PH 481 **Physical Optics** **Winter 2023**

Laboratory #7 **Week of February 27**

Read: pp. 330-339, 408-416 of "Optics" by Hecht
Do: 1. Experiment VII.1: Linearly polarized light
2. Experiment VII.2: Law of Malus

Experiment VII.1: Linearly polarized light

Identify the transmission axis of the polarizer using the Brewster angle technique from Lab 2 (Experiment II.1). Recall that you should first verify that your laser is polarized at approximately 45˚ with respect to the vertical. Adjust the polarizer and the glass plate (microscope slide or cover slip will work fine) so that the reflected beam is minimized. The polarizer is then aligned to transmit *P* polarized light. Remove the polarizer so that the incident beam is a mixture of *S* and *P* polarizations. Then use the polarizer to verify that the reflected beam is indeed polarized. Is it *S* or *P* polarized?

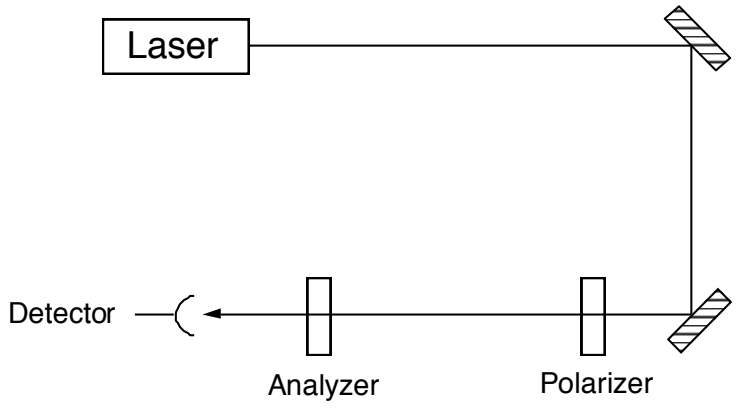
Experiment VII.2: Law of Malus

The goal here is to verify the Law of Malus (Hecht, p. 338, Eq. 8.24). This law describes how the intensity of light transmitted through a linear polarizer varies as a function of the angle θ between the polarizer transmission axis and the plane of polarization of the incident light. Malus's Law is

$$I(\theta) = I(0)\cos^2(\theta),$$

where $I(0)$ is the transmitted intensity when the polarizer transmission axis and the plane of polarization of the incident light are parallel.

To verify Malus's Law, you will use two polarizing sheets and a photodetector as shown in the figure (see also Hecht p. 338). By convention, we will call the first polarizing sheet the Polarizer and the second the Analyzer. The Polarizer ensures that the light reaching the Analyzer is linearly polarized. Since the laser is already linearly polarized, the Polarizer can also be used to adjust the amount of laser light used in the experiment so that the photodetector is not saturated. In practice, you want to make sure that the maximum signal you measure from the photodetector is no more than the half the battery bias voltage (12V).



Only one of the polarizing sheets is mounted in a rotation mount; use that one as the Analyzer. The Polarizer can simply be held in a filter holder. Measure the power transmitted

through the Analyzer as a function of the rotation angle of the Analyzer. Measurements at 5˚ or 10˚ intervals should be sufficient, except near $\theta = 0^\circ$ and $\theta = 90^\circ$ where more points will be needed. It is useful to first find the minimum and maximum points and eliminate noise, so that $I(0)$ can be properly determined. Plot your results and compare them with the theory.

Equipment needed:

Item	Qty	Source (part #)
Helium-Neon Laser	1	Melles Griot 05 LHP 121
Al mirror	3	Newport 10D10ER.1
Polarizer	2	Edmund A38,396
Microscope cover slip	1	Edmund A40,002
Rotation Mount	1	Thor Labs RSP1
Filter holder	1	Thor Labs DH1
Photodetector	1	Thor Labs DET1-SI
Voltmeter	1	Fluke 75
Hot gun or soldering iron	1	