Lab 7 Rydberg Constant Tasks

Report (including Abstract, Introduction and Data & Analysis sections) due Wednesday, November 11th at 6pm

Read Ch. 2, sections 2.7-10 in your Lyons text (pp 57-70)

The particular wavelengths emitted (and absorbed) by each element are unique, but in the 19th century there was no understanding of the origin of each element's spectrum. In 1888, Johannes Rydberg came up with an empirical formula that matched the experimentally observed sequence of wavelengths emitted by hydrogen:

$$\frac{1}{\lambda} = R\left(\frac{1}{n'^2} - \frac{1}{n^2}\right).$$

Here n and n' are positive integers (with $n > n'$) and R is a constant, now known as the Rydberg constant. The integer n' corresponds to various "series" of spectral lines (corresponding to sequential values of n), with the best known and first discovered being the $n' = 2$ Balmer Series that is observable in the visible spectrum. Others include the $n' = 3$ Paschen Series in the infrared and the $n' = 1$ Lyman Series in the ultraviolet, both of which were observed in the first decade of the 20th century, after Rydberg put forth his formula.

Your task is to make measurements of the visible Balmer Series wavelengths (you'll likely only be able to see the first 3 lines) and use these to find as precise and accurate a value of the Rydberg constant as possible.

Update: The Geisler tubes that we planned to use for this lab have been contaminated with other elements.

However, I would like to make the most of the situation. So I have found two nice data sets to give to you and you can analyze them for your lab reports. The first of these data sets is displayed in figure 1 below. This is an emission spectrum for a hydrogen lamp and is almost identical to what you would have measured yourselves, except that a computer has been used to measure the intensity of the lines as your rotate the telescope part of the spectrometer around the lamp. You can use this plot to extract the wavelengths of the first three lines of the Balmer series.

The second data set is a bit different, see figure 2. This spectrum was obtained by looking at the star Vega, which is the 2nd brightest star in the night sky of the northern hemisphere. As you know from our study of hot objects, they emit a whole spectrum of wavelengths. This data shows the absorption spectrum of Vega. Instead of the star emitting bright lines at only certain wavelengths, it emits less intensity at only certain wavelengths. You can use this second data set to measure many more lines of the Balmer series of Hydrogen.

Note that the two data sets don't measure the same range of wavelengths and that they use different units. You will have to take these issues into account.

Finally, I have attached a graphic that illustrates the difference between an emission spectrum and absorption spectrum, see figure 3.

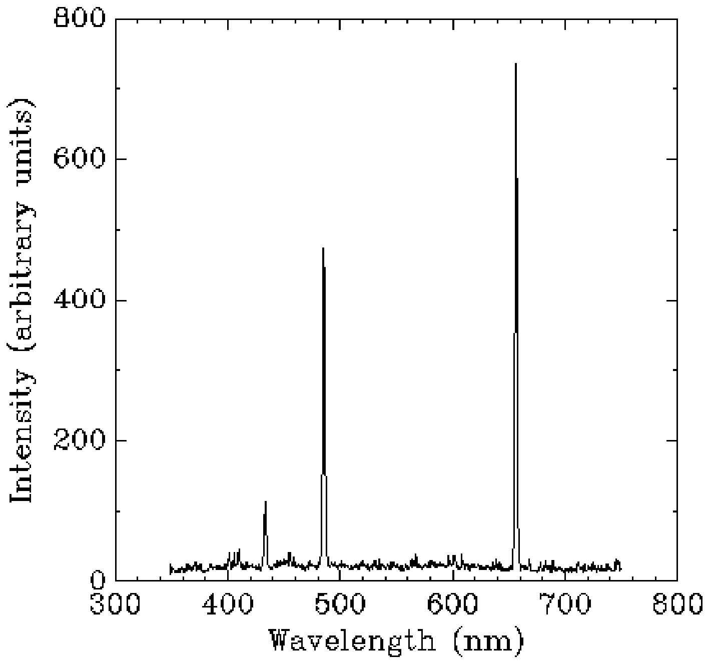

Figure 1: Emission spectrum of Hydrogen showing the first few lines in the Balmer series.

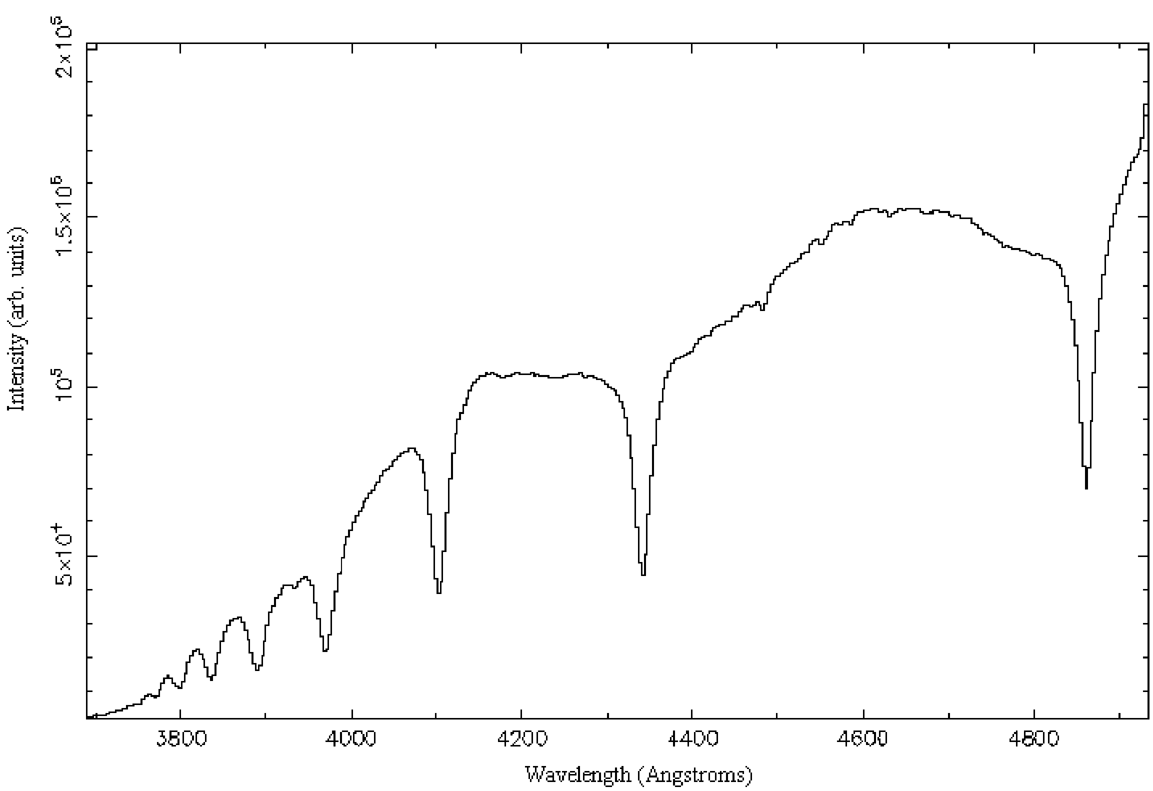

Figure 2: Absorption spectrum of the star Vega, showing several lines in the Balmer series.

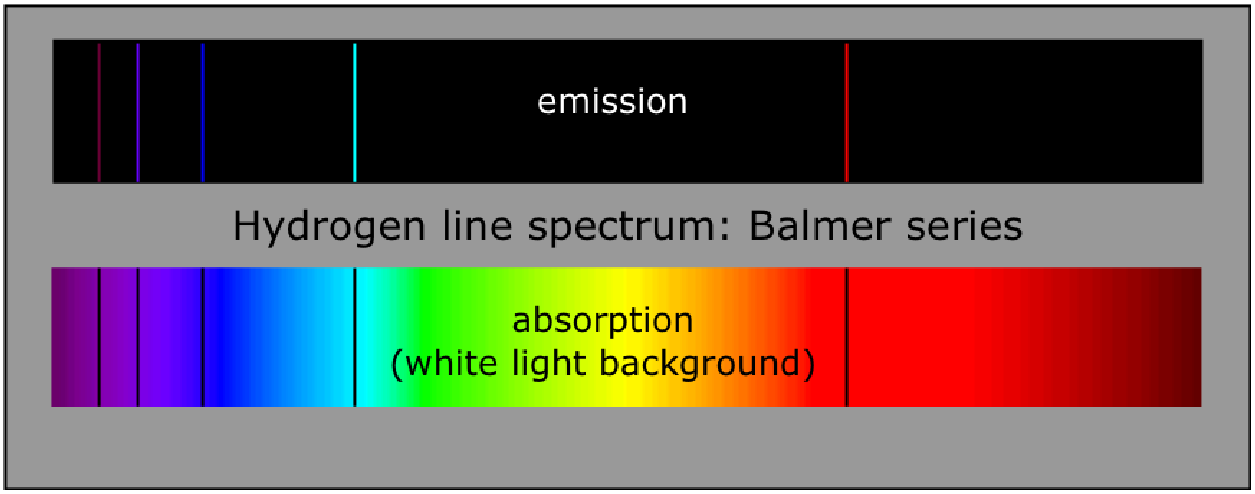

Figure 3: Illustration of the Balmer emission and absorption lines.

Because I am giving you the data, it no longer makes sense for you to write a Methods section. So, instead I would like you to in include the following in your **Lab Report**:

Abstract
Introduction
Data & Analysis

For your introduction section you should do some research on why we measure absorption spectra from stars and explain what an absorption spectrum is telling us. For your data and analysis section be sure to include an uncertainty analysis based on how you extracted wavelengths of the lines from the data sets that I have given you. The goal of the lab is the same: you would like to extract the best value of the Rydberg constant as you can from these data sets.