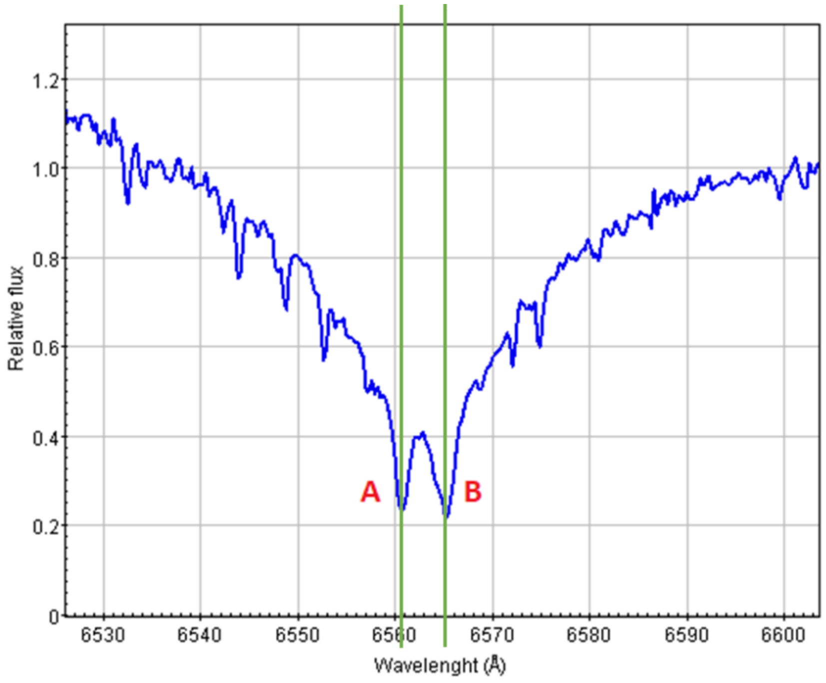
SOLUTION

TQ7 [13 point]

7.1 Observing the plot, it is possible to estimate the wavelength of both Hα lines and later find the velocity of each star by Doppler.



$$v_A = \frac{6561\ Å - 6562.8\ Å}{6562.8\ Å} \times (2.998 \cdot 10^5\ km \cdot s^{-1}) = -82.23\ km \cdot s^{-1}$$ [2 point]

$$v_B = \frac{6565\ Å - 6562.8\ Å}{6562.8\ Å} \times (2.998 \cdot 10^5\ km \cdot s^{-1}) = +100.50\ km \cdot s^{-1}$$ [2 point]

So, Menkalinan A is approaching and Menkalinan B is moving away from us.

[1 point]

7.2

$$m_A > m_B \Rightarrow \alpha_B > \alpha_A$$

From the definition of CM:

$$\frac{\alpha_B}{\alpha_A} = 1.026$$ [0.5 points]

$$\alpha = (\alpha_A + \alpha_B) = \alpha_B(1 + \frac{\alpha_A}{\alpha_B}) = 1.975\,\alpha_B$$ [0.5 points]

Applying the 3rd Kepler's law, the total mass of the system is :

$$M_{tot} = \frac{4\pi^2}{G} \times \frac{\alpha^3 \bullet d^3}{T^2}$$ [1 point]

$$M_{tot} = \frac{4\pi^2}{G} \times \frac{\left(0.00662'' \times \frac{1rad}{206265''}\right)^3 \bullet \left(81.1ly \cdot \frac{9.46\bullet 10^{15}m}{1ly}\right)^3}{\left(3.96d \bullet \frac{86400s}{1d}\right)^2}$$

$$M_{tot} = 7.528 \cdot 10^{31} kg = 37.868 M_\odot$$ [2 point]

7.3

$$m_A / m_B = 1.026$$

$$M_{tot} = m_A + m_B = 1.026 \cdot m_B + m_B = 2.026\, m_B = 37.868 M_\odot$$

$$m_B = 18.691 M_\odot$$ [1 point]

$$m_A = 1.026 \cdot m_B = 19.177\, M_\odot$$ [1 point]

7.4 Using the mass/luminosity relation given:

$$\frac{L_A}{L_\odot} = (\frac{m_A}{M_\odot})^{3.5} = (\frac{19.177 M_\odot}{M_\odot})^{3.5}\ 3.088 \times 10^4$$

$$L_A = 3.088 \times 10^4 L_\odot$$ [1 point]

$$\frac{L_B}{L_\odot} = (\frac{m_B}{M_\odot})^{3.5} = (\frac{18.691 M_\odot}{M_\odot})^{3.5} = 2.823 \times 10^4$$

$$L_B = 2.823 \times 10^4 L_\odot$$ [1 point]