59/60 Good job! GAURAV

INDIAN INSTITUTE OF TECHNOLOGY

NO. CLASS BATCH 1st

NAME VARALA CHARISHMA

EXPT. No. 2. LABORATORY

PHYSICS DEPT. DATE

GRATING SPECTROMETER

AIM:- To determine wavelength of spectral lines of mercury and angular dispersive power of a diffraction grating

Apparatus

1. Spectrometer
2. Prism
3. Diffraction grating
4. Polychromatic light source.

Theory

An arrangement consisting of a large number of parallel slits of some width (a) which are separated by equal opaque scales is known as diffraction grating

Grating Constant (g) = $a+b$.

$$N = \frac{1}{g} = \frac{1}{a+b}$$

N is number of slits per unit length.

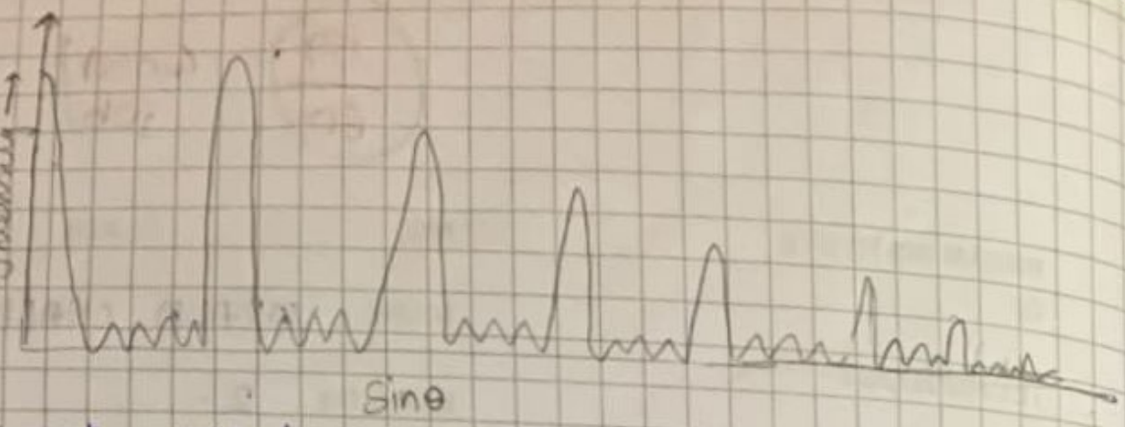
If monochromatic light of wavelength λ is incident normally on diffraction grating, diffraction pattern consists of extremly sharp lines called principle maxima and are given by:

$$(a+b)\sin\theta = \pm m\lambda.$$

where θ = diffraction angle

m = order of diffraction

g = grating constant.



There are also weak secondary maxima between principal maxima
The angular dispersion power (DP) is rate of change of diffr
angle with change in wavelength.

$$DP = \frac{\delta\theta}{\delta\lambda} = \frac{n}{(a+b)\cos\theta} = \frac{n}{g\cos\theta}$$

$$\delta DP = \frac{n}{g} \sec\theta \cdot \tan\theta \cdot d\theta$$

Procedure

Check the alignment of turntable using bubble level (in 3 dim
Put the slit on turntable without touching glass/grating.
Rotate telescope to obtain spectrum.

Precautions

1. Never touch surface of grating by hand.
2. Once the collimator and the telescope are adjusted for parall
their focusing should not be disturbed throughout the experiment
3. Once the grating is properly adjusted on the table it should
4. While taking measurements at different positions of the telesc
it must always be locked.
5. While rotating the telescope from one angular position to
if vernar crosses 0° on main scale, take the angular diff
appropriately.

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Observations

Value of one main scale division $n = 0.5^\circ$

Total number of divisions of vernier scale $N = 30$

Least count (LC) $= \frac{n}{N} = \frac{0.5}{30} = 1/60^\circ = 1'$

Colour	$\alpha_A(^\circ)$ MSR	VSR	Total	$\alpha_B(^\circ)$ MSR	VSR	Total	$\alpha'_A(^\circ)$ MSR	VSR	Total	$\alpha'_B(^\circ)$ MSR	VSR	Total
Yellow light	303	10	303.17	123	19	123.32	262.5	0	262.50	82.5	15	82.75
Yellow Dark	303	1	303.02	123	9	123.15	262.5	9	262.65	82.5	25	82.91
Violet	297.5	27	297.95	118	5	118.08	263	20	263.33	88	29	88.48
Green	301.5	27	301.95	122	6	122.10	263.5	24	263.90	84	4	84.07

Data → (16)

Formula.

$$\theta_A = \frac{|\alpha_A - \alpha'_A|}{2} \qquad \theta_B = \frac{|\alpha_B - \alpha'_B|}{2}$$

$$\theta = \frac{\theta_A + \theta_B}{2} \qquad \Delta\theta = \frac{|\theta_A - \theta_B|}{2} \quad \left[\text{if } \theta_A = \theta_B \text{ take } \Delta\theta = \frac{LC}{2}\right]$$

$N = 15000$ lines per inch.

$g = a+b = 1/N = 1/15000$ inch $= 1.693 \times 10^{-6}$ m.

$\lambda = g\sin\theta = (a+b)\sin\theta$ (for $m=1$)

$\Delta\lambda = g\cos\theta\,\Delta\theta = (a+b)\cos\theta\,\Delta\theta$.

Calculations

S.No.	Color of line	θ_A (°)	θ_B (°)	θ (°)	$\Delta\theta$ (°)
1	Yellow (right) 2	20.34	20.29	20.32	0.03
2	Yellow (left) 1	20.26	20.12	20.19	0.07
3	Violet	14.81	14.80	14.81	0.01
4	Green	19.03	19.02	19.03	0.01

Calculation of λ and $\Delta\lambda$

$$\lambda = g\sin\theta = 1.693\times10^{-6}\times\sin\theta \text{ m}$$

$$\Delta\lambda = g\cos\theta\cdot\Delta\theta = 1.693\times10^{-6}\times\cos\theta\times\Delta\theta \text{ m}.$$

1. Yellow (right) 2

$$\lambda = (a+b)\sin\theta$$

$$= 1.693\times10^{-6}\times\sin(20.32) \text{ m}$$

$$= 587.92 \text{ nm}$$

$$\Delta\lambda = (a+b)\cos\theta\times\Delta\theta$$

$$= 1.693\times10^{-6}\times\cos(20.32)\times\left[\left(\frac{0.03}{60}\cdot\frac{\pi}{180}\right)\text{rad}\right] \text{m}.$$

$$= 0.83 \text{ nm}$$

2. Yellow (left) 1

$$\lambda = (a+b)\sin\theta$$

$$= 1.693\times10^{-6}\times\sin(20.19^\circ) \text{ m}$$

$$= 1.693\times10^{-6}\times$$

$$\lambda = 582.37 \text{ nm}$$

$$\Delta\lambda = (a+b)\cos\theta\,\Delta\theta$$

$$= 1.94 \text{ nm}$$

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$(a+b)\sin\theta$

$1.693 \times 10^{-6} \times \sin(14.81) m \times \left(\frac{0.01}{60} \times \frac{\pi}{180} \text{ radians}\right)$

$432.76\ nm$

$= (a+b)\cos\theta\ \Delta\theta$

$= 1.693 \times 10^{-6} \times \cos(14.81)\ m \times \left(\frac{0.01}{60} \times \frac{\pi}{180} \text{ radians}\right)$

$= 0.29\ nm$

$(a+b)\sin\theta$

$= 1.693 \times 10^{-6} \times \sin(19.03)\ m$

$= 552.02\ nm$

$= (a+b)\cos\theta\ \Delta\theta$

$= 0.28\ nm.$

Colour of spectral line	$\lambda \pm \Delta\lambda$ (in nm)
Yellow (right) (2)	$(587.92 \pm 0.83)\ nm$
Yellow (dark) (1)	$(582.37 \pm 1.94)\ nm$
Violet	$(432.76 \pm 0.29)\ nm$
Green	$(552.02 \pm 0.28)\ nm$

Calculation of dispersive power

1. Yellow (Light) (2)

Dispersive Power (DP) $= \frac{\Delta\theta}{\Delta\lambda} = \frac{1}{g\cos\theta} = \frac{1}{1.693\times10^{-6}\times\cos(20.32)}$

$DP = 6.298\times10^{5}\ m^{-1}$

2. Yellow (Black) (1)

Dispersive Power (DP) $= \frac{\Delta\theta}{\Delta\lambda} = \frac{1}{g\cos\theta} = \frac{1}{1.693\times10^{-6}\cos(20.19)}$

$DP = 6.293\times10^{5}\ m^{-1}$

3- Violet

Dispersive Power (DP) $= \frac{\Delta\theta}{\Delta\lambda} = \frac{1}{g\cos\theta} = \frac{1}{1.693\times10^{-6}\cos(14.81)}$

$DP = 6.120\times10^{5}\ m^{-1}$

4- Green.

Dispersive Power (DP) $= \frac{\Delta\theta}{\Delta\lambda} = \frac{1}{g\cos\theta} = \frac{1}{1.693\times10^{-6}\cos(19.03)}$

$DP = 6.248\times10^{5}\ m^{-1}$

S No.	Colour of line	DP (Dispersive Power) (m⁻¹)	Δ DP (m⁻¹)
1	Yellow (Light) (2)	$6.298\times10^{5}\ m^{-1}$	$122.4\ m^{-1}$
2	Yellow (Black) (1)	$6.293\times10^{5}\ m^{-1}$	$282.58\ m^{-1}$
3	Violet	$6.120\times10^{5}\ m^{-1}$	$28.23\ m^{-1}$
4	Green.	$6.248\times10^{5}\ m^{-1}$	$37.59\ m^{-1}$

Result → 2+1

↓

Inconsistent Decimals.