Diffraction Gratings

Brandi Tungett

Background

- Diffraction gratings are optical components with a period modulation on its surface
- Diffraction gratings split an incident beam into several beams that corresponds with a diffraction order and angle

Position of Reflected Beams

$$n_r \ \sin(\theta_r) = \ n_i \ \sin(\theta_{inc}) + m \ \frac{\lambda}{\Lambda}$$

Position of Transmitted Beams

$$n_t \ \sin(\theta_t) = \ n_i \ \sin(\theta_{inc}) + m \ \frac{\lambda}{\Lambda}$$

Period of a Grating

$$\Lambda = \frac{\lambda_0}{2 \, n_i \sin(\theta_{inc})}$$

Objectives

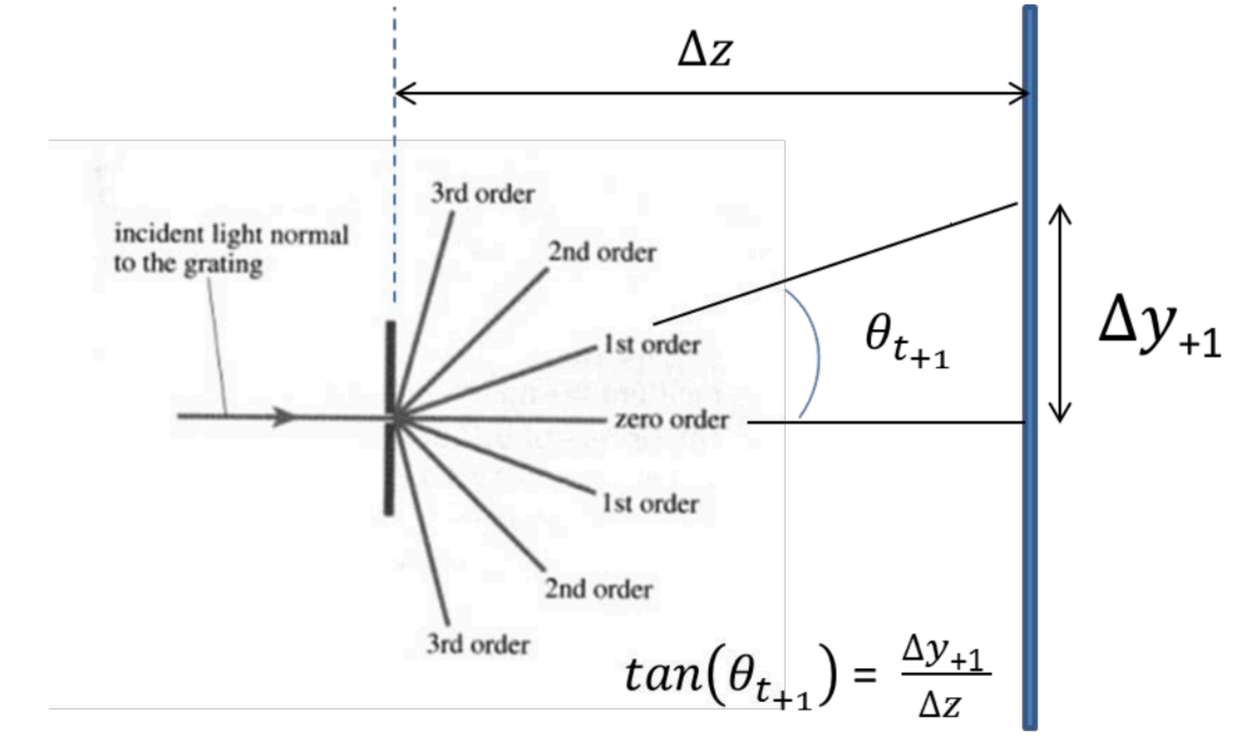
- Solve for the period of a diffraction grating
- Solve for the angle of transmission
- Solve for the wavelength separation

Procedure

- Shine a laser onto a diffraction grating, where the transmitted beams appear on a screen placed a distance away
- The angle of first order reflected beam is measured to find the period of the grating
- The separation distances are measured for the transmitted beams as many orders as can be measured, to solve for the transmission angles
- The width of the “dot” at the first order is measured to find the smallest separation in wavelength that you can resolve with this grating at this order

Experimental Set-Up

Analysis



$$\theta_{t_m} = arc\tan\left(\frac{\Delta y_m}{\Delta z}\right)$$

$$\Delta\lambda_0 = \frac{n_t\,\Delta\theta_{t_{+1}}\,\Lambda\cos(\theta_{t_{+1}})}{m}$$

Data

# Gratings	600	300	100
Angle (rad) M= -1	0.19	0.087	0.035
Period (micm)	1.658	3.3	9.1

m	delta Y(m)	Z (m)	theta t	theoretical theta t
2	0.157	1.32	0.12	0.14
1	0.078	1.32	0.06	0.07
-1	0.08	1.32	0.06	-0.07
-2	0.159	1.32	0.12	-0.14

Width of Spot M1 (m)	Angular Width (rads)	Smallest Separation in Wavelength (nm)
0.0025	0.0019	18

Conclusions

- My data isn’t perfectly matching of expected values but is close
- Differences can largely be attributed to human error