PHYSICS 1040L LAB
LAB 10: SPECTROSCOPY OF LIGHT
MERCURY SPECTRUM

OBJECT: To find the wavelengths of the emission lines from mercury source.
APPARATUS: Mercury light source, slit, optical bench, mounts, diffraction grating.

THEORY: In a previous laboratory, the wavelength of the red light was measured by observing the diffraction pattern of the red light after it had passed through a double slit. If more slits are added the diffraction maxima become narrower (See last three figures in previous lab handout), but remain at the same angular positions. One benefit of this property is that if two colors of light pass through the multiple slit, aperture (called a diffraction grating), then the two colors produce separate an, distinct diffraction patterns at measurably different angles. It is found that the angular diffraction Θ of light of wavelength λ by a diffraction grating of slit spacing d obeys the relation:

$$n \lambda = d \sin \Theta_n \qquad (1)$$

Where n is the diffraction order number, and Θ_n is the angular position of the n-th diffraction maximum.

The set of emission colors from elements and chemical compounds are unique signatures of those elements. The measurement of emission wavelengths can allow the identification of elements and compounds present in the light source, whether that source is a distance galaxy or small piece of cloth from the Shroud of Turin. Measurement of the wavelength of these emission colors also provided the initial clues to the atomic structure of the elements.

Please read carefully sections on diffraction gratings and atomic spectra in your physics text book.

PROCEDURE

1. Obtain a transmission diffraction grating and a mercury light source.

2. Assemble them as shown on Fig. 1and 2.

3. Record the Number of Lines per mm marked on the diffraction grating and record this value in the proper place in your data table.

4. Measure the length between the grating and the screen, L , and record this measurement in meters in your data table.

Safety: You should not look directly at the mercury discharge coming from the slit in the mercury lamp. When you observe the spectra, you will be looking at an angle to the slit, but you should not stare directly at the slit. The mercury vapour lamp emits radiation in the UV part of the spectrum, similar to that given out by the sun.

5. Look through the grating towards the light source and locate the first position of the virtual image along the transverse meter stick (screen).

6. Find the positions of the first color spectral line on either side of the central maximum and record the positions as Blue Left and Blue Right in the appropriate places in your data table.

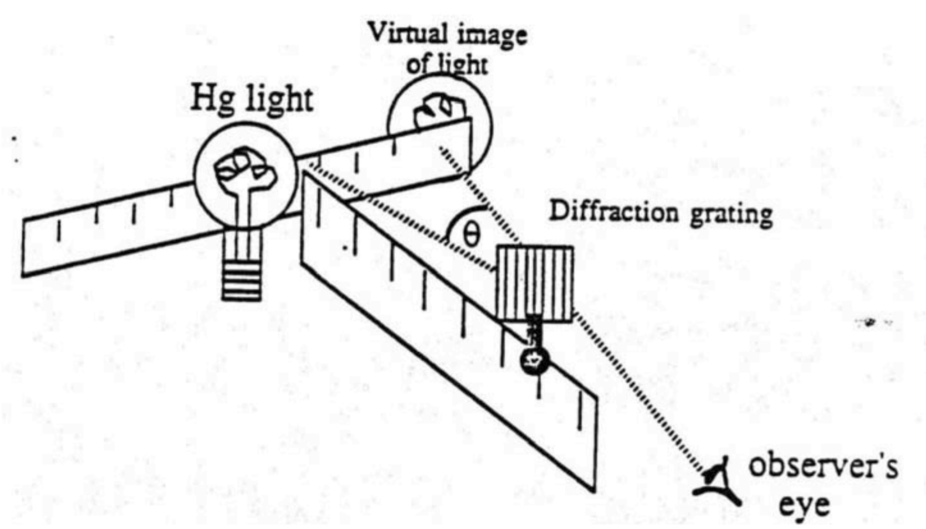

Figure 1. Sketch of the diffraction grating spectrometer used to measure the wavelength of light.

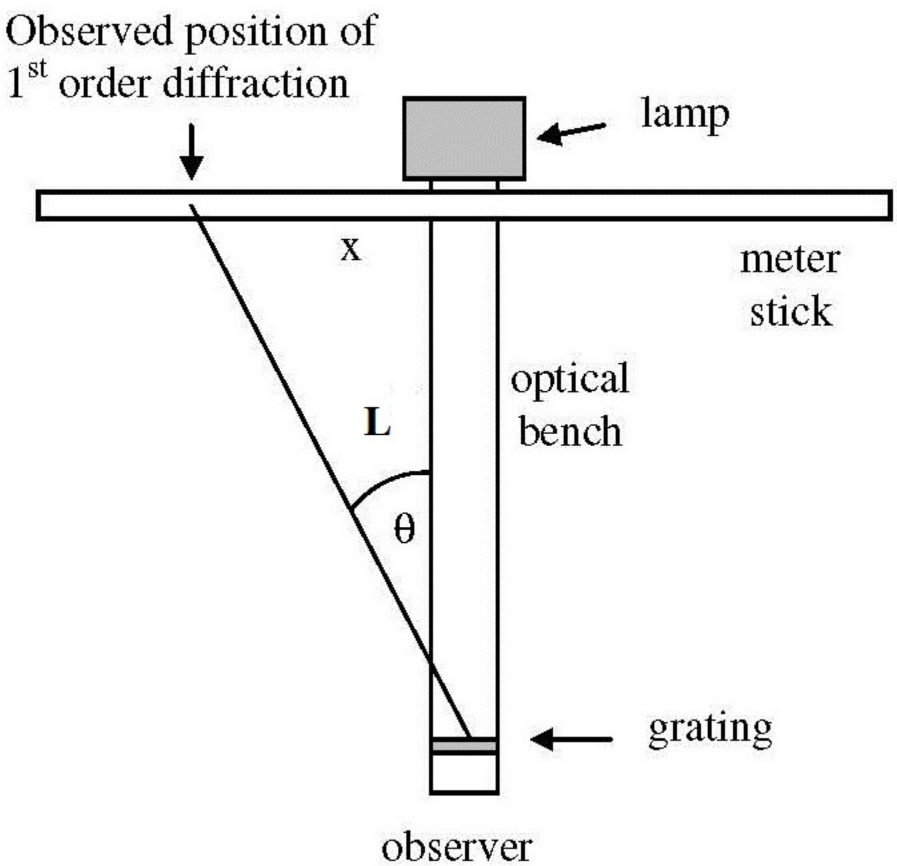

Figure 2 EQUIPMENT SET UP

7. This will be the location of the first order diffraction maximum for that particular color.

8. Measure the positions of the second spectral lines and record them as Green Left and Green Right.

9. Measure the positions of the second spectral lines and record them as Yellow Left and Yellow Right.

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DATA ANALYSIS

1. **Calculate the distance x from the left and right positions of each color spectral line.**

$$x = \frac{P_L + P_R}{2} \quad \textbf{(2)}$$

$$\tan \Theta_1 = x / L. \quad (3)$$

2. **Note that angles Θ are small, so we can use the small angle approximation in the equation (1):**

$$\sin \Theta = \tan \Theta = x / L \quad (4)$$

3. **Calculate the wavelengths of all emission lines using equation (1).**

4. **Using a per cent difference, compare your results with the published wavelengths for the mercury emission lines.**

5. **Make sure that you reference your source either from a textbook or the internet in your results section of your report..**

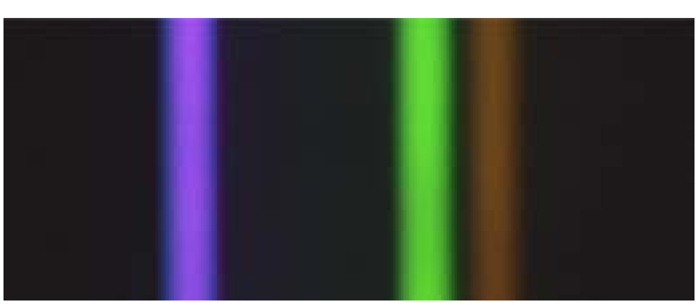

Figure 3. Hg Spectrum in the Visible portion of the spectrum