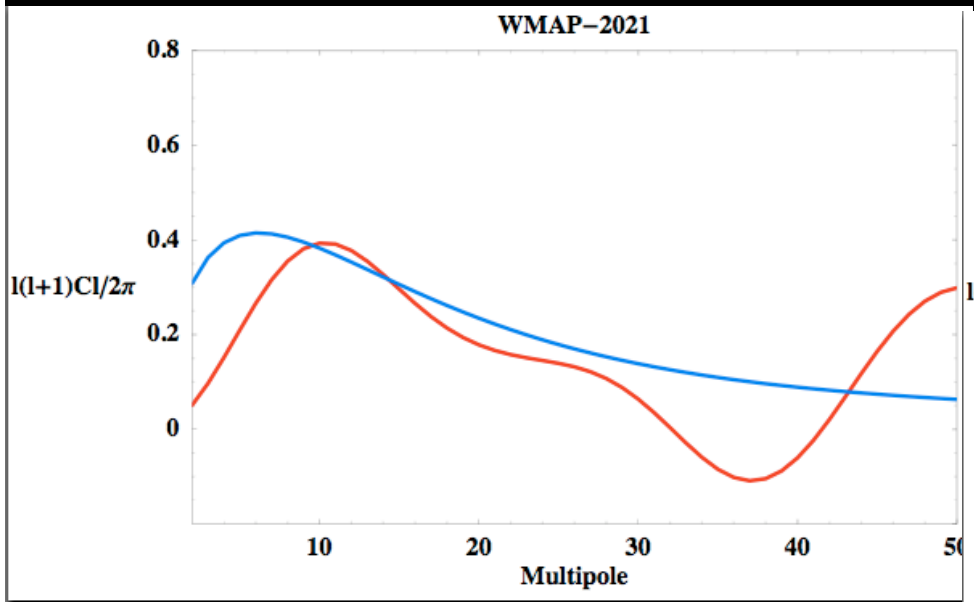
σ_8=1.0

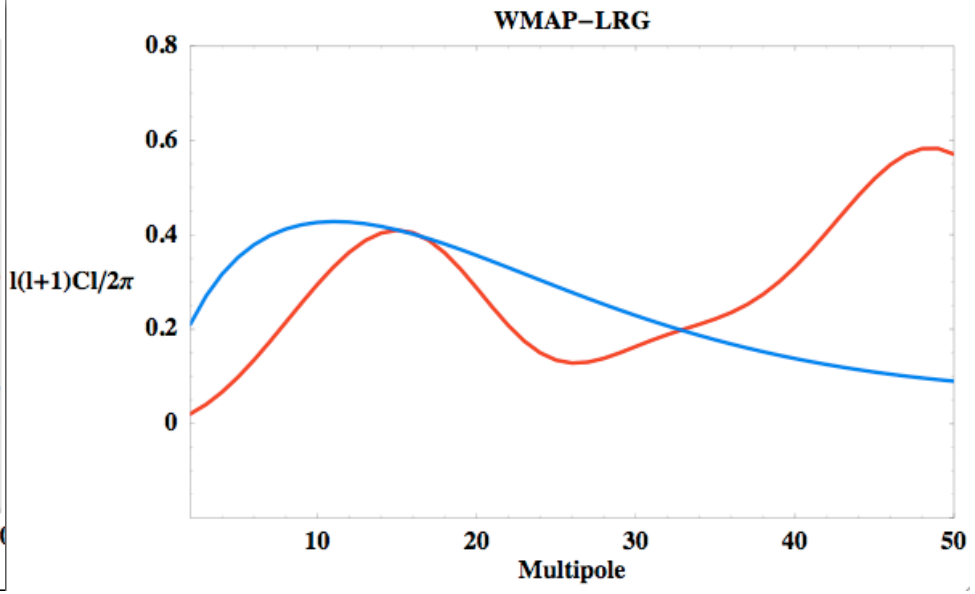




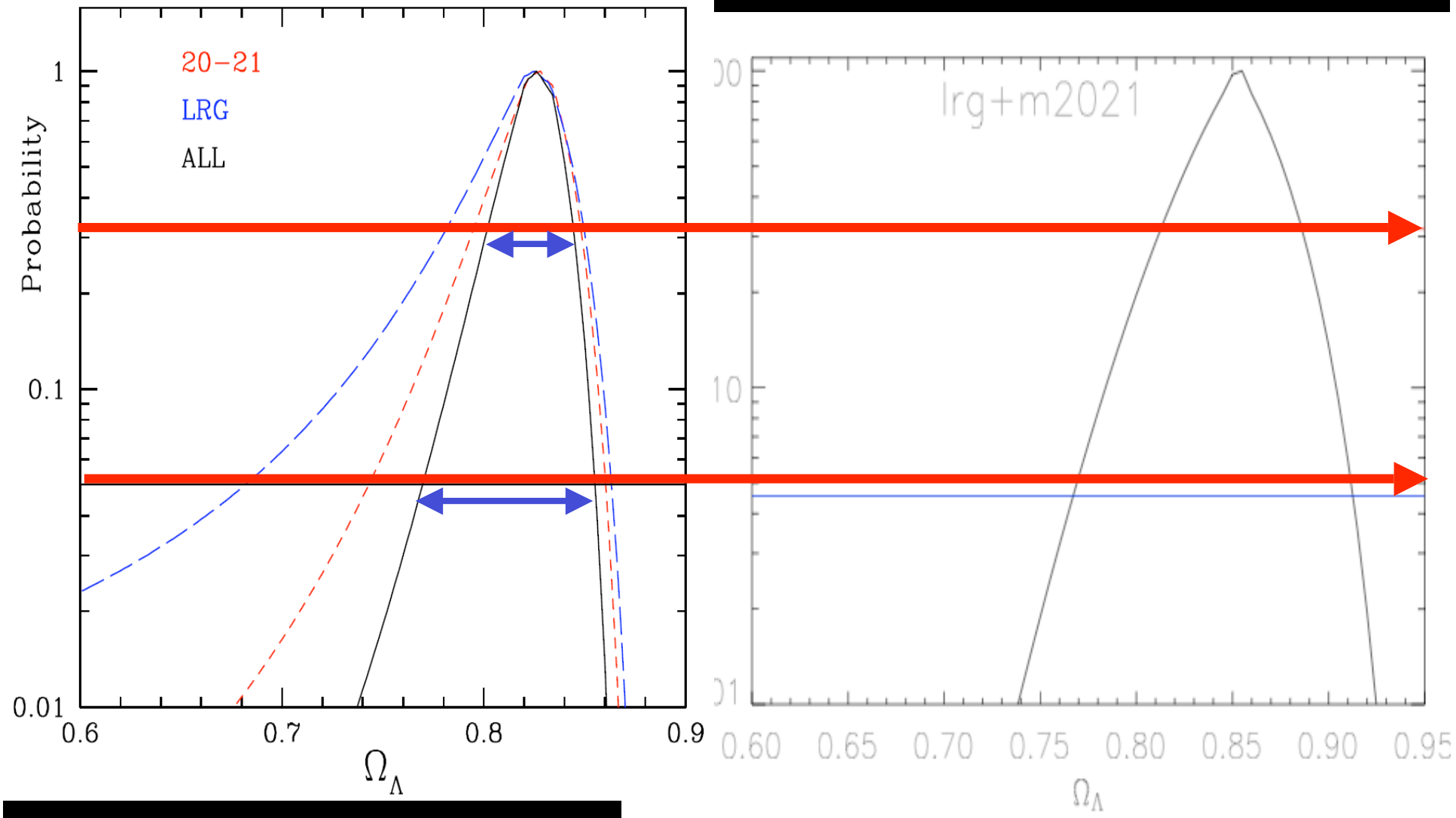

WMAP 3yr


SDSS DR4


WMAP−2021
0.8
0.6
0.4
0.2
0
l(l+1)Cl/2π
10
20
30
40
50
Multipole

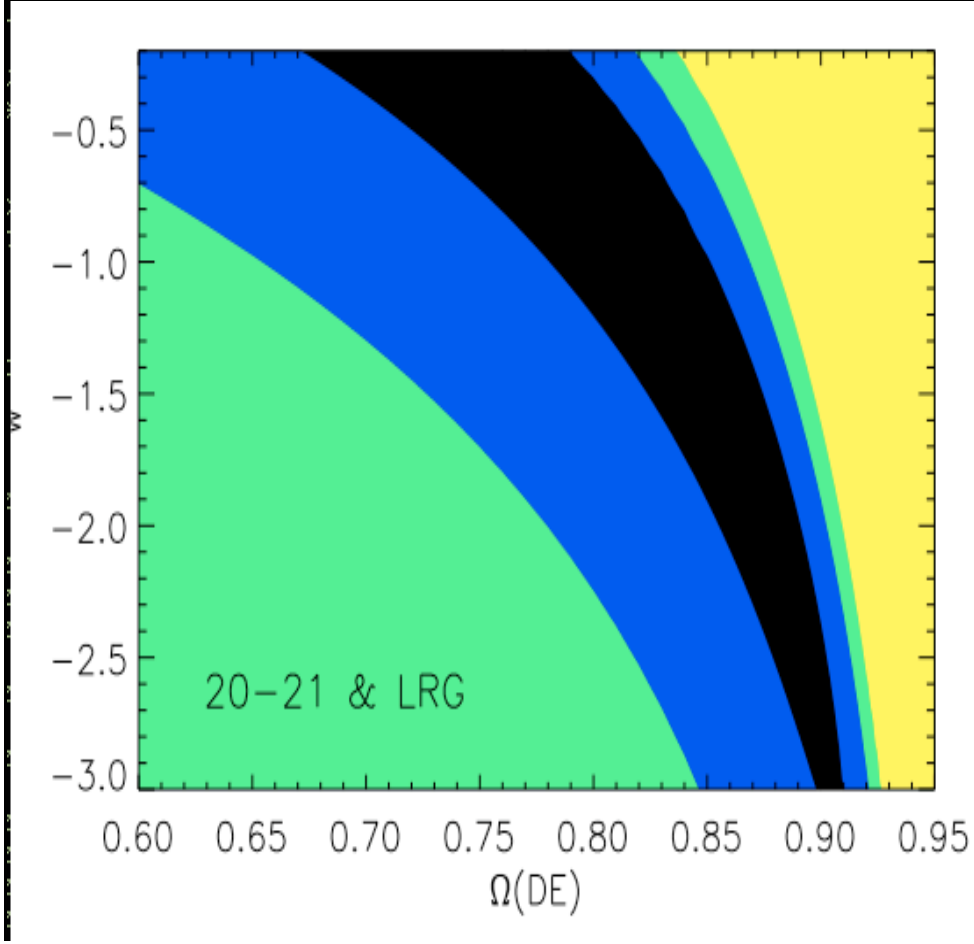

WMAP−LRG
0.8
0.6
0.4
0.2
0
l(l+1)Cl/2π
10
20
30
40
50
Multipole

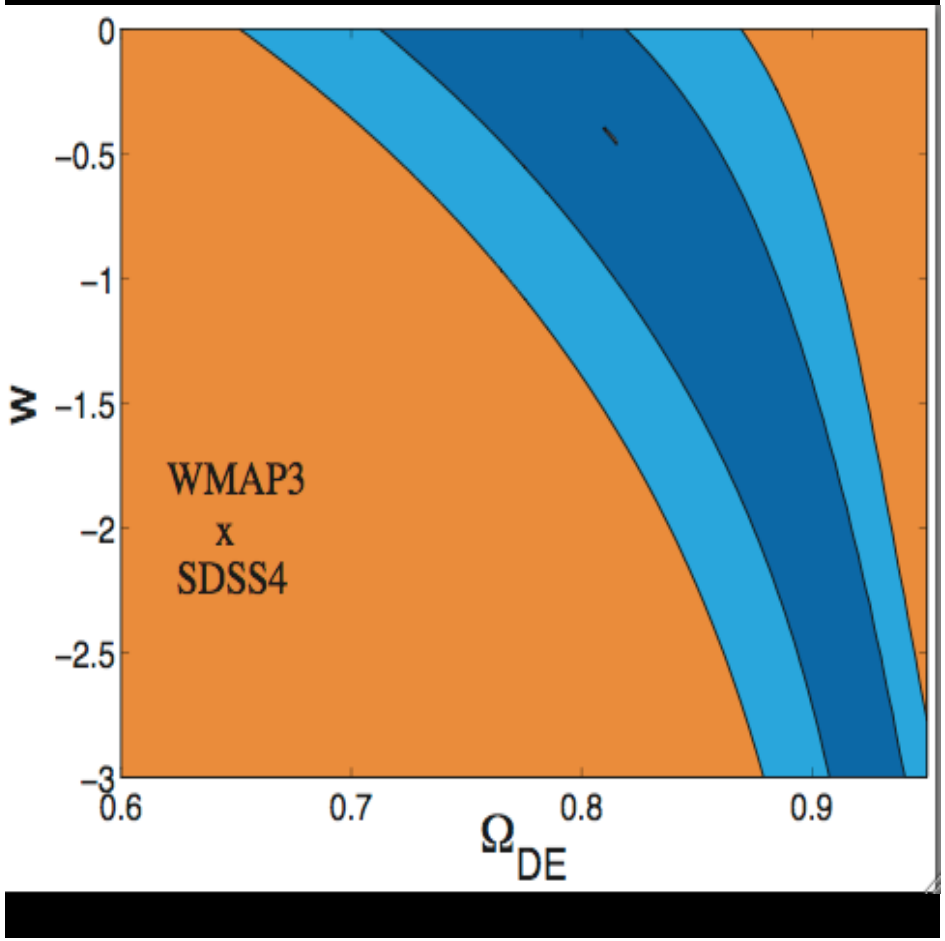
Comparing Configuration and Harmonic space error analysis

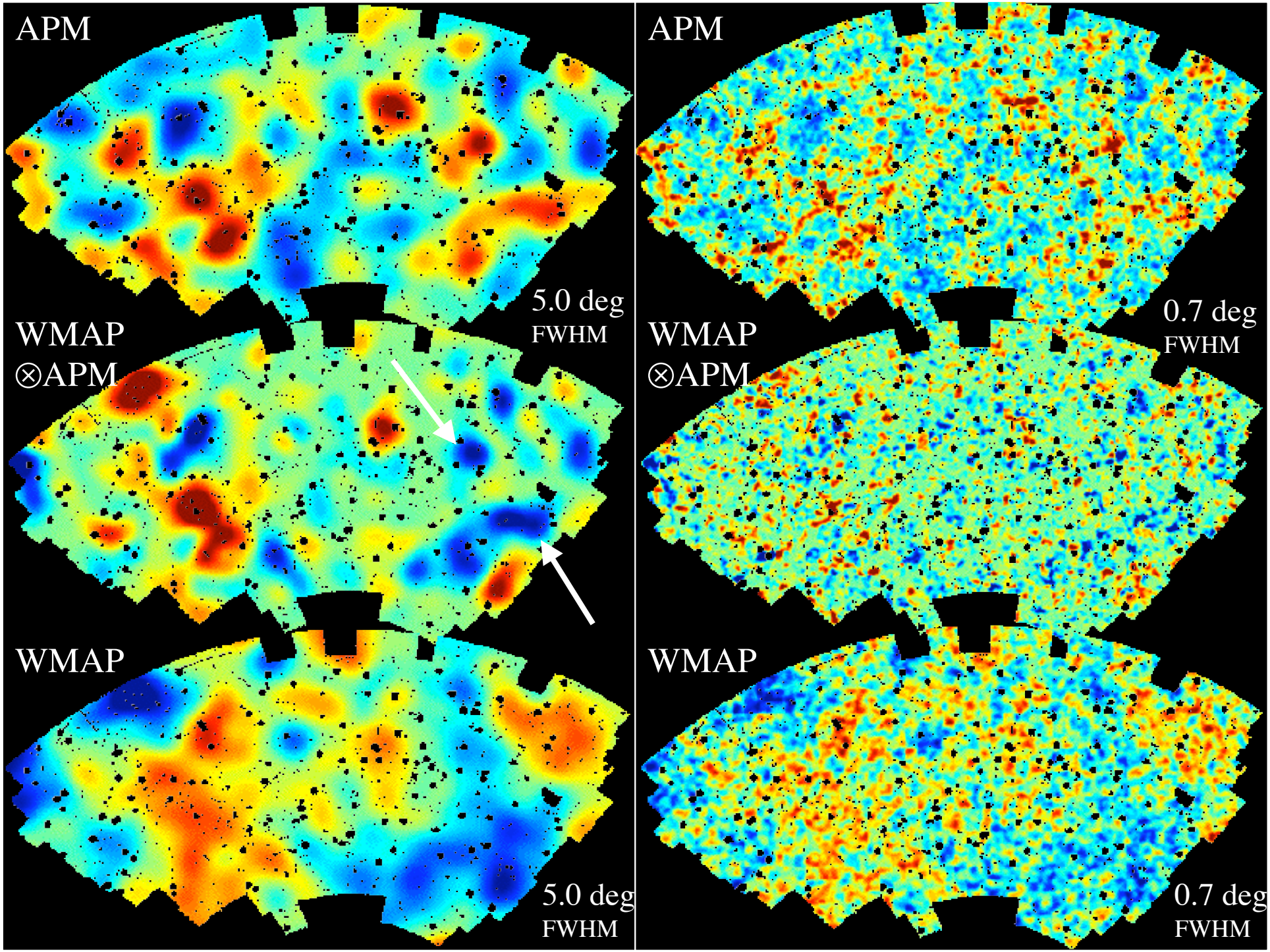


Comparing Configuration and Harmonic space error analysis

Marginalized over sigma8






APM
5.0 deg
FWHM
WMAP
⊗APM
WMAP
5.0 deg
FWHM
APM
0.7 deg
FWHM
WMAP
⊗APM
WMAP
0.7 deg
FWHM

Data Compilation

EG, Manera, Multamaki (astro-ph/ 0407022, MNRAS 2006)

Coverage: *z= 0.1 - 1.0*

Area 4000 sqrdeg to All sky

Bands: *X-ray,Optical, IR, Radio*

Sytematics: *Extinction*

& dust in galaxies.

WMAP team (Nolta et al., astro-ph/0305467) and Boughm & Crittenden (astro-ph/0305001). Radio Galaxies (NVSS) + X-ray HEAO (both at z =0.8-1.1)

APM (Fosalba & EG astro-ph/05468)

z=0.15-0.3

SDSS (Fosalba, EG, Castander, astro-ph/0307249) z=0.3-0.5

SDSS team (Scranton et al 0307335)

2Mass (Afshordi et al 0308260) z=0.1

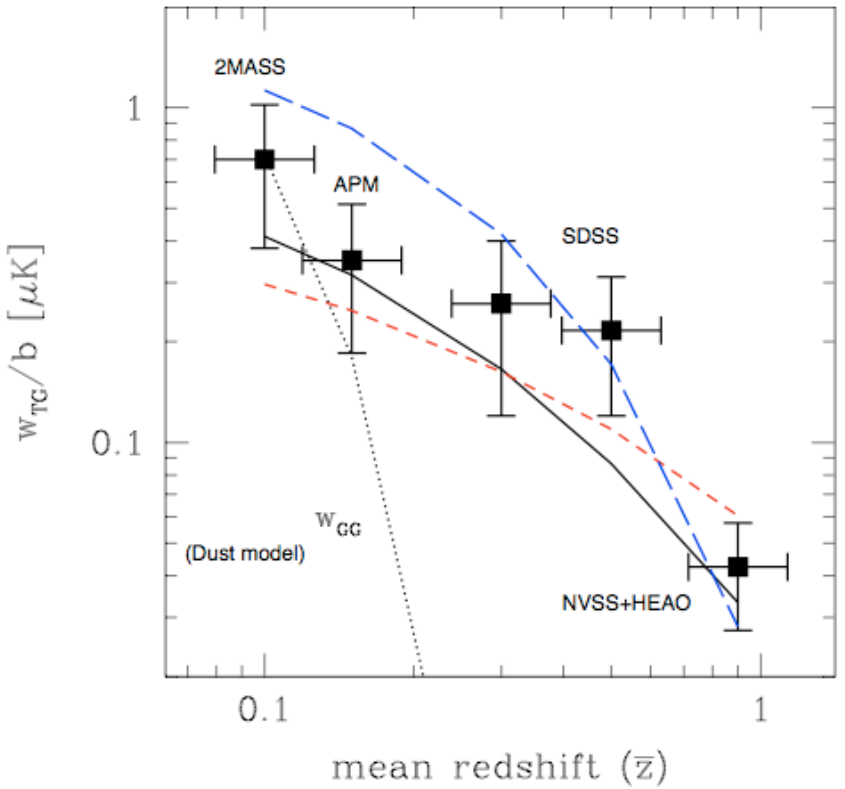


Figure 4. Symbols with error bars correspond to the different measurements w_{TG}/b in Table 1. As an illustration of the shape, the continuous, short-dashed and long-dashed lines show the concordance ($\Omega_m = 0.3, \Omega_\Lambda = 0.7$), opened ($\Omega_m = 0.3, \Omega_\Lambda = 0.0$) and closed ($\Omega_m = 0.3, \Omega_\Lambda = 1.1$) model predictions (at $\theta = 6°$). The dotted line corresponds to the galaxy-galaxy prediction (and also the dust contamination model). All lines have arbitrary normalization.

Compilation

EG, Manera, Multamaki (MNRAS 2006)

Marginalized over:

-h=0.6-0.8

-relative normalization of P(k)

Normalize to sigma8=1 for CM

Bias from Gal-Gal correlation

With SNIa:

$\Omega_\Lambda = 0.71 +/- 0.13$

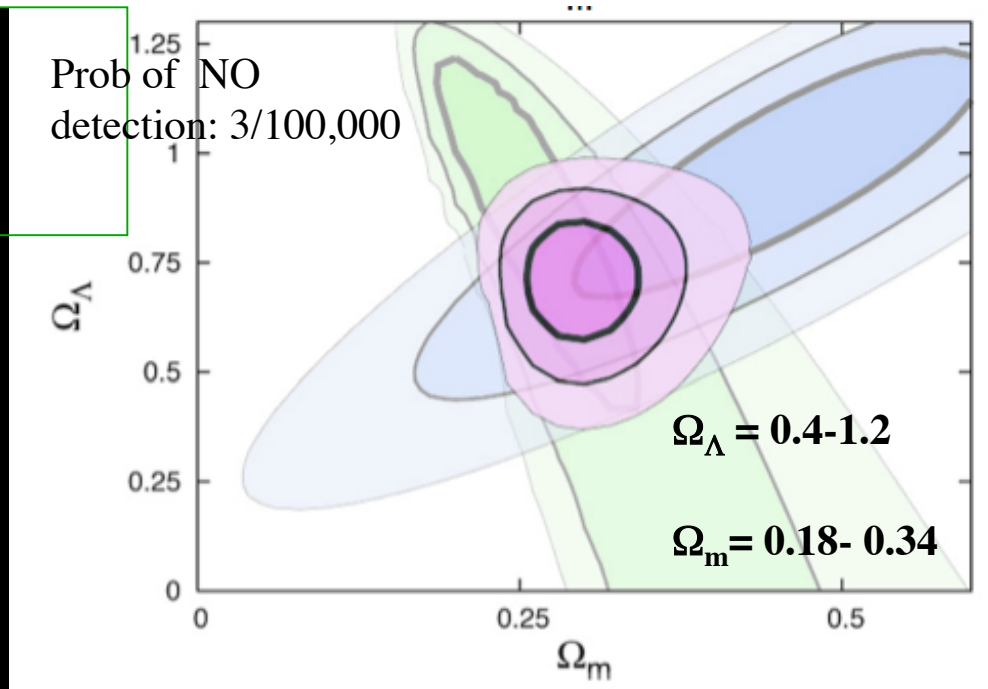
$\Omega_m = 0.29 +/- 0.04$

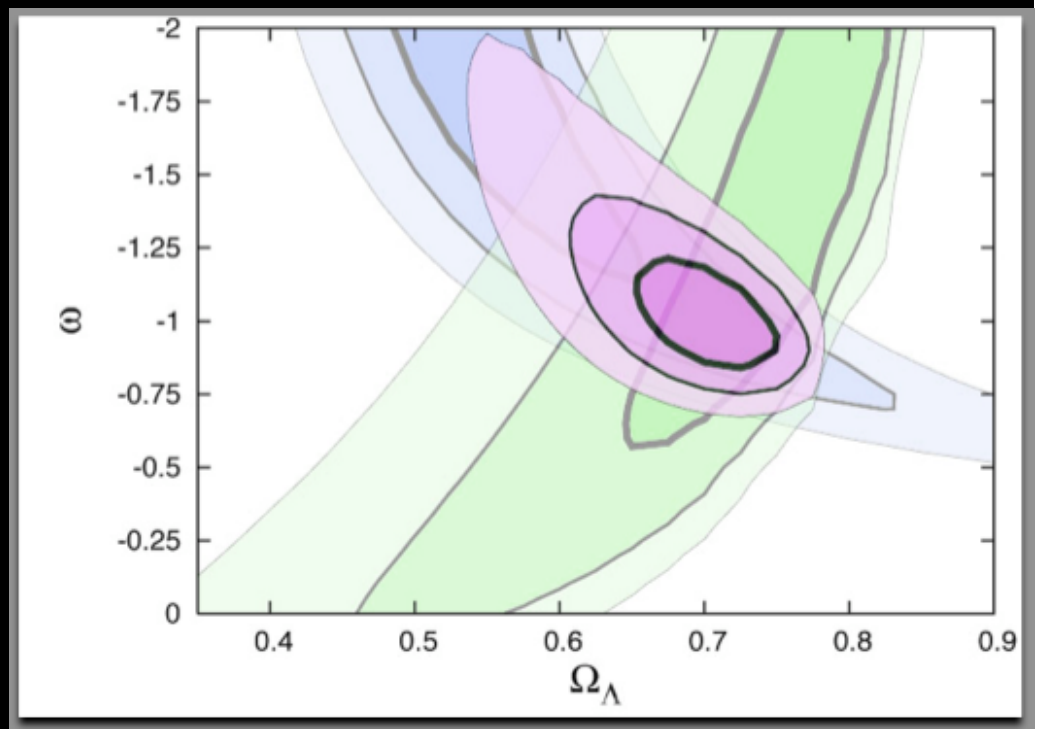
With SNIa+ flat prior:

$\Omega_\Lambda = 0.70 +/- 0.05$

$w = 1.02 +/- 0.17$

Prob of NO detection: 3/100,000





Conclusions

Preminary!

- JK errors are quite OK (for Gaussian sim).
- theory errors are OK for gaussian case.
- cross-correlation: up to 20%
- c_l equiv. to w2 (despite diff. assumptions on mask and gaussianity)
- S/N ~ 4-5 (model dependent). Who cares?
- WMAP3xSDSS4 detection is high
- whatch out for b dependence and b=b(z)
- DES error in w up to ~ 20%
- tomography: w=w(z)?
- constraints on c_s?