PHYF214 PHYSICS LAB REPORT SEM1 2018-2019
Lab 5 Group 7: Spectroscopy using a Diffraction Grating [DG]

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1 Experimental Tasks

1. To calibrate the grating spectrometer using the known source (Hg source) of light and to calculate the grating constant.
2. Using the same grating, to calculate the wavelength of sodium doublet lines.

2 Apparatus

Spectrometer, transmission diffraction grating, sodium vapour lamp, mercury vapour lamp, power supply for spectral lamps, magnifying glass.

3 Theory

Light from a mercury source is incident normally on a diffraction grating mounted on a spectrometer after calibration. The diffraction angle of the diffracted light is measured for each spectral line of the Hg-source.This enables us to calculate a constant d using the formula

$$dsin\theta = \lambda \tag{1}$$

d is related to the no of slits in the grating.
Likewise for sodium source, the diffraction angle and angular separation $\Delta\theta$ of the sodium doublet is measured. Then using equation (1) we can back calculate the wavelength λ of the two lines.

4 Observations and Analysis

4.1 Calibration of the Diffraction Grating

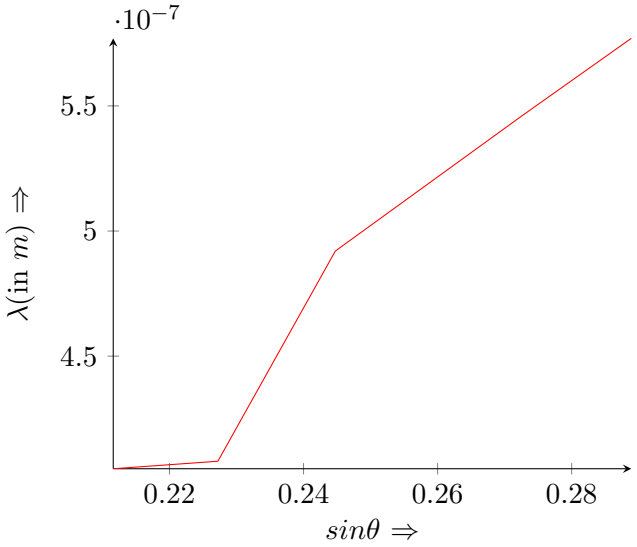
Least count of the scale = $\frac{1}{60}^{\circ}$.
Table 1: Data gathered while making the slit perpendicular to collimator .

Angle for step 4(a)	Angle for step (4b)	Angle for step (4c)	Angle for step (4d)
348.33°	78.33°	124°	79°

Table 2: Data gathered during calibration with mercury lamp.

Colour	wavelength (in m)	LHS reading (in°)	RHS reading (in°)	Angle (in°)	$sin\theta$	d= $\frac{\lambda}{sine\theta}$
Violet 1	4.05E-007	2.03	337.6	12.216	0.211	1.91E-006
Violet 2	4.08E-007	2.93	336.67	13.133	0.227	1.79E-006
Blue-green	4.92E-007	3.53	335.2	14.166	0.244	2.01E-006
Green	5.46E-007	5.16	333.53	15.817	0.272	2.00E-006
Yellow 1	5.77E-007	6.16	332.58	16.797	0.288	2.00E-006
Yellow 2	5.79E-007	6.3	333.5	16.4	0.2823414587	2.05E-006

Figure 1: Graph of λ vs $sin\theta$ for the calibration part



slope of the graph $d = 2.03E - 06$ m.

Analysis:
Error in value of d can be given by the standard deviation $\sigma = 9.3E - 8$ m

4.2 Determination of wavelength of sodium doublet lines

Table 3: Data gathered with sodium lamp.

Colour	LHS reading (in°)	RHS reading (in°)	θ (in °)	$sin\theta$	λ (in m)
Yellow 1	5.8167	333.3833	16.2167	0.279	5.48E-007
Yellow 2	6.533	332.33	17.1	0.294	5.77E-007

Analysis:
To calculate the error in λ we make use of the equation

$$\frac{\Delta\lambda}{\lambda} = \frac{\Delta d}{d} + \frac{\Delta\theta}{\theta}$$

(2)

$\therefore$ we get $\Delta\lambda$ for yellow 1 as 1.74E-7 and that for yellow 2 as 1.92E-7.

5 Precautions

- The directions of rotation of the telescope micrometer screw should be maintained the same. Otherwise the play in the micrometer spindle will lead to backlash errors.
- The experiment should be performed in a dark room.
- The spectral lamps should attain their full illuminating power after being warmed up for about 5 minutes, so the observations should be taken after 5 minutes.
- One of the essential precautions for the success of this experiment is to set the grating normal to the incident rays. Small variation in the angle of incidence causes large error in the angle of diffraction. If the exact normality is not achieved, one finds that the angles of diffraction measured on the left and on the right are not exactly equal.

6 Conclusions and Results

By following the standard procedure for calibrating the diffraction grating and measurement of sodium divergence angle , we were able to find two lines in the sodium emission spectra namely yellow 1 and yellow 2 lines peaking at $(5.48 \pm 1.74)E-7$ m and $(5.77 \pm 1.92)E-7$m respectively.