Physics 312 set up

Lab 10: Linear polarization

Goals: To use linear polarizers to 1) measure the polarization state of a diode laser, 2) test the validity of Malus's law and 3) create a 3D image.

1. *Measuring the Polarization State of the Laser*

Position the polarizer between the laser and the photodetector as in Fig. To avoid a non-linear signal, the iris in front of the photodiode should be adjusted so that the output of the photodetector remains below 220 mV. Find the maxima and minima and record the angles at which they occurred. Is the laser linearly polarized? Explain your logic. Leave the polarizer in a position corresponding to a maximum.

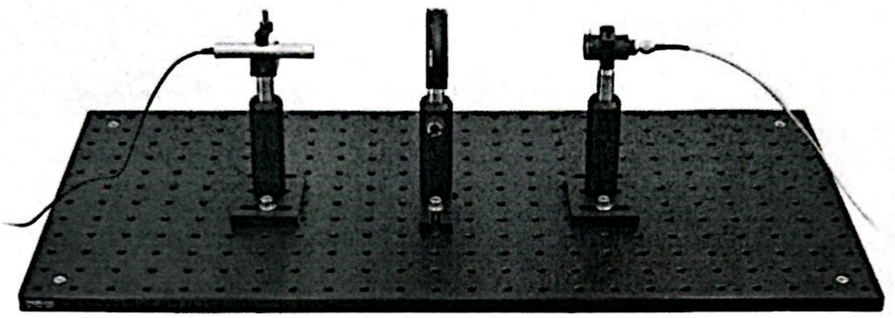

Figure 1. Setup to measure the polarization properties of the laser: laser, linear polarizer, and photodetector.

2. *Malus's law*

Add a second polarizer to the setup between the original polarizer and the photodetector. Rotate the second polarizer at an increment size of your choice and record the voltage values on the photodetector. Be sure to find and record the angle at which the signal is minimized. Decide what values you should plot to validate Malus's law using a linear fit.

3. *3D projection with linear filters*

A person's ability to perceive depth is based on the fact that each eye takes in one image of the same environment, but from a slightly different perspective. From these different perspectives, the brain calculates the three-dimensional position of the object relative to the viewer. The basic principle of any 3D display is to direct two images captured from different perspectives into the eyes of the viewer, with only one image entering each eye. Analogous to normal vision, the brain then constructs an impression of depth from the two different images

For this purpose, pairs of polarizers, one with a horizontal transmission axis and the other with a vertical transmission axis, are used, as shown in Fig. 3. The light from each lamp passes through one of the filters, making them perpendicularly polarized to each other. After that, the light strikes the screen – here, it is essential that the reflected light keeps its state of polarization! For this purpose a conductive screen (metal or metallic-vapor-coated) must be used. The reflected light now falls on the glasses, which also have built-in perpendicular polarizers. These crossed polarizers now act as analyzers: the light from one projector is polarized parallel to the transmission axis of the polarizer and is transmitted to your eye. The light from the other projector is polarized perpendicular to the transmission axis and is absorbed. This ensures that an image from only one of the projectors enters each eye.

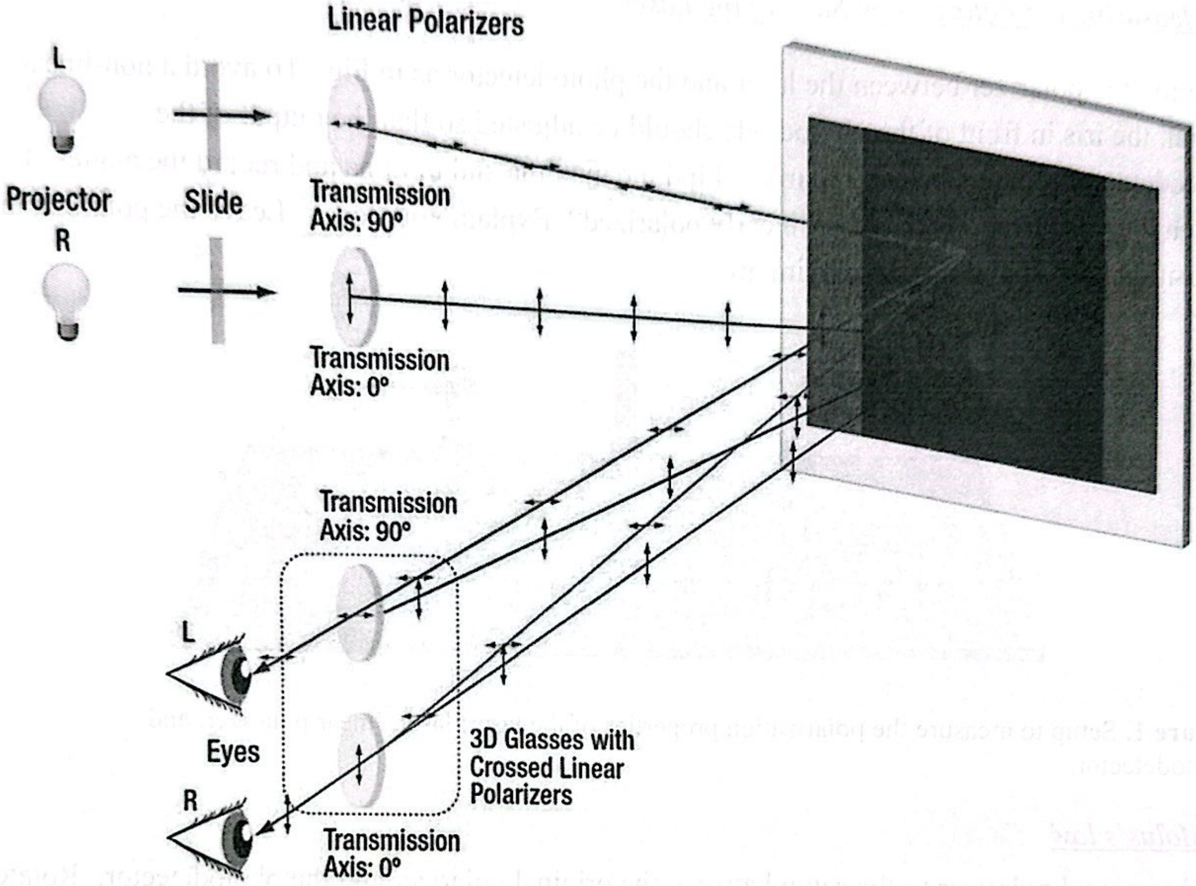

Figure 3. Schematic diagram of the 3D technology with linear polarizers. The light transmitted through one polarizer film is polarized perpendicularly to the light transmitted through the other polarizer film. The glasses also have two polarizers with axes oriented perpendicularly to each other. Each polarizer film serves as an analyzer that absorbs one polarization (and thus an image/slide) and transmits the other.

As a first step, the polarizers must be aligned to the glasses being used. Use the laser to adjust the polarizers in such a way that one polarizer is perpendicular to one of the films in the glasses (this way it is automatically parallel to the other). The lamps are set up side by side and turned at a slight angle to each other, as in Fig. 4. The slides are placed in front of the lamps in a way that no light shines past the edges of the slides. The little red dot is a marker that helps to separate the two images of a set: the one with the red dot is supposed to be the left image (when you face the screen). The red dot should be in the lower, left corner.

The lens are now added to the set-up, in such a way that the images are sharp on the screen and superimposed. Next, the polarizers are added to the setup, one for each beam path. To ensure that no part of the image is cut off, the polarizers should be positioned close to the focal points of the lenses. Fine adjustment is again carried out, in which either the slides (recommended) or the lenses are moved. In so doing, the images are shifted with respect to each other on the screen until you get the impression of depth when wearing the glasses. What happens when you replace the screen with a white piece of paper? What happens when you change one of the polarizers by 90 degrees?

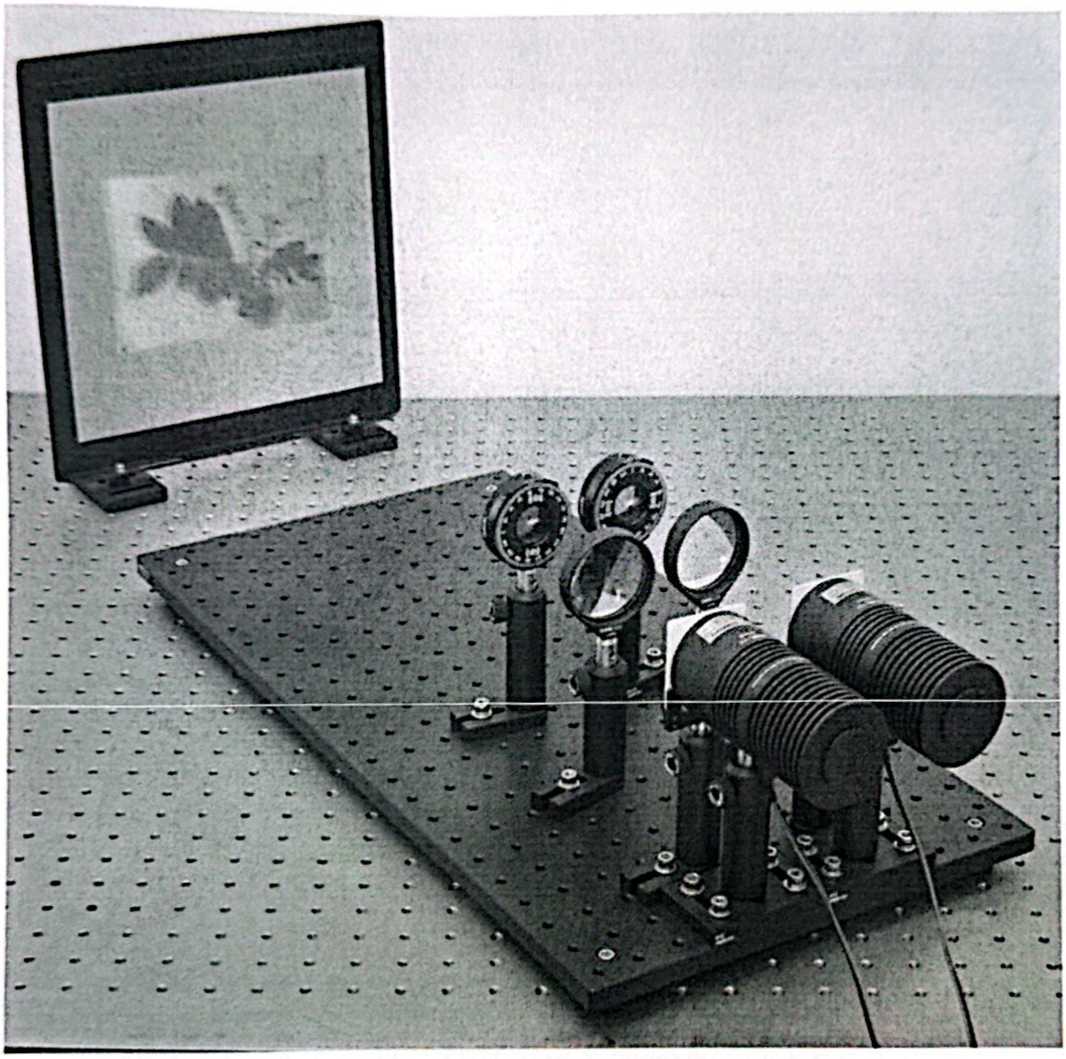

Figure 4 Two Halogen lamps, shown at the bottom of the image shine light through the two slides. The lenses focus the images on to the screen, while the final optical elements, the linear polarizers serve to encode the left and right images with orthogonal polarization.