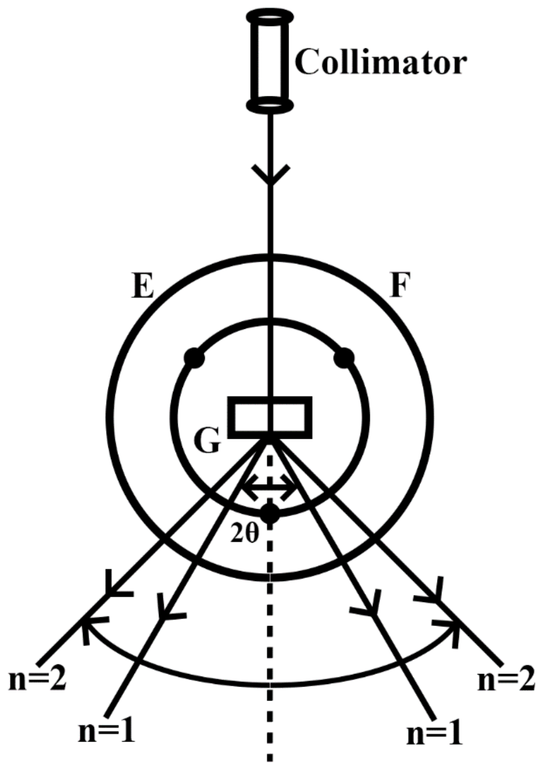
Experiment No. 03

Name of the experiment: Determination of wavelengths of spectral lines from discharge tube by a diffraction grating.



Theory: If the monochromic light of λ wavelength is incident perpendicularly on the diffraction grating leaving from the collimator of a spectrometer, then the produced diffraction angle θ for n^{th} bright fringe we get

$$(a+b)sin\theta = n\lambda \quad ---(i)$$

Hence, $a + b = d$ = Grating constant

If the number of lines is N per cm, then

$$a + b = \frac{1}{N} \quad or, \quad N = \frac{1}{a+b} = \frac{1}{d}$$

From equation *(i)* we get,

$$\frac{1}{N}sin\theta = n\lambda \quad or, \quad \lambda = \frac{sin\theta}{nN} \quad ---(ii)$$

Apparatus:

1. Spectrometer.
2. Diffraction grating.
3. Spirit level.
4. Helium discharge tube.

Procedure:

1. At first, we made the apparatus (collimator, prism table, telescope) horizontal by using the spirit level.
2. We determined the vernier constant of the microscope.
3. Sodium tube was set before the slit, so that beams are parallel.
4. After removing the prism from the prism table, the reading for the image of the collimator's slit was taken directly setting the cross wire.
5. We set the grating plane normal to the collimator's axis.
6. We made the lines vertical and took readings for each line.
5. We used Helium discharge table by replacing the sodium tube taking the position of the grating unchanged.

Data collection:

Table For λ:

Colum Of light	Serial Of diffraction n =	Reading for telescope position								Diffraction angle $\theta = \left(\frac{x \sim y}{2}\right)$deg.	$\lambda = \frac{sin\theta}{nN}$ (cm)
		Left side				Right side					
		Main scale reading (deg)	Vernier Reading	Vernier constant (deg)	Total reading x (deg)	Main scale reading (deg)	Vernier reading	Vernier constant (deg)	Total reading y (deg)		
Green	1	80°	10	1´	80°10´	122°	15	1´	122°15´	21°02´	5.97×10^{-5}
yellow	1	79°30´	11	1´	79°41´	123°	16	1´	123°16´	21°88´	6.21×10^{-5}
Orange	1	78°	23	1´	78°23´	123°30´	26	1´	123°56´	22°66´	6.42×10^{-5}
Red	1	77°30´	22	1´	77°52´	124°55´	25	1´	124°55´	23°51´	6.64×10^{-5}

Vertical constant (v. c)

$$= \frac{value\ of\ the\ smallest\ division\ of\ the\ mainscale}{Total\ numbers\ of\ division\ of\ vernier\ scale}$$

$$= \frac{\left(\frac{1}{2}\right)^{\circ}}{30} \quad = \left(\frac{1}{60}\right)^{\circ} \quad = 1'$$

N = Number of lines per cm = 6000

<u>Calculation</u>: For helium discharge tube:

For Green color, $\lambda_G = \frac{sin\theta}{nN} = \frac{\sin(21.02)}{6000} = 5.97 \times 10^{-5} = 5978Å$

For Yellow color, $\lambda_Y = \frac{sin\theta}{nN} = \frac{\sin(21.88)}{6000} = 6.21 \times 10^{-5} = 6211Å$

For Orange color, $\lambda_O = \frac{sin\theta}{nN} = \frac{\sin(22.66)}{6000} = 6.42 \times 10^{-5} = 6421Å$

For Red color, $\lambda_R = \frac{sin\theta}{nN} = \frac{\sin(23.51)}{6000} = 6.64 \times 10^{-5} = 6648Å$

<u>Result</u>: Using the helium discharges tube we get the following wavelengths for different colors:

The wavelength of green color, $\lambda_R = 5978Å$
The wavelength of yellow color, $\lambda_y = 6211Å$
The wavelength of orange color, $\lambda_O = 6421Å$
The wavelength of red color, $\lambda_G = 6648Å$

<u>Precautions & Discussion</u>:

1. We made the grating plane perpendicular to the collimator's axis.
2. We used one vernier scale for taking the exact reading.
3. The front side of the grating was taken to telescope.
4. We didn't touch the grating plane to remove the granting.