APPENDIX D

SYMBOLS

Symbol	Explanation	First page listed
$\dot{}$	Derivative with respect to time (before Chapter 4)	
	or conformal time (afterwards)	
$\alpha^{(2)}$	Recombination rate of hydrogen	71
β	Ionization rate of hydrogen	71
$\Gamma^{\mu}_{\alpha\beta}$	Christoffel symbol	30
$\gamma_{1,2}$	Two components of shear	300
Γ	Parameter determining the power spectrum	205
δ_b	Baryon overdensity	106
$test_i$	Estimated anisotropy in pixel i	340
$\Delta^2(k)$	Dimensionless power on scale k	185
δ	Dark matter overdensity	104
δ	Slow-roll parameter (Chapter 6 only)	155
$\delta^D(\vec{k}-\vec{k}')$	Dirac delta function in D dimensions	16
$\delta\phi$	Perturbation to the scalar field driving inflation	152
δT^{μ}_{ν}	Perturbation to energy–momentum tensor	163
δ_{ij}	Kronecker delta $= 0(i \neq j)$ or $1(i = j)$	27
δ_H	Amplitude of primordial perturbations at horizon	171
ϵ	Slow-roll parameter	155
$\hat{\epsilon}$	Polarization unit vector	97
$\epsilon_{1,2}$	Two components of ellipticity	301
ϵ_0	Ionization energy of hydrogen, 13.6 eV	70
η	Conformal time	34
η_*	Conformal time at recombination	218
$\eta_{\rm eq}$	Conformal time at matter–radiation equality	213
η_b	Baryon-to-entropy ratio	62
$\eta_{\rm prim}$	Conformal time at the end of inflation	149
$\eta_{\mu\nu}$	Minkowski metric	26

Symbol	Explanation	First page listed
Θ	Perturbation to photon distribution	93
Θ_l	Legendre moment of photon perturbation	110
Θ_P	Polarization perturbation	111
Θ_r	Perturbation to radiation $= \rho_\gamma\Theta + \rho_\nu\mathcal{N}$	135
Θ^T	Photon perturbation due to tensor perturbations	116
κ	Convergence	300
Λ	Cosmological constant	10
μ	Cosine of the angle between $\hat{k}$ and $\hat{p}$	101
$\xi(r)$	3D correlation function	264
ξ^0, ξ	Generators of coordinate transformations	133
ρ_b	Baryon energy density	41
$\rho_{\rm cr}$	Critical energy density	3
$\rho_{\rm de}$	Dark energy density	50
$\rho_{\rm dm}$	Dark matter energy density	123
$\rho_{\rm m}$	Matter energy density	38
ρ_γ	Energy density of photons	40
ρ_ν	Energy density of neutrinos	46
ρ_r	Energy density of all radiation	38
σ_T	Thomson cross-section	72
$\tau(\eta)$	Optical depth of photons back to conformal time η	101
$\dot{\tau}$	Scattering rate	101
τ_n	Neutron lifetime	67
Φ	Scalar perturbation to metric	87
$\Phi_{\rm p}$	Primordial value of Φ set during inflation	183
$\phi^{(0)}$	Zero-order value of the field driving inflation	152
$\chi(z)$	Comoving distance out to redshift z	34
χ_∞	Comoving distance to redshift infinity	263
Ψ	Scalar perturbation to metric	87
ψ_{ij}	2×2 distortion tensor	302
Ω_i	Energy density in ith species over $\rho_{\rm cr}$	10
Ω_k	Ratio of curvature density to critical density	35
A_{ij}	2×2 transformation matrix	300
a	Scale factor of the universe	2
a_*	Scale factor at recombination	186
$a_{\rm eq}$	Scale factor at matter–radiation equality	51
$a_{\rm late}$	Scale factor after which perturbations evolve as D_1	183
B	B-mode of polarization or weak lensing	306
B_D	Binding energy of deuterium	65
C	Full covariance matrix	341
$\mathcal{C}$	Band power	389
$C_l^{\rm matter}$	Angular power spectrum for matter	290

Symbol	Explanation	First page listed
c_s	Sound speed	82
C_N	Covariance matrix due to the noise	339
C_S	Covariance matrix due to the signal	340
D_1	Growth function	183
d_A	Angular diameter distance	35
d_L	Luminosity distance	36
E	E-mode of polarization or weak lensing	306
$F_{\alpha\beta}$	Fisher matrix	366
$\mathcal{F}$	Curvature matrix	365
f	Distribution function, often referring to photons	38
$f_{\rm dm}$	Distribution function of dark matter	102
f_e	Distribution function of electrons	95
$f^{(0)}$	Zero-order distribution function of photons	93
$g(\eta)$	Visibility function	236
g_*	Effective relativistic degrees of freedom	67
$g_{\mu\nu}$	Metric	25
g_i	Number of spin states of species i	38
G	Newton's constant	3
$G_{\mu\nu}$	Einstein tensor	32
h	Parameter for Hubble constant	5
$\tilde{h}$	Variable tracing tensor perturbations	158
$h_\times, h_+$	Tensor perturbations to metric	116
$\mathcal{H}$	3D matrix describing tensor perturbations	126
H	Hubble rate of expansion	3
H_0	Hubble rate today	3
k	Wavenumber	101
$k_i = k^i$	Wavevector	101
$k_{\rm eq}$	Wavenumber crossing horizon at $a_{\rm eq}$	194
$k_{\rm nl}$	Wavenumber of nonlinearity	185
$k_{\rm p}$	Location of acoustic peaks	229
$\mathcal{L}$	Likelihood function	337
$\mathcal{M}$	Particle physics amplitude for a process	59
m_e	Electron mass	70
m_n	Neutron mass	64
m_ν	Neutrino mass	46
$m_{\rm Pl}$	Planck mass	53
m_p	Proton mass	64
N_p	Number of pixels in an experiment	341
$n_{\rm b}$	Baryon number density	62
$n_{\rm dm}$	Dark matter number density	103
$n_{\rm dm}^{(0)}$	Zero-order dark matter number density	104

Symbol	Explanation	First page listed
$n^{(0)}$	Equilibrium number density	61
$\mathcal{N}$	Perturbation to neutrino distribution function	111
$\mathcal{P}_l$	Legendre polynomial of order l	112
$\mathcal{P}$	Pressure	37
P^α	4D comoving energy–momentum vector	31
p	Proper momentum	56
$P(k)$	Power spectrum of matter	16
$P_\Phi(k)$	Gravitational potential power spectrum	167
$\hat{p}^i = \hat{p}_i$	Unit direction vector	90
$\mathcal{Q}$	Proton–neutron mass difference	65
Q	Stokes parameter	312
r	Tensor/scalar ratio	248
r_s	Sound horizon	228
$R_{\mu\nu}$	Ricci tensor	32
$\mathcal{R}$	Ricci scalar $= g^{\mu\nu}R_{\mu\nu}$	32
R	Baryon-to-photon ratio, $3\rho_b/4\rho_\gamma$	82
s	Entropy density	40
t	Age of the universe	2
$T_{\rm ant}$	Antenna temperature	379
T	Zero-order photon temperature	4
$T_{\mu\nu}$	Stress–energy tensor	32
U	Stokes parameter	312
$\vec{v}_{\rm b} = \hat{k}v_{\rm b}$	Velocity of baryons	96
$\vec{v} = \hat{k}v$	Velocity of dark matter	103
$v_{\rm H}$	Velocity due to Hubble expansion	261
$v_{\rm pec}$	Peculiar velocity	261
w	Pressure to energy-density ratio	50
$w(\theta)$	Angular correlation function	266
X_e	Free electron fraction	70
X_n	Neutron abundance	66
$X_{n,\rm EQ}$	Equilibrium neutron abundance	66
Y_p	Mass fraction of ^{4}He	69
y	Scale factor normalized to 1 at $a_{\rm eq}$	190
y_H	y when mode crosses horizon	202
$Y_{\rm EQ}$	Equilibrium abundance of dark matter particles	74
z	Redshift	7
z_*	Redshift at recombination	51
$z_{\rm eq}$	Redshift at matter–radiation equality	51