A Spectroscopic Eclipsing Binary System

Near alpha Aurigae is located a spectroscopic eclipsing binary system (star A and star B) which have nearly circular orbits about their common center of mass with a period of 88.2 days. The system is oriented such that the orbital plane is viewed edge-on as seen from the Earth. Hydrogen lines are observed in the spectra of both components. Data for three of these lines are given in the table below. (The units are nanometers.) The maximum and minimum observed values of the wavelengths are given for each star. From the Doppler shifts evident in the data, it is clear that the stars have different orbital speeds, hence different masses. From the data, determine:

  a) How fast and in which direction along the line of sight the entire system is moving relative to the Earth.
  b) The orbital speed of each star and the distance between the two.
  c) The mass of each star.

	Star A		Star B	
Laboratory	Minimum	Maximum	Minimum	Maximum
656.273	656.202	656.532	656.332	656.402
486.133	486.080	486.325	486.177	486.228
434.047	434.000	434.218	434.086	434.132

Useful Equations

$$\frac{\lambda - \lambda_\circ}{\lambda_\circ} = \frac{v_r}{c} \qquad \text{Doppler Shift}$$

$$2\pi a = v\text{P}$$

$$(M_A + M_B) = \frac{a^3}{\text{P}^2} \qquad \text{Kepler's Third Law}$$

Useful Definitions

Speed of Light $= 3.0 \times 10^5 \ km/_s$

$1 \ \text{AU} = 1.5 \times 10^8 \ km$