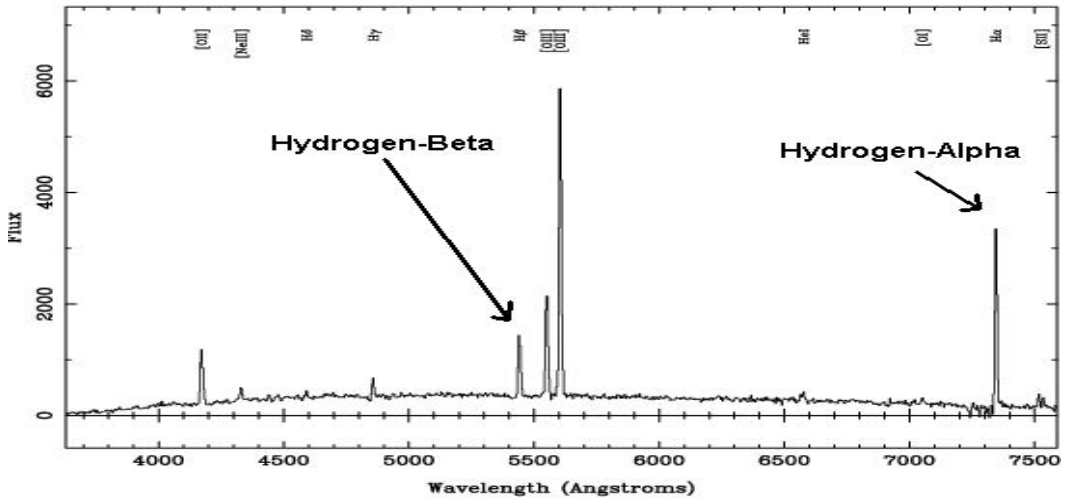
The Doppler Shift is an important physical phenomenon that astronomers use to measure the speeds of distant stars and galaxies. When an ambulance approaches you, its siren seems to be pitched higher than normal, and as it passes and travels away from you, the pitch becomes lower. A careful measurement of the pitch change can let you determine the speed of the ambulance once you know the speed of the sound wave. A very similar method can be used when analyzing light waves from distant stars and galaxies. The basic formula for slow-speed motion (that is, speeds much slower than the speed of light) is:

$$\text{Speed} = 299{,}792 \frac{W_O - W_R}{W_R}$$

The speed of the object in km/s can be found by measuring the wavelength of the signal that you observe (Wo), and knowing what the rest wavelength of the signal is (Wr), with wavelength measured in units of Angstroms (1.0×10^{-10} meters).



This is a small part of the spectrum of the Seyfert galaxy Q2125-431 in the constellation Microscopium. An astronomer has identified the spectral lines for Hydrogen Alpha (Wr = 6563 Angstroms), and Beta (Wr = 5007 Angstroms).

Question 1: From the graph of the spectrum above, use you millimeter ruler to determine the scale of the figure in angstroms per millimeter.

Question 2: What are the observed wavelengths of the Hydrogen-Alpha and Hydrogen-Beta lines?

Question 3: What are the rest wavelengths of the Hydrogen-Alpha and Hydrogen-Beta lines?

Question 4: If Wr is defined by your answers to question 3, and Wo is defined from your answers to question 2, what velocity do you calculate for each line from the formula above?

Question 5: From your answer to question 4, what is the average of the two velocities?

Question 6: Is the galaxy moving towards or away from the Milky Way? Explain.