Phys 4910 Spectroscopy
Isotope Effect in Hydrogen

Introduction

Because the mass of the nucleus in a hydrogen atom is finite the energy levels that are to be expected depend on the reduced mass of an electron, not its true mass. Since the mass of the nucleus also varies from isotope to isotope there is a small change in the measured wavelengths when switching from hydrogen (^{1}H) to deuterium (^{2}H).

In this project the objective is to measure the wavelength change between the different isotopes for each of the four visible lines (B_α through B_δ).

Experimental

You will need to record the spectrum of both hydrogen and deuterium together. Since the separation between the lines from the two are isotopes are small you will need to spread the spectrum our as much as possible, which makes it a challenge to calibrate the spectrum. The more you spread the spectrum out the greater the chances that you will have few, possibly even no, calibration lines visible. As starting points you might try the following

- for the B_β, B_γ, and B_δ you might be able to get accurate values by recording the spectrum from 400 nm to 500 nm, and use the known hydrogen lines to calibrate the spectrum.
- Fr the B_α line (in the red), try recording the two isotopic spectra in conjunction with a neon spectrum, and use the neon spectrum to calibrate. Since there are a lot of neon lines in this portion of the spectrum you might be able to really narrow down the range of your spectrum.

Report

It is now time to start putting together the main structure of a research paper. A full report consists of the following

- Abstract
- Introduction
- Experimental apparatus and method
  - A brief description of the method should include any relevant (bit not trivial) details of the apparatus. For example you would probably include the fact that you used a Roper Spectra Pro 760 monochromator, but not describe how the monochromator works.
  - Include any relevant details, such as the slit widths that you used.
  - Discuss how you calibrated your spectrum.
- Data
  - A sample graph is optional, but not obligatory

    - Tabulate the lines you measured, including any uncertainties
- Analysis
    - Correction for the refractive index of air
    - Calculation of energy splitting
    - Comparison with theory
- Conclusion

References

- http://physics.nist.gov/PhysRefData/ASD/levels_form.html
- Any text which discusses either the Bohr model of hydrogen-like atoms, or the quantum mechanics of hydrogen-like atoms.