Physics 475: Concave Grating Spectrometer

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Purpose

To use the concave grating spectrometer (aka *grand piano spectrometer*) to measure the Rydberg constant.

Secondary Goals

1. Learn about a simple optics setup. How to use a collector lens to maximize intensity.
2. Learn how to load and unload the film canister in the dark.
3. Learn how to develop the film.
4. Use a travelling microscope to make measurements of spectral lines.

Background

Have a look at a lab description from *Physics 331A* on the *Concave Diffraction Grating Spectrograph* from the University of Washington. This at least explains some of the optics.

Safety

The gas discharge tubes use high voltage. Don't stick your fingers into the sockets! Also the tubes can become hot so be careful when you remove them.

Broad Procedure

1. I would suggest using a helium discharge tube for calibration purposes. Set it up and just have a quick look with a handheld spectrometer so you can see the major lines and their colours. Make some quick notes about this.
2. Once you have the tube mounted use the collector lens to focus the image of the tube on the spectrometer slit. The slit is the "object" that you are viewing i.e. a spectral line is an image of the illuminated slit.
3. In principle for a very narrow slit the transmitted light should act as a "line" source and the light should go in different directions but in practice it still shines in one direction. Take the top off of the spectrograph and make sure the light from the slit is shining on the diffraction grating. A piece of white paper held gently in front of the

grating is quite useful for this. You can change either the angle of the spectrometer or the tube/collector lens.

4. This next part is a pain (and one part of the group should focus on this and the other should load the film). There is a magnifier that will slide in the "output" section of the spectrograph and it is set up to focus on the images of the spectral lines. However I find it very difficult to get your eye in a place to make comfortable observation and you need to be at just the right angle to see the lines. Once you observe one you can make some fine adjustments of the slit size and height and even the collector lens. You might be able to see "ghosts" of the lines. These are single-slit diffraction lines associated with the primary and aren't new lines.

5. Once you have looked at a couple of strong lines make sure that **nothing moves**. Were the lines in the right place compared to your earlier observations? What is the rough calibration i.e. how many centimeters do you move for a certain wavelength change?

6. If you are part of the film loading team take the cartridge apart so that you know what you need to do. There are pieces of film and plastic around so you practice (in the light, with your eyes closed, and then in the dark). The emulsion side of the film (slightly tacky) should face the grating (i.e. towards the centre). In addition to cutting it the correct length you might want to snip one of the corners so you know which end of the film is which. Make sure there is still a tail sticking out of the film cartridge so that the next person can pull a strip of film out. (BTW if you have someone in your group who is fairly nearsighted they might be better at working with their fingers in the dark from years of hunting for glasses etc.)

7. Now you should be ready to take some spectrograms. If your slit height isn't too high you should be able to take 4 quite easily by adjusting the height of the cartridge. I recall that 5 second exposure isn't bad. Take a couple with helium (different exposure times) and then switch to hydrogen. Try and keep everything in the same place.

8. Unload the film in darkness and load it into the developing canister. I think there are developing instruction on the developer.

9. Now have a look at it! More than likely it will take a couple of attempts to get it right.

10. Once you have a good set of data use the helium lines to calibrate the hydrogen lines.