CHAPTER 25

Photometry: measuring starlight

Answers to revision questions

1. A star's absolute magnitude is how bright it would appear to be from a distance of 10 pc. It is a measurement of the star's total light output, or luminosity. The apparent brightness is how bright the star actually appears to be in the sky when compared to other reference stars.

2. Originally, stars were allocated magnitudes on the basis of the brightest being given a magnitude of 1 down to the dimmest visible assigned a magnitude of 6. This same basis was adopted by modern astronomers and quantified so that a magnitude *difference* of 5 equates to a brightness ratio of exactly 100, retaining 'the lower the magnitude the brighter the star' ranking system.

3. The new distance to the star is 1/10th the old distance. Using the inverse square law, the brightness will be increased by a factor of $10^2 = 100$. By definition, this results in a magnitude change of 5. The new magnitude will be 8.0 – 5.0 = 3.0.

4. Use $M = m - 5\log(\frac{d}{10})$, where $m = 8.0$ and $d = 20$ pc.

$$\begin{aligned} M &= m - 5\log\left(\frac{d}{10}\right) \\ &= 8.0 - 5\log\left(\frac{20}{10}\right) \\ &= 8.0 - 5 \times 0.301 \\ &= 6.5 \end{aligned}$$

The same calculation using $m = 3.0$ and $d = 2$ pc also gives $M = 6.5$. A star's absolute magnitude is not dependent on distance as it is a measure of the star's luminosity.

5. Use $\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$ where $m_B = 7.0$ and $m_A = 4.5$, and I represents the intensity of light from the stars so that $\frac{I_A}{I_B}$ is the brightness ratio of the two stars P and Q.

$$\begin{aligned} \frac{I_A}{I_B} &= 100^{(m_B - m_A)/5} \\ &= 100^{(7.0-4.5)/5} \\ &= 10 \end{aligned}$$

That is, star P is 10 times brighter than star Q.

6. The colour index of a star ($m_B - m_V$) gives a number that corresponds to the colour of the star, and hence its surface temperature. The actual colour of a star is often too difficult to observe directly. Using a blue and a yellow filter to obtain the colour index is an indirect way of finding a star's surface temperature.

7. Such a star has a colour index of +1.5 (see Fig. 25.1).
C.I. = $m_B - m_V$
1.5 = m_B – 12.5
m_B = 14

8. Photoelectric technology has largely replaced photographic technology for measuring starlight because:
   - it is more sensitive
   - it is sensitive to a wider range of wavelengths
   - it can be digitally enhanced
   - it can have filters applied electronically
   - it can have images taken remotely and transmitted immediately
   - it does not need developing and fixing (no chemicals required).

9. Photometry, being the measurement of starlight, can be applied to spectroscopic parallax (the calculation of a star's distance based on its brightness) and to the process of obtaining a star's colour index using measurements of a star's brightness at certain wavelengths.