

# Experiment 8 Grating Spectrometer 光柵分光儀

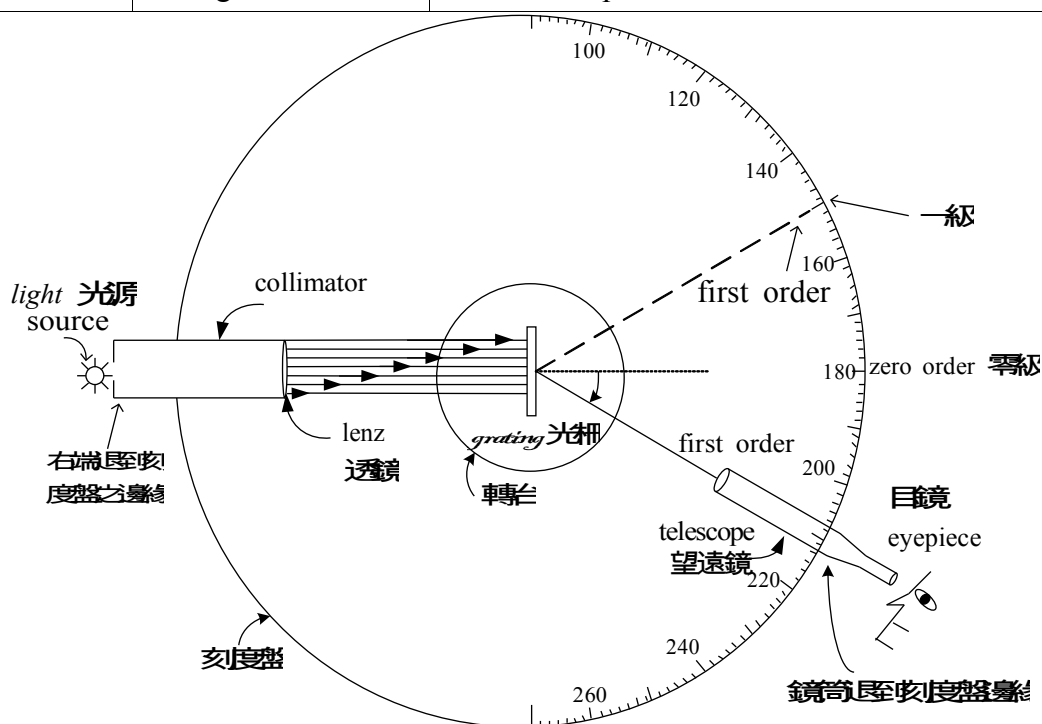
Translation: J D White (Bench 8)

## Part A: Grating Spectrometer

### 1. Theory (See Online Links)

### 2. 實驗儀器 (Laboratory instruments)

Chinese	Roman Pinyin	English Name	Label
繞射光柵	Rào shè guāngshān	Diffraction Grating	
汞燈	gǒng dēng	Mercury Lamp	
分光儀	fēnguāng yí	Spectrometer	
瞄準器	miáozhǔn qì	Aiming Device (Collimator)	
望遠鏡	wàngyuǎnjìng	Telescope	
刻度盤	kèdù pán	Dial to read degrees	
鈉燈	nàdēng	Sodium Lamp	



### 3. 實驗目的 (Purpose)

1. To understand the operation of a spectrometer and know how to use it
2. To use a grating to obtain the wavelength of light in comprising a spectrum

### 4. 注意事項 (Items to concern)

1. Gratings are expensive and fragile. Do not touch the face of the grating
2. The front knob can control the slit width. If the slit width is too wide the spectrometer resolution will decrease and you will be unable to see the spectrum.
3. The light bulb is hot. To change the light bulb, must first either shut down power for five minutes or wear a glove
4. When reading the spectral lines, ensure that the telescope is aligned to the right side of the spectrum

5. Note: 1 degree (1°) = 60 minutes (60') = 3600 seconds (3600")

## 5. 實驗步驟 (Procedure):

### 5.1 Mercury Emission Lines

1. Making use of the level, ensure that the rotating stage is horizontal
2. Rotate and adjust the position and inclination of the telescope so that it and the aiming device are in a straight line.
3. Place the mercury lamp into the power source. Turn on the mercury lamp power source. Align the light with the input of the aiming device.
4. Adjust the lens position and slit width of the aiming device until the lines are most clear. At the same time adjust the eyepiece of the telescope so the cross hairs are clearly visible. Adjust the position of the scale (for degrees) to ensure that 0° is towards the aiming device and 180° is towards the telescope.
5. Place the diffraction grating negative in the holder on the swivel table
6. Turn the telescope. You should be able to see that the spectra is composed purple, green (most strong), yellow and red spectral lines. Record the angular position ( $\theta'$ ) of each of these ( $m=1$ ) spectral lines. Rotate in the opposite direction and record the angular position( $\theta''$ ) . Using the average value, i.e.,  $\theta = |(\theta' - \theta'')/2|$ , calculate the wavelength of each line using  $m\lambda = d \sin(\theta)$
7. Increase the angle and repeat step 6 for the ( $m=2$ ) spectral lines.
8. Repeat steps 6 and 7 using different gratings.

Fig. {Hg} Reference: Mercury Emission Lines

### 5.2 Application to Fine Structure Spectroscopy of the Sodium Atom Procedure

1. Repeat steps 1 to 7 of the previous procedure replacing the mercury lamp with the sodium lamp.
2. Record data in Table 3 below

Fig. {Na} Reference Sodium Emission Lines

## 6. Experiment Data 實驗記錄

6.1 Mercury Spectrum Grating  $N = \underline{\hspace{2cm}}$  [stripes/cm]  $\rightarrow$   $d(\text{period}) = N^{-1} = \underline{\hspace{2cm}}$  [ cm]

Order m	color	Diffraction Angle					sin( $\theta$ )	$\lambda^*$
		$\theta'$		$\theta''$		$\theta^{**}$		
		min	deg	min	deg			
1	purple							
	green							
	yellow							
	red							
2	purple							
	green							
	yellow							
	red							

\*  $\lambda = d \sin(\theta)/m$

\*\*  $\theta = |(\theta'' - \theta')/2|$

6.2 Mercury Spectrum Grating  $N =$  \_\_\_\_\_ [stripes/cm]  $\rightarrow$   $d(\text{period}) = N^{-1} =$  \_\_\_\_\_ [ cm]

Order m	color	Diffraction Angle					sin( $\theta$ )	$\lambda^*$
		$\theta'$		$\theta''$		$\theta^{**}$		
		min	deg	min	deg	deg		
1	purple							
	green							
	yellow							
	red							
2	purple							
	green							
	yellow							
	red							

6.3 Sodium Spectrum Grating  $N =$  \_\_\_\_\_ [stripes/cm]  $\rightarrow$   $d(\text{period}) = N^{-1} =$  \_\_\_\_\_ [ cm]

Order m	color	Diffraction Angle					sin( $\theta$ )	$\lambda^*$
		$\theta'$		$\theta''$		$\theta^{**}$		
		min	deg	min	deg	deg		
2	Yellow 1							
	Yellow 2							

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