

Chapter 2

Observations

2.1 $\nu = c/\lambda$

$$\lambda = 390 \text{ nm} \Rightarrow \nu = 7.69 \times 10^{14} \text{ Hz}$$

$$\lambda = 700 \text{ nm} \Rightarrow \nu = 4.29 \times 10^{14} \text{ Hz}$$

$$\lambda = 10 \text{ cm} \Rightarrow \nu = 3.0 \times 10^9 \text{ Hz}$$

2.2

$$\theta > 1.22 \frac{\lambda}{D} \text{ (in radians)}$$

$\lambda = 500 \text{ nm}$ and $D = 2.4 \text{ m}$. Hence $\theta > 0.052''$. This is much better than the $1''$ resolution possible with Earth-based optical telescopes.

2.3 For VLA, $\theta > 0.14''$

For VLBI, $\theta > 0.005''$

2.4

$$E = h\nu = hc/\lambda$$

For $\lambda = 10 \text{ cm}$, 500 nm , 0.1 nm , and 10^{-5} nm we obtain $E = 1.24 \times 10^{-5} \text{ eV}$, 2.48 eV , $1.24 \times 10^4 \text{ eV}$, $1.24 \times 10^8 \text{ eV}$ respectively.

2.5 As given in text,

$$h = 6.6261 \times 10^{-34} \text{ Kg m}^2/\text{s} = 4.1357 \times 10^{-15} \text{ eV} \cdot \text{s}.$$

This implies that,

$$1 \text{ eV} = \frac{6.6261 \times 10^{-34}}{4.1357 \times 10^{-15}} \text{ J} = 1.6022 \times 10^{-19} \text{ J}$$

An electron volt (eV) is defined as the energy gained by an electron accelerated between one volt. The corresponding energy acquired by 1 Coulomb of charge is 1 J. Also charge of electron is $1.60217657 \times 10^{-19} \text{ C}$. Hence the energy gained by electron due to 1 V potential difference, that is, 1 eV, is

$$1 \text{ J/C} \times 1.6022 \times 10^{-19} \text{ C} = 1.6022 \times 10^{-19} \text{ J}$$

which agrees with the result given in text.

2.6 Using $\xi = 10^\circ$ in the following equation:

$$\delta\theta \approx 58.2'' \tan \xi ,$$

we obtain, $\delta\theta \approx 10.3''$.

2.7 From Figure 2.8, we see that

$$\sin \theta = n_k \sin \theta_k$$

$$n_k \sin \theta_k = n_{k-1} \sin \theta_{k-1}$$

$$n_{k-1} \sin \theta_{k-1} = n_{k-2} \sin \theta_{k-2}$$

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$$n_1 \sin \theta_1 = n_0 \sin \xi$$

Eliminating n_1, n_2, \dots, n_k we obtain

$$n_0 \sin \xi = \sin \theta$$