Chapter 1

Chapter 2

Chapter 3

- Stellar parallax:
$$d = \frac{1\ \text{AU}}{\tan p} \approx \frac{1}{p}\ \text{AU} \tag{1}$$
  - parsec: distance when parallax angle is 1 arcsecond.
  - Hipparcos (ESA): accuracies approaching $0.001''$
  - Gaia: accuracies approaching 4 microarcsec
- apparent magnitude:
  - difference of 5 magnitudes = factor of 100 difference in brightness $\Longrightarrow 100^{1/5} = 2.512$
  - Solar constant: 1.4 kW m^{-2}
  - $$\frac{F_2}{F_1} = 100^{(m_1-m_2)/5} \Longrightarrow m_1 - m_2 = -2.5\log_{10}\left(\frac{F_1}{F_2}\right) \tag{2}$$
- absolute magnitude:
  - apparent magnitude at 10 kpc
  - distance modulus
$$100^{(m-M)/5} = \frac{F_{10}}{F} = \left(\frac{d}{10\ \text{pc}}\right)^2 \Longrightarrow d = 10^{(m-M+5)/5}\ \text{pc}$$
$$\Longrightarrow m - M = 5\log_{10}(d) - 5 = 5\log_{10}\left(\frac{d}{10\ \text{pc}}\right)$$
- Double slit experiment:
  - spacing d between slits, distance L to screen. At angle θ, extra path length of $d\sin\theta$ for far slit $\Longrightarrow$ bright if $d\sin\theta = n\lambda$, dark if $d\sin\theta = (n-\frac{1}{2})\lambda$.
- Poynting vector:
$$\boldsymbol{S} = \frac{1}{\mu_0}\boldsymbol{E}\times\boldsymbol{B}\ \text{(SI)} = \frac{c}{4\pi}\boldsymbol{E}\times\boldsymbol{B}\ \text{(cgs)} \tag{3}$$
  - radiation pressure:
$$F_{rad} = \frac{\langle S\rangle A}{c}\cos\theta \qquad \text{(absorption)}$$
$$F_{rad} = \frac{2\langle S\rangle A}{c}\cos^2\theta \qquad \text{(reflection)}$$

- Blackbodies:
  - Wien's displacement law:
$$\lambda_{\max} T = 0.002897755 \text{ m K} \tag{4}$$
  - Stefan-Boltzmann equation:
$$L = A\sigma T^4, \quad \sigma = 5.67 \times 10^{-8} \text{ W m}^{-2}\text{K}^{-4}. \tag{5}$$
  - Rayleigh-Jeans law: works for λ large. Take oven with distance L between walls, then can have standing waves with wavelength $\lambda = 2L/1, 2L/2, 2L/3, 2L/4, 2L/5, \ldots,$ each wavelength with energy kT. Then (DERIVATION — LEARN)
$$B_\lambda(T) \approx \frac{2ckT}{\lambda^4} \tag{6}$$
  - Wien's approximation: works for λ small. (DERIVATION — LEARN)
$$B_\lambda(T) \approx a\lambda^{-5} e^{-b/\lambda T} \tag{7}$$
  - Planck:
$$B_\lambda(T) = \frac{a/\lambda^5}{e^{b/kT} - 1} \tag{8}$$
    Assume energy must be quantized: $nh\nu$. (DERIVATION — LEARN)
$$B_\lambda(T) = \frac{2hc^2/\lambda^5}{e^{hc/\lambda kT} - 1} \tag{9}$$
    $\lambda = c/\nu$, so $d\lambda = c/\nu^2 d\nu$:
$$B_\nu(T) = \frac{2h\nu^3/c^2}{e^{h\nu/kT} - 1} \tag{10}$$

- Color index
$$U - B = M_U - M_B$$
$$B - V = M_B - M_V$$
  - Bolometric correction:
$$BC = m_{\text{bol}} - V = M_{\text{bol}} - M_V \tag{11}$$
  - Sensitivity function $S(\lambda)$
$$U = -2.5 \log_{10}\left(\int_0^\infty F_\lambda S_U d\lambda\right) + C_U \tag{12}$$
    C_U chosen such that Vega has magnitude zero in each filter.
$$U - B = -2.5 \log_{10}\left(\frac{\int F_\lambda S_U d\lambda}{\int F_\lambda S_B d\lambda}\right) + C_{U-B}, \quad C_{U-B} \equiv C_U - C_B \tag{13}$$
  - *** Color index does not depend on distance, so it is a measure solely of the temperature of a model blackbody star

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10