

# Characterizing the universe

Alain Blanchard, LATT

March 19, 2010

# Constraints on C.D.M. cosmology from galaxy power spectrum, CMB and SNIa evolution

(**Ferramacho**, Blanchard & Zolnierowski, 2009, *A&A*, **499**, 21)

# Standard Cosmological model: $\Lambda$ CDM

## Parameters in $\Lambda$ CDM

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Parameter	Vanilla	Vanilla + $\Omega_k$	Vanilla + w	Vanilla + $\Omega_k$ + w
$\Omega_b h^2$	$0.0227 \pm 0.0005$	$0.0227 \pm 0.0006$	$0.0228 \pm 0.0006$	$0.0227 \pm 0.0005$
$\Omega_c h^2$	$0.112 \pm 0.003$	$0.109 \pm 0.005$	$0.109 \pm 0.005$	$0.109 \pm 0.005$
$\theta$	$1.042 \pm 0.003$	$1.042 \pm 0.003$	$1.042 \pm 0.003$	$1.042 \pm 0.003$
$\tau$	$0.085 \pm 0.017$	$0.088 \pm 0.017$	$0.087 \pm 0.017$	$0.088 \pm 0.017$
$n_s$	$0.963 \pm 0.012$	$0.964 \pm 0.013$	$0.967 \pm 0.014$	$0.964 \pm 0.014$
$\log(10^{10} A_s)$	$3.07 \pm 0.04$	$3.06 \pm 0.04$	$3.06 \pm 0.04$	$3.06 \pm 0.04$
$\Omega_k$	0	$-0.005 \pm 0.007$	0	$-0.005 \pm 0.0121$
w	-1	-1	$-0.965 \pm 0.056$	$-1.003 \pm 0.102$
$\Omega_\Lambda$	$0.738 \pm 0.015$	$0.735 \pm 0.016$	$0.739 \pm 0.014$	$0.733 \pm 0.020$
Age	$13.7 \pm 0.1$	$13.9 \pm 0.4$	$13.7 \pm 0.1$	$13.9 \pm 0.6$
$\Omega_m$	$0.262 \pm 0.015$	$0.270 \pm 0.019$	$0.261 \pm 0.020$	$0.272 \pm 0.029$
$\sigma_8$	$0.806 \pm 0.023$	$0.791 \pm 0.030$	$0.816 \pm 0.014$	$0.788 \pm 0.042$
$z_{re}$	$10.9 \pm 1.4$	$11.0 \pm 1.5$	$11.0 \pm 1.5$	$11.0 \pm 1.4$
h	$0.716 \pm 0.014$	$0.699 \pm 0.028$	$0.713 \pm 0.015$	$0.698 \pm 0.037$



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SNIa, CMB, P(k)

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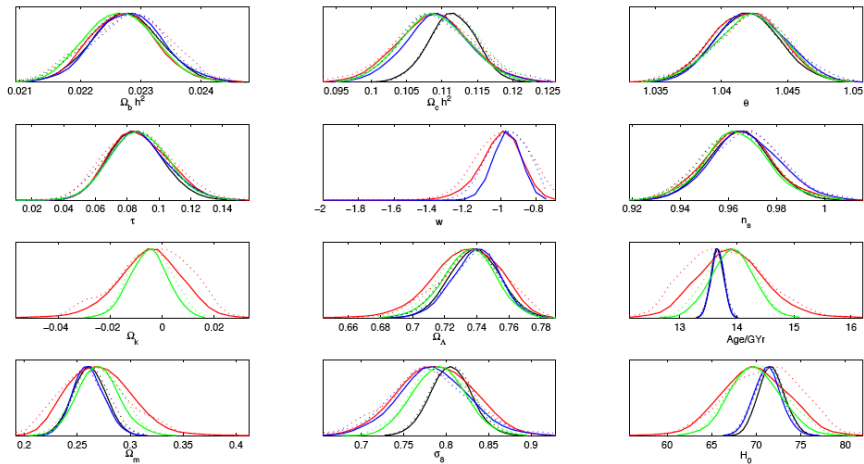
First combined likelihood published (?)

# Standard Cosmological model: $\Lambda$ CDM

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Standard Cosmological model:  $\Lambda$ CDM

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Not much progresses...

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Table 10. Basic and Derived Cosmological Parameters: Running Spectral Index Model<sup>a</sup>

	Mean and 68% Confidence Errors
Amplitude of fluctuations	$A = 0.83^{+0.09}_{-0.08}$
Spectral Index at $k = 0.05 \text{ Mpc}^{-1}$	$n_s = 0.93 \pm 0.03$
Derivative of Spectral Index	$dn_s/d \ln k = -0.031^{+0.016}_{-0.018}$
Hubble Constant	$h = 0.71^{+0.04}_{-0.03}$
Baryon Density	$\Omega_b h^2 = 0.0224 \pm 0.0009$
Matter Density	$\Omega_m h^2 = 0.135^{+0.008}_{-0.009}$
Optical Depth	$\tau = 0.17 \pm 0.06$
Matter Power Spectrum Normalization	$\sigma_8 = 0.84 \pm 0.04$
Characteristic Amplitude of Velocity Fluctuations	$\sigma_8 \Omega_m^{0.6} = 0.38^{+0.04}_{-0.05}$
Baryon Density/Critical Density	$\Omega_b = 0.044 \pm 0.004$
Matter Density/Critical Density	$\Omega_m = 0.27 \pm 0.04$
Age of the Universe	$t_0 = 13.7 \pm 0.2 \text{ Gyr}$

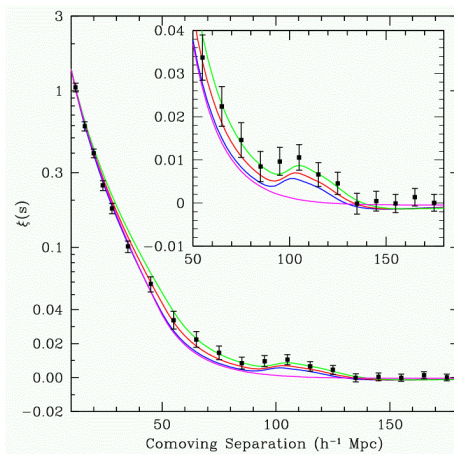
WMAP 2003

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Instead of  $P(k)$  use  $\xi_{LRG}(r)$

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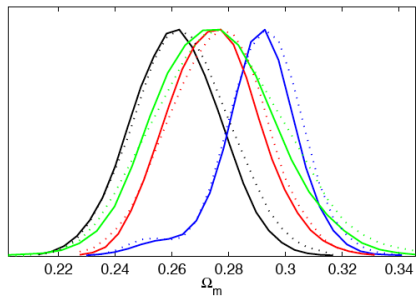
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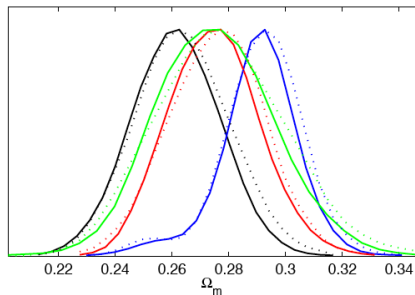
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Vanilla:  $\Omega_m = 0.295 \pm 0.015$

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Lattest results:

Standard Cosmological model:  $\Lambda$ CDM

Lattest results:

parameter	$\Lambda$ CDM	$\omega\Lambda$ CDM	wCDM	$\omega$ wCDM	$\omega$ wCDM+SN
$\Omega_m$	$0.289 \pm 0.019$	$0.309 \pm 0.025$	$0.328 \pm 0.037$	$0.306 \pm 0.050$	$0.312 \pm 0.022$
$H_0$	$69.4 \pm 1.6$	$66.0 \pm 2.7$	$64.3 \pm 4.1$	$66.7^{+5.9}_{-5.6}$	$65.6 \pm 2.5$
$D_V(0.35)$	$1349 \pm 23$	$1415 \pm 49$	$1398 \pm 45$	$1424 \pm 49$	$1418 \pm 49$
$r_s/D_V(0.35)$	$0.1125 \pm 0.0023$	$0.1084 \pm 0.0034$	$0.1094 \pm 0.0032$	$0.1078^{+0.0033}_{-0.0034}$	$0.1081 \pm 0.0034$
$\Omega_k$	-	$-0.0114^{+0.0076}_{-0.0077}$	-	$-0.009 \pm 0.012$	$-0.0109 \pm 0.0088$
$w$	-	-	$-0.79 \pm 0.15$	$-1.06 \pm 0.38$	$-0.99 \pm 0.11$
$\Omega_\Lambda$	$0.711 \pm 0.019$	$0.703 \pm 0.021$	$0.672 \pm 0.037$	$0.703^{+0.057}_{-0.058}$	$0.699 \pm 0.020$
Age (Gyr)	$13.73 \pm 0.13$	$14.25 \pm 0.37$	$13.87 \pm 0.17$	$14.27 \pm 0.52$	$14.24 \pm 0.40$
$\Omega_{\text{tot}}$	-	$1.0114^{+0.0077}_{-0.0076}$	-	$1.009 \pm 0.012$	$1.0109 \pm 0.0088$
$100\Omega_b h^2$	$2.272 \pm 0.058$	$2.274 \pm 0.059$	$2.293^{+0.062}_{-0.063}$	$2.279^{+0.066}_{-0.065}$	$2.276^{+0.060}_{-0.059}$
$\Omega_c h^2$	$0.1161^{+0.0039}_{-0.0038}$	$0.1110 \pm 0.0052$	$0.1112^{+0.0056}_{-0.0057}$	$0.1103^{+0.0055}_{-0.0054}$	$0.1110^{+0.0051}_{-0.0052}$
$\tau$	$0.084 \pm 0.016$	$0.089 \pm 0.017$	$0.088 \pm 0.017$	$0.088 \pm 0.017$	$0.088 \pm 0.017$
$n_s$	$0.961 \pm 0.013$	$0.962 \pm 0.014$	$0.969 \pm 0.015$	$0.965 \pm 0.016$	$0.964 \pm 0.014$
$\ln(10^{10} A_{05})$	$3.080^{+0.036}_{-0.037}$	$3.068 \pm 0.040$	$3.071^{+0.040}_{-0.039}$	$3.064 \pm 0.041$	$3.068 \pm 0.039$
$\sigma_8$	$0.824 \pm 0.025$	$0.796 \pm 0.032$	$0.735 \pm 0.073$	$0.79 \pm 0.11$	$0.790^{+0.045}_{-0.046}$

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$\sigma_8$	$0.824 \pm 0.025$	$0.796 \pm 0.032$	$0.735 \pm 0.073$	$0.79 \pm 0.11$	$0.790^{+0.045}_{-0.046}$

WMAP5 + DR 7  $\Omega_m = 0.289 \pm 0.019$

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What if SNIa evolved ?

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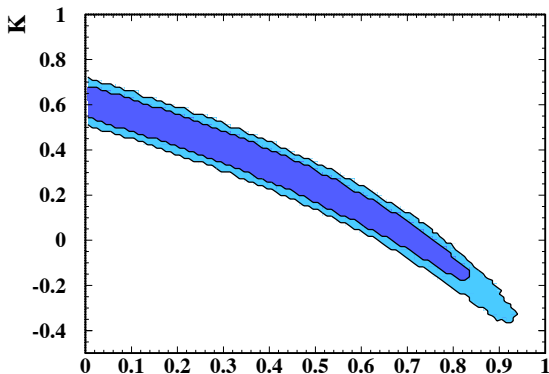
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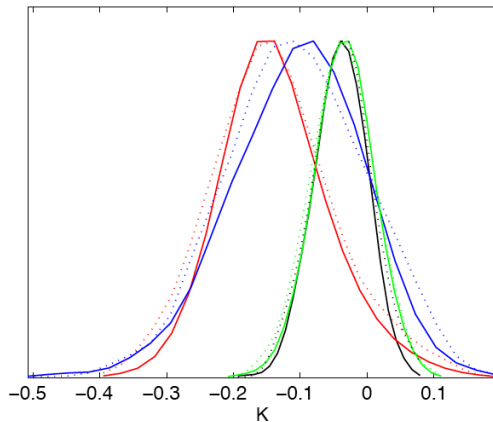
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$\Omega_c h^2$	$0.110 \pm 0.004$	$0.109 \pm 0.005$	$0.113 \pm 0.005$	$0.111 \pm 0.005$
$\theta$	$1.042 \pm 0.003$	$1.042 \pm 0.003$	$1.042 \pm 0.003$	$1.042 \pm 0.003$
$\tau$	$0.088 \pm 0.017$	$0.087 \pm 0.017$	$0.085 \pm 0.017$	$0.085 \pm 0.016$
$n_s$	$0.968 \pm 0.013$	$0.965 \pm 0.013$	$0.963 \pm 0.014$	$0.960 \pm 0.014$
$\log(10^{10} A_s)$	$3.07 \pm 0.04$	$3.06 \pm 0.04$	$3.07 \pm 0.04$	$3.06 \pm 0.04$
$\Omega_k$	0	$-0.002 \pm 0.007$	0	$-0.017 \pm 0.013$
w	-1	-1	$-1.112 \pm 0.148$	$-1.33 \pm 0.242$
K	$-0.042 \pm 0.042$	$-0.035 \pm 0.042$	$-0.105 \pm 0.091$	$-0.133 \pm 0.077$
$\Omega_\Lambda$	$0.747 \pm 0.017$	$0.745 \pm 0.020$	$0.756 \pm 0.022$	$0.744 \pm 0.022$
Age	$13.6 \pm 0.1$	$13.7 \pm 0.4$	$13.6 \pm 0.1$	$14.5 \pm 0.7$
$\Omega_m$	$0.253 \pm 0.017$	$0.257 \pm 0.025$	$0.244 \pm 0.022$	$0.272 \pm 0.029$
$\sigma_8$	$0.801 \pm 0.026$	$0.794 \pm 0.029$	$0.846 \pm 0.068$	$0.867 \pm 0.060$
$z_{re}$	$11.1 \pm 1.5$	$11.0 \pm 1.4$	$10.9 \pm 1.5$	$10.8 \pm 1.4$
h	$0.725 \pm 0.017$	$0.720 \pm 0.036$	$0.748 \pm 0.038$	$0.703 \pm 0.042$

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Constraining SNIa evolution!

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