APPENDIX B

NUMBERS

Numbers in parentheses denote one standard deviation uncertainties in last digits (e.g., the Rydberg $\epsilon_0 = 13.60569172 \pm 5.3 \times 10^{-7}$ eV). The vast majority of these numbers, at least the physical constants, come from the Particle Data Group (Groom *et al.*, 2001).

B.1 PHYSICAL CONSTANTS

Fine structure constant	α	=	$1/137.03599976(50)$
Rydberg	ϵ_0	=	$m_e c^2 \alpha^2/2$
		=	$13.60569172(53)\,\mathrm{eV}$
Thomson cross-section	σ_T	=	$8\pi\alpha^2\hbar^2/3m_e^2c^2$
		=	$0.665245854(15) \times 10^{-24}\,\mathrm{cm}^2$
Neutron lifetime	τ_n	=	$885.7(0.8)\,\mathrm{sec}$
Speed of light	c	=	$2.99792458 \times 10^{10}\,\mathrm{cm\ sec}^{-1}$
Fermi constant	G_F	=	$1.16639(1) \times 10^{-5}\,\mathrm{GeV}^{-2}(\hbar c)^3$

Newton's constant	G	=	$6.673(10) \times 10^{-8}\,\mathrm{cm^3 g^{-1} sec^{-2}}$
		=	$\hbar c^5 m_{\mathrm{Pl}}^{-2}$
Reduced Planck's constant	$\hbar$	=	$6.58211889(26) \times 10^{-16}\,\mathrm{eV\ sec}$
		=	$1.973269602(77) \times 10^{-5}\,\mathrm{eV\ cm}/c$
Boltzmann constant	k_B	=	$8.617342(15) \times 10^{-5}], \mathrm{eV\ K^{-1}}$
Electron mass	m_e	=	$0.510998902(21)\,\mathrm{MeV}/c^2$
Neutron mass	m_n	=	$939.565330(38)\ \mathrm{MeV}/c^2$
Proton mass	m_p	=	$1.67262158(13) \times 10^{-24}\,\mathrm{g}$
		=	$938.271998(38)\ \mathrm{MeV}/c^2$
Planck mass	m_{Pl}	=	$1.221 \times 10^{19}\ \mathrm{GeV}/c^2$
		=	$1.094 \times 10^{-38}\, M_\odot$
Neutron–proton mass difference	$\mathcal{Q}$	=	$1.2933\ \mathrm{MeV}/c^2$

B.2 COSMOLOGICAL CONSTANTS

Cosmic microwave background	ρ_γ	=	$\pi^2 k_B^4 T^4/15(\hbar c)^3$
energy density		=	$2.47 \times 10^{-5} h^{-2} (T/T_0)^4 \rho_{\mathrm{cr}}$
Critical density	ρ_{cr}	=	$1.879\ h^2 \times 10^{-29}\,\mathrm{g\ cm^{-3}}$
		=	$2.775\ h^2 \times 10^{11}\, M_\odot \mathrm{Mpc^{-3}}$
		=	$8.098\ h^2 \times 10^{-11}\,\mathrm{eV}^4/(\hbar c)^3$

Massive neutrino density	$\Omega_\nu h^2$	=	$(m_\nu/94\,\mathrm{eV})$
Massless neutrino density (N generations)	$\Omega_\nu h^2$	=	$1.68 \times 10^{-5}(N/3)$
Scale factor at equality	a_{eq}	=	$4.15 \times 10^{-5}(\Omega_m h^2)^{-1}$
Wavenumber at equality	k_{eq}	=	$0.073\,\Omega_m h^2\,\mathrm{Mpc}^{-1}$
Hubble constant	H_0	=	$100h\,\mathrm{km\ sec}^{-1}\,\mathrm{Mpc}^{-1}$
		=	$2.133h \times 10^{-42}\,\mathrm{GeV}/\hbar$
		=	$1.023h \times 10^{-10}\,\mathrm{year}^{-1}$
Solar mass	$M_\odot$	=	$1.989 \times 10^{33}\,\mathrm{g}$
		=	$1.116 \times 10^{57}\ \mathrm{GeV}/c^2$
Parsec	pc	=	$3.0856 \times 10^{18}\ \mathrm{cm}$
Cosmic microwave background temperature today	T_0	=	$2.725(2)\,\mathrm{K}$
		=	$2.348 \times 10^{-4}\,\mathrm{eV}/k_B$