Chapter 4

Exercise Solutions

1. From Eq. 4.3, parallax angle (deg) $= 57.3^\circ \left(\frac{\text{baseline}}{\text{object distance}}\right)$

   parallax angle $= 10'' = 10'' \times \left(\frac{1 \text{ deg}}{3600''}\right) = 2.78 \times 10^{-3}$ deg

   baseline $= 2R_E = 12{,}756$ km

$$\begin{aligned}
\text{parallax angle (deg)} &= 57.3^\circ \left(\frac{\text{baseline}}{\text{object distance}}\right), \text{ so} \\
\text{object distance} &= 57.3^\circ \left(\frac{\text{baseline}}{\text{parallax angle (deg)}}\right) \\
&= 57.3^\circ \left(\frac{12,756 \text{ km}}{2.78 \times 10^{-3} \text{ deg}}\right) \\
&= 2.63 \times 10^8 \text{ km (ans.)} \\
&\text{(this is about 1.75 AU)}
\end{aligned}$$

2. In this case, parallax angle $= 1'' \times \left(\frac{1 \text{ deg}}{3600''}\right) = 2.78 \times 10^{-4}$ deg

Baseline is the same as in the previous exercise: 12,756 km

$$\text{object distance} = 57.3^\circ \left(\frac{\text{baseline}}{\text{parallax angle (deg)}} \right) \text{ as before, so}$$
$$= 57.3^\circ \left(\frac{12,756 \text{ km}}{2.78 \times 10^{-4} \text{ deg}} \right)$$
$$= 2.63 \times 10^9 \text{ km (ans.)}$$
$$\text{(this is about 17.5 AU)}$$

3. In this case, baseline = 2 AU = 3×10^8 km

$$\text{For } 10'' \text{ parallax angle: object distance} = 57.3^\circ \left(\frac{\text{baseline}}{\text{parallax angle (deg)}} \right)$$
$$= 57.3^\circ \left(\frac{3 \times 10^8 \text{ km}}{2.78 \times 10^{-3} \text{ deg}} \right)$$
$$= 6.18 \times 10^{12} \text{ km (ans.)}$$

$$\text{For } 10'' \text{ parallax angle: object distance} = 57.3^\circ \left(\frac{3 \times 10^8 \text{ km}}{2.78 \times 10^{-4} \text{ deg}} \right)$$
$$= 6.18 \times 10^{13} \text{ km (ans.)}$$

4. From Eq. 4.8, angular size (deg) = $57.3^\circ \left[\frac{\text{physical size}}{\text{distance}} \right]$

$$\text{physical size} = 1000 \times 2R_{\text{Sun}} = 1000 \times 2(6.96 \times 10^5 \text{ km})$$
$$= 1.39 \times 10^9 \text{ km}$$

$$\text{distance} = 650 \text{ light years} = 650 \text{ light years} \times \left(\frac{9.46 \times 10^{12} \text{ km}}{1 \text{ light year}} \right)$$
$$= 6.15 \times 10^{15} \text{ km}$$

$$\text{angular size (deg)} = 57.3^\circ \left[\frac{1.39 \times 10^9 \text{ km}}{6.15 \times 10^{15} \text{ km}} \right]$$
$$= 1.3 \times 10^{-5} \text{ deg (ans.)}$$

5. From Eq. 4.14, angular resolution (arcsec) $= 0.25\left[\frac{\lambda(\mu\text{m})}{\text{aperture (m)}}\right]$

$$\lambda = 550 \text{ nm} = 550 \text{ nm}\left[\frac{1 \times 10^{-9} \text{ m}}{1 \text{ nm}}\right] = 5.50 \times 10^{-7} \text{ m}$$
$$= 0.550 \times 10^{-6} \text{ m} = 0.550\,\mu\text{m}$$

aperture $= 4$ mm $= 4 \times 10^{-3}$ m

$$\text{angular resolution (arcsec)} = 0.25\left[\frac{0.550}{4 \times 10^{-3}}\right]$$
$$= 34.4 \text{ arcsec (ans.)}$$

6. In this case, aperture $= 9$ mm $= 9 \times 10^{-3}$ m

wavelength, λ, is the same as before: 0.550 μm

$$\text{angular resolution (arcsec)} = 0.25\left[\frac{0.550}{9 \times 10^{-3}}\right]$$
$$= 15.3 \text{ arcsec (ans.)}$$