

Theory and implementation of spectroscopy

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1. INTRODUCTION

2. THEORY AND ANALYSIS

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2.1. Theory

The following equation is known as the grating equation[1]:

$$d(\sin \alpha + \sin \beta) = m\lambda \quad (1)$$

Where: d = spacing between the slits
 α = the incident angle
 β = the diffraction angle
 m = the order of the spectrum
 λ = the wavelength

The angle α is the angle between the incident light and the normal of the grating, and β is the angle between the diffracted light and the normal of the grating. Notice the plus sign instead of minus in the equation. The incident angle is measured counter-clockwise from the grating normal and the diffraction angle is measured clockwise from the grating normal. This is a sign convention for transmission gratings. The equation governs the angular locations of the diffracted light of wavelength λ .

For our research project, transmission gratings are used for a test model as shown in Fig. 1.

To simplify the construction of the testmodel, the incident light beam must be parallel to the grating normal. Hence, defining $\theta = \beta_{-1}$, Eq. 1 reduces to:

$$d \sin \theta = m\lambda \quad (2)$$

This implies that the the camera must be placed at a specific angle so that it can capture the spectrum of the first order ($m = 1$). According to [3] (see: mountings), aligning elements can be used to refine the operation of the spectroscopy meter. Fig. 2 shows the setup for a monochromator. The alignment elements used in this setup can also be applied to our spectrometer prototype. From the entrance slit (1), the light diverges to a collimating mirror (2). This mirror reforms the diverging

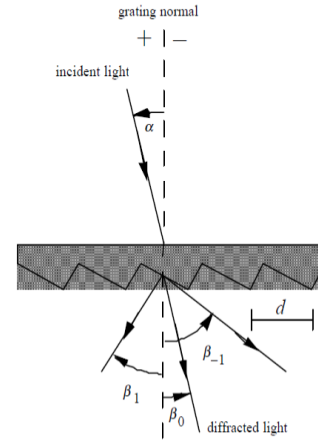


FIG. 1: Diffraction by a plane transmission grating. Adapted from [2].

incident light beam to a parallel light beam. The diffraction grating (3) is a reflective grating which reflects and disperses the light beam into different colors (and at an angle, governed by Eq. 1). The camera mirror (4) must then be substituted by a camera for our project. For a more advanced prototype, this setup must be considered. A video[4] shows the operation of this setup.

2.2. Analysis

3. RESULTS

4. DISCUSSION

5. CONCLUSION

6. BIBLIOGRAPHY NOTES

[1] *The grating equations*, URL <https://www.shimadzu.com/opt/guide/diffraction/03.html>.

[2] E. L. C. Palmer, *Diffraction Grating Handbook* (Newport

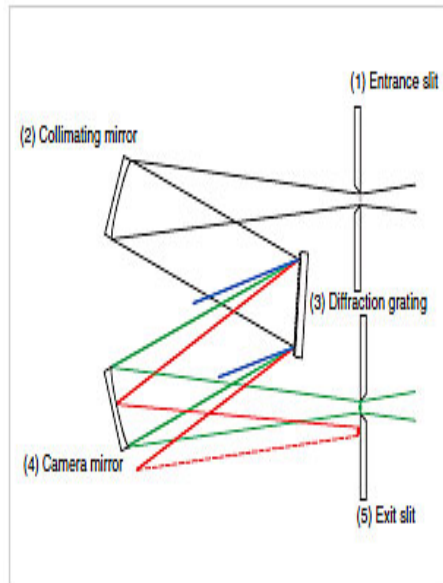


FIG. 2: Aligning elements for a monochromator [3].

Corporation, 2005).

- [3] *Monochromators*, URL <https://www.shimadzu.com/an/uv/support/fundamentals/monochromators.html>.
- [4] *How does a spectrometer work?*, URL <https://www.youtube.com/watch?v=0I3pIvLhVcc&frags=pl%2Cwn>.