

# Mathematical Physics

## MP467

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## Cosmology and Astrophysics

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### Textbooks:

1. A.C. Phillips: The Physics of Stars, 2nd edition, Wiley (1994) 523.8 PHI
2. S.L. Shapiro and S.A. Teukolsky: Black Holes, White Dwarfs and Neutron Stars: the physics of compact objects, Wiley (1983) 523.01 SHA
3. A. Liddle: An Introduction to Modern Cosmology, Wiley (1998) 523.1 LID
4. V. Mukhanov: Physical Foundations of Cosmology, CUP (2005)
5. S. Weinberg: The First Three Minutes, Basic Books (1994) 523.12 WEI
6. B. Carroll and D. Ostlie: An Introduction to Modern Astrophysics, Addison-Wesley (1996) 523.01 CAR
7. R. Bowers and T. Deeming: Astrophysics I+II, Jones and Bartlett (1984) 523.01 BOW

### Topics:

1. Moons and Planets
2. Stellar formation and stellar structure
3. Degenerate Stars: white dwarves, neutron stars, pulsars and black-holes
4. Cosmology and the early Universe

Quantity	Symbol	Value
Speed of light (in vacuum)	$c$	$299\,792\,458\text{ m s}^{-1}$ (exact)
Newton's constant	$G$	$6.673 \times 10^{-11}\text{ kg}^{-1}\text{ m}^3\text{ s}^{-2}$
Planck's constant	$h$	$6.626 \times 10^{-34}\text{ J s}$
Electron charge (magnitude)	$e$	$1.602 \times 10^{-19}\text{ C}$
Electric permittivity (vacuum)	$\epsilon_0 = \frac{1}{\mu_0 c^2}$	$8.854 \times 10^{-12}\text{ C}^2\text{ N}^{-1}\text{ m}^{-2}$
Magnetic permeability (vacuum)	$\mu_0$	$4\pi \times 10^{-7}\text{ N s}^2\text{ C}^{-2}$
Fine structure constant	$\alpha = \frac{e^2}{2\epsilon_0 h c}$	$7.297 \times 10^{-3}$
Thompson cross-section	$\sigma_T$	$6.652 \times 10^{-29}\text{ m}^2$
Electron mass	$m_e$	$9.109 \times 10^{-31}\text{ kg}$
Proton mass	$m_p$	$1.673 \times 10^{-27}\text{ kg}$
Atomic mass unit (mass of $^{12}\text{C}$ atom)/12	$a.m.u.$	$1.661 \times 10^{-27}\text{ kg}$
Boltzmann's constant	$k_B$	$1.381 \times 10^{-23}\text{ J K}^{-1}$
Stefan-Boltzmann constant	$\sigma_{SB}$	$5.670 \times 10^{-8}\text{ J s}^{-1}\text{ m}^{-2}\text{ K}^{-4}$
Avagardo's number	$N_A$	$6.022 \times 10^{23}\text{ mol}^{-1}$
Earth mass	$M_{\oplus}$	$5.97 \times 10^{24}\text{ kg}$
Earth radius (equatorial)	$R_{\oplus}$	$6.38 \times 10^3\text{ km}$
Lunar mass	$M_{\text{☾}}$	$7.35 \times 10^{22}\text{ kg}$
Lunar radius	$R_{\text{☾}}$	$1.74 \times 10^3\text{ km}$
Earth-Moon distance (mean)	$d_{\oplus-\text{☾}}$	$3.84 \times 10^5\text{ km}$
Earth-Sun distance (mean)	$d_{\oplus-\odot}$	$1.50 \times 10^8\text{ km}$
Solar mass	$M_{\odot}$	$1.99 \times 10^{30}\text{ kg}$
Solar radius (equatorial)	$R_{\odot}$	$6.961 \times 10^5\text{ km}$
Solar luminosity	$L_{\odot}$	$3.85 \times 10^{26}\text{ J s}^{-1}$
Temperature of microwave background	$T_0$	$2.7255 \pm 0.0006\text{ K}$
Hubble constant	$H_0$	$67.74 \pm 0.46\text{ km s}^{-1}\text{ Mpc}^{-1}$
$(H_0 = 100h\text{ km s}^{-1}\text{ Mpc}^{-1})$	$h$	$0.674 \pm 0.0046$
Critical density	$\rho_c = \frac{3H_0^2}{8\pi G}$	$(8.62 \pm 0.12) \times 10^{-27}h^2\text{ kg m}^{-3}$
Dark energy density (Cosmological constant)	$\Omega_{\Lambda}$	$0.6911 \pm 0.0062$
Baryon density	$\Omega_B = \rho_B/\rho_{crit}$	$0.0491 \pm 0.0003$
Dark matter density	$\Omega_M = \rho_M/\rho_{crit}$	$0.3089 \pm 0.0062$
Total density	$\Omega_{tot}$	$0.9999 \pm 0.0088$
Age of the Universe	$t_0$	$13.799 \pm 0.021 \times 10^9\text{ yr}$
Electron Volt	$eV$	$1.602 \times 10^{-19}\text{ J}$
year	$yr$	$3.156 \times 10^7\text{ s}$
light year	$lyr$	$9.461 \times 10^{15}\text{ m}$
parsec ( $1pc=3.26\text{ lyr}$ )	$pc$	$3.086 \times 10^{16}\text{ m}$