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 at least three 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 and so determine the wavelengths of the deuterium lines.
- For all four lines separately record the spectrum over a narrow range of wavelength, just large enough to see both the hydrogen line and its sister deuterium line. Then, assuming that the scan rate of the monochromator and the sampling rate of the data taking program are both accurate, find he wavelength difference in the wavelengths of the four lines of the two isotopes.

In either case you will need to record the spectra of hydrogen and deuterium together. That will mean putting one lamp behind the other, and an open style mount will be needed for the front lamp. ***Be careful of the voltage in this mount***. It is in the range of a few kilovolts, and accssible.

Report

- Describe your experiment and report your results
- Compare your results with theory

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.