# Diploma in Astronomy—First Term 2005-6

## DP11 Foundations of Astronomy: *Solutions* to Problem Paper 3.

Dec. 6th 2005

**1a)** $\frac{\Delta\lambda}{\lambda} = \frac{\mathrm{v}}{\mathrm{c}}$, $\Delta\lambda = 670.0 - 656.3 = 13.7$ nm, and $\lambda = 656.3$, so

$\frac{\Delta\lambda\times\mathrm{c}}{\lambda} = \mathrm{v} = \frac{13.7\ \mathrm{nm}\times 3\ \times\ 10^5\ \mathrm{km/s}}{656.3\mathrm{nm}} = \mathbf{6270}$ km/s

**1b)** $\Delta\lambda = \frac{\lambda\times\mathrm{v}}{\mathrm{c}} = \frac{486\ \mathrm{nm}\times 6270\mathrm{km/s}}{3\ \times\ 10^5\mathrm{km/s}} = 10$ nm
$\lambda_{H\beta,\mathrm{obs}} = \lambda_{H\beta,\mathrm{lab}} + \Delta\lambda = 486\ \mathrm{nm} + 10\ \mathrm{nm} = \mathbf{496}$ nm

**1c)** This galaxy must be moving away from us, because its light is *redshifted.*

**2a)** $d = 1/p$, so $p = 1/d$, and $d = 50$ Mpc $= 50\ \times\ 10^6$ pc
$p = \frac{1}{50\ \times\ 10^6\mathrm{pc}} = \mathbf{2\times 10^{-8}}$ arcseconds

**2b)** $\theta = 2.5\times 10^5\ \frac{\lambda}{\mathrm{D}} \longrightarrow \mathrm{D} = 2.5\times 10^5\ \frac{\lambda}{\theta}$
$\lambda = 500$ nm $= 500\times 10^{-9}$ m and $\theta = 2\times 10^{-8}$ arcseconds
so D = **6250 km**, obviously this is much too large to build. So, while parallax is the most direct way of measuring a distance to an object it is not practical for very distant objects. Thus, we need alternative means, such as Cepheid variables.

**3a)** $L = 4\pi R^2\sigma T^4 \longrightarrow \frac{R}{R_\odot} = (\frac{T_\odot}{T})^2\sqrt{\frac{L}{L_\odot}}$ (see derivation on page 426)
$\frac{R}{R_\odot} = (\frac{5800\ K}{50{,}000\ K})^2\sqrt{100{,}000} = \mathbf{4.2\ R_\odot}$ (i.e. not so much larger than a solar mass star).

**3b)** $\frac{R}{R_\odot} = (\frac{5800\ K}{4{,}000\ K})^2\sqrt{100{,}000} = \mathbf{665\ R_\odot}$