A Assumed Cosmology

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One of the most important scientific goals of the LSST is to refine and rigorously test our current "standard model" of cosmology. In predictions of LSST's performance, however, we must agree on a fiducial cosmology, which we describe here. This book will describe our predictions for LSST's ability to tighten our constraints on these parameters, test for consistency among a variety of cosmological probes, and test some of the basic assumptions of the model, from the Cosmological Principle, to the clustering and isotropy of dark energy.

Our fiducial model is a cold dark matter (CDM) universe with a large fraction of its energy density in the form of dark energy that has an equation of state $w = p/\rho$ (wCDM). This model is characterized by the 11 parameters listed in Table A.1, which are taken from the WMAP five-year data analysis (Dunkley et al. 2009). We use the WMAP-only results to avoid dealing with the complex correlations between LSST probes and other probes incorporated in Dunkley et al. (2009). Slight changes to the fiducial model do not affect our assessment of the LSST performance. Since the cosmic microwave background (CMB) alone cannot constrain all 11 parameters, we center the fiducial model on the concordance ΛCDM model (i.e., $w_0 = -1$, $w_\mathrm{a} = 0$, and $\Omega_\mathrm{k} = 0$) and allow all the 11 parameters to float in the forecasts.

We adopt a phenomenological parametrization for the dark energy equation of state used by the report of the Dark Energy Task Force (Albrecht et al. 2006): $w(a) = w_0 + w_\mathrm{a}(1 - a)$, where a is the expansion factor. The rest of the parameters are chosen to be convenient for techniques such as baryon acoustic oscillations (BAO) and weak lensing and for combining LSST constraints with CMB results. For example, the lensing potential scales with the physical matter density ω_m, not by the matter fraction Ω_m alone ($\omega_\mathrm{m} = \Omega_\mathrm{m} h^2$ and h is the reduced Hubble constant). Likewise, the BAO features are determined by ω_m and the physical baryon density $\omega_\mathrm{b} = \Omega_\mathrm{b} h^2$, where Ω_b is the baryon fraction.

In addition to Table A.1, we also make standard assumptions about other parameters and processes, e.g., adiabatic initial condition, standard recombination history, three effective number of neutrino species, etc. We fix the neutrino mass to zero in all but § 15.2 where we estimate the upper limit that can be placed by LSST shear and galaxy clustering data. The actual values of the neutrino masses have little impact on most forecasts, as long as they are held fixed.

References

Albrecht, A. et al., 2006, ArXiv Astrophysics e-prints, astro-ph/0609591

Dunkley, J. et al., 2009, *ApJS*, 180, 306

Table A.1: Cosmological parameters from WMAP five-year results[†]

Symbol	Value	Remarks
w_0	-1	dark energy equation of state at $z = 0$
w_a	0	rate-of-change of the dark energy EOS as in $w(a) = w_0 + w_a(1 - a)$
$\omega_{\rm m}$	0.133	physical matter density $\omega_{\rm m} = \Omega_{\rm m} h^2$, $\Omega_{\rm m} = 0.258$
$\omega_{\rm b}$	0.0227	physical baryon density $\omega_{\rm b} = \Omega_{\rm b} h^2$, $\Omega_{\rm b} = 0.0441$
θ_s	0.596°	angular size of the sound horizon at the last scattering surface
$\Omega_{\rm k}$	0	curvature parameter
τ	0.087	optical depth to scattering by electrons in the reionized intergalactic medium
Y_p	0.24	primordial helium mass fraction
n_s	0.963	spectral index of the primordial scalar perturbation power spectrum
α_s	0	running of the primordial scalar perturbation power spectrum
Δ_R^2	2.13×10^{-9}	normalization of the primordial curvature power spectrum at $k^* = 0.05\,\mathrm{Mpc}^{-1}$ ($\sigma_8 = 0.796$ or $\Delta_R^2 = 2.41 \times 10^{-9}$ at $k^* = 0.002\,\mathrm{Mpc}^{-1}$)

[†] The reduced Hubble constant $h = 0.719$ and the present equivalent matter fraction of dark energy $\Omega_X = 0.742$ are implicit in this parametrization, meaning that either one of them can replace θ_s or any parameter that affects θ_s.