

EXP.5: Diffraction Grating

Lab Report

Complete this report YOURSELF except DATA taking parts! This report will not be submitted (except the very last page), but you should carefully complete it as preparation for the applied exam.

Suggested Pre-Lab Questions

Q1. What is diffraction grating?

Q2. Why is it preferable to use a grating with a small d for accurate spectral analysis?

Q3. Should the angular separation between two lines be the same for each order? Why?

Q4. Prove that the angular dispersion of a grating can be written as: $D = \tan \theta / \lambda$. Hint: Use the grating equation.

1

EXP.5: Diffraction Grating

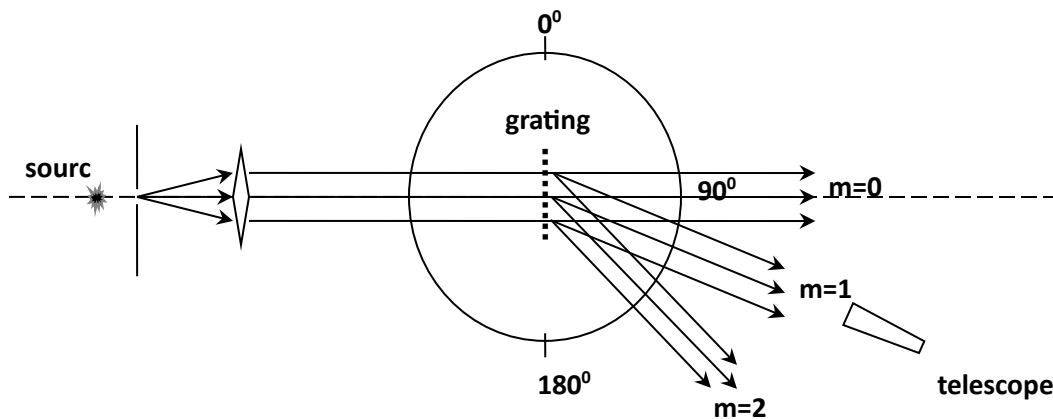
Experiment

OBJECTIVE : To use a diffraction grating to determine the wavelengths corresponding to various spectral lines.

THEORY : Light shining perpendicularly on a diffraction grating produces an interference pattern on a screen or on your retina if you are viewing from behind the grating. Positions of the maxima in the resulting interference pattern are given by the grating equation:

$$m\lambda = d \sin \theta$$

where m is the order of the spectrum, λ is the wavelength of the incident light, d is the distance between the lines on the grating, and θ is the angle at which the maximum intensity occurs. Angles are measured with respect to the incident light direction.



2

If the incident light has components with many wavelengths then you will see these different wavelengths separated from each other. The resolving power of a grating is given in terms of its ability to separate two wavelengths which differ by $\Delta\lambda$:

$$R = \frac{\lambda}{\Delta\lambda}$$

where λ is the average of these two wavelength values. Resolving power is also related to the number of lines (N) on the grating through

$$R = Nm$$

The angular dispersion D of a grating is defined as a measure of the angular separation produced between two monochromatic light waves whose wavelengths are close to each other.

$$D = d\Theta / d\lambda = \tan \Theta / \lambda$$

where Θ is the average of the angles corresponding to the two lines that are close to each other in wavelength and λ is the average of these wavelength.

EXP.5: Diffraction Grating

APPARATUS : Spectrometer, sodium lamp with its power supply, discharge tube with its power supply



PROCEDURE :

1. Adjust the collimator for parallel light, focus the objective on a distant object, and adjust the cross-hair so that it is visible on the image of the distant object and fix the telescope so that the zero position of the body becomes the zero position of the telescope.

3

2. Release the telescope to move freely. Then mount the diffraction grating carefully on the spectrometer.
3. Using the sodium lamp as the light source, determine the angular position of the first order maximum for the yellow line on either side of the center. C
4. Calculate the diffraction separation d .
5. Using the discharge tube containing unknown gas as the light source, determine the angles for all visible lines.
6. Calculate the wavelengths of those spectrum lines. Identify the gas in the discharge tube by making use of the table in Appendix A.
7. Selecting two barely separated lines in your discharge tube spectrum, determine the angular dispersion of your grating.
8. Use the white light source to determine the wavelength limits for visible light.

EXP.5: Diffraction Grating

PART I: DETERMINATION OF DIFFRACTION GRATING CONSTANT, d

Wavelength of

sodium doublet $\lambda = 5890 \text{ \AA}$ and 5895 \AA average 5893 \AA

Order of the spectrum $m = \dots\dots\dots$

Angle of spectrum line $\theta_{\text{left}} = \dots\dots\dots$

(Uncalibrated)

Angle of spectrum line $\theta_{\text{right}} = \dots\dots\dots$

(Uncalibrated)

Average angle $\theta_{\text{ave}} = \dots\dots\dots$

Diffraction Separation $d = \dots\dots\dots$

$\dots\dots\dots$

Theoretical value of d

Diffraction Separation $d_{TV} = \dots\dots\dots$

% Error for $d = \dots\dots\dots$

4

EXP.5: Diffraction Grating

PART II: UNKNOWN DISCHARGE TUBE

Discharge Tube Number :

Color	θ_{left} (uncalibrated)	θ_{right} (uncalibrated)	θ_{average}	λ ()

5

EXP.5: Diffraction Grating

PART III: DISPERSION MEASUREMENT

COLOUR	θ_1 (uncalibrated)	θ_2 (uncalibrated)	θ_{ave}	λ_{ave} ()

PART IV: WHITE LIGHT SPECTRUM

COLOUR	θ_{left} (uncalibrated)	θ_{right} (uncalibrated)	$\theta_{average}$	λ ()
Red End				
Violet End				

RESULTS:

Gas in the Discharge Tube is (check the appropriate box) :

Argon

Xenon

Hydrogen

Helium

Mercury

Neon

EXP.5: Diffraction Grating

Dispersion of the spectrometer:

$$D = \tan \Theta / \lambda = \dots\dots\dots$$
$$\dots\dots\dots$$

Limits of the visible range :

$$\dots\dots\dots < \lambda (\quad) < \dots\dots\dots$$

Suggested Post-Lab Questions

Q1. What is the maximum number of orders that can be observed with the grating used in the experiment?

7

In the next experiment, which is an applied exam, you will have a similar setup but a different experiment. The same principles (significant figures, units etc.) will be valid. You should study the experiment before the exam, try to get familiar with the spectrometer device and data taking/analysis today!

EXP.5: Diffraction Grating

8

Post-Lab Report

Aim of the experiment:

Suggestions for possible solutions to the problems experienced during the experiment:

Conclusion:

9 I have completed this experiment myself as specified in the lab sheet and as explained by the lab instructor.

Name & Surname:

Student ID:

Lab Section:

Table #:

Date:

Signature of the
student

As the instructor of this Lab Section I confirm that the student has participated in and completed this experiment on time.

Stamp of the PHYS
Labs and signature of
the instructor

This page serves as proof of the fact that the student participated in and completed the experiment, only if it is submitted in time and accepted by the Lab instructor. The student and the instructor shall sign it along with the stamp of the Physics Laboratories.