Polarization Lab Version α

Equipment: Optical Track, Incandescent Source, Laser Source, Screen/Beam Stop, Square Polarizer Film, Mounted Polarizers (2x), computer running Data Studio

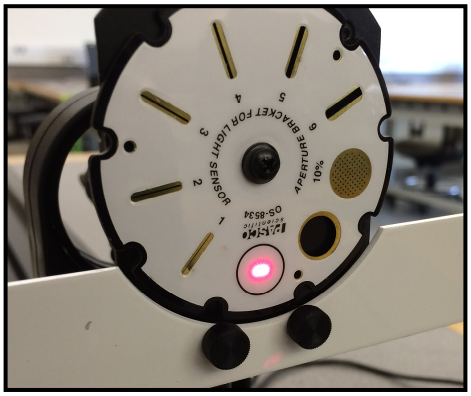
Safety Note: Do not look into the laser OR the incandescent source. Both are high intensity and can cause damage or blindness with prolonged exposure. If you are having trouble aligning the light with the detector, do not bend over and look for the beam. Instead use a small piece of white paper to observe the specular reflection of the light.

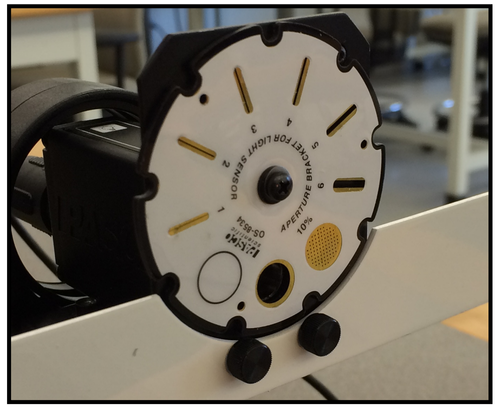
Objectives: Through completion of the lab exercises, the student will…

1. Become familiar with new optical instruments(polarizers, lasers, incandescent sources).
2. Understand the nature and properties of polarized and unpolarized light.
3. Learn the difference between laser light and incandescent light
4. Learn the meaning of 'coherent' light
5. Measure the inverse square relationship between intensity and distance. away from source in standard, incandescent sources.
6. Verify the Law of Malus.
7. Utilize scientific thinking to make predictions and draw conclusions

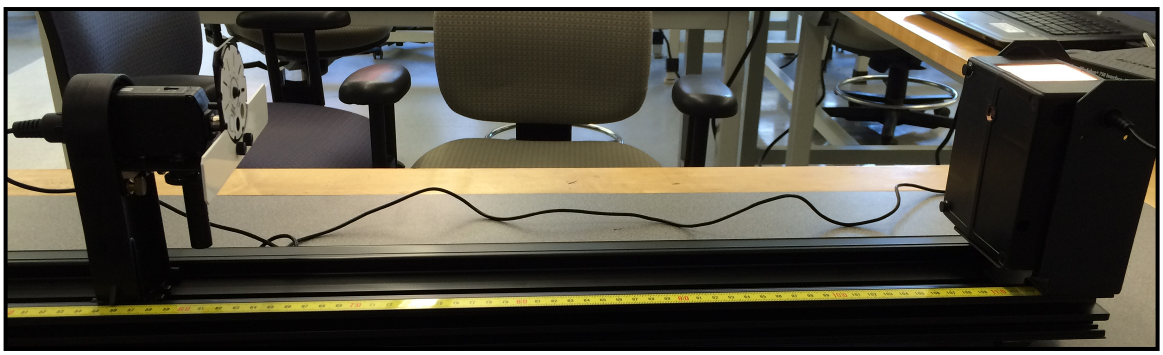
Part 1: Initial Set-Up

- ♣ Mount the incandescent light source on the track. You will need to slide it in from the end and tighten the mounting screw at the bottom. Mount it so that the aperture that produces a nice, round, uniform circle of light propogates down the track.
- ♣ Mount the detector on the track and set it, initially so that the aperture is closed.
- ♣ Connect the detector to the lab view interface and open lab view. Add the light sensor to the experiment
- ♣ Open the aperture so that it is completely unblocked (round opening). Look at the reading you are getting and put your hand over the sensor to verify that the reading changes depending on how much light reaches the detector.





Above Left: Laser hitting a close aperture on the sensor
Above Right: Laser centered on the open aperture of the sensor
Below: The initial set up for Part 2 of the Experiment



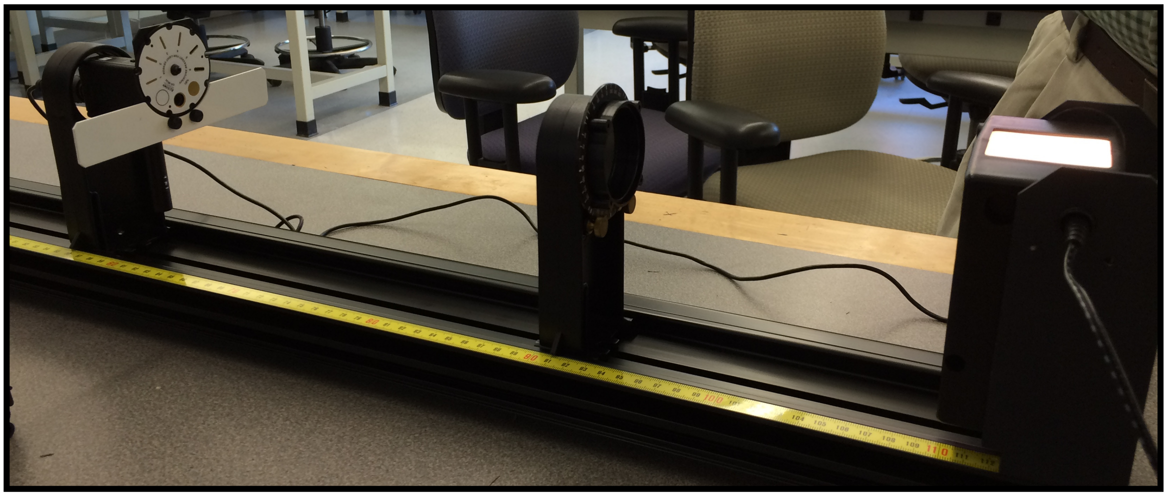
<u>Part 2: Incandescent Source</u>

- With the aperture closed, place the sensor 30cm away from the incandescent source and make sure the light falls on the sensor.
- Open the sensor aperture so that it is completely unblocked.
- Starting from this position, measure the intensity as a function of distance in 10cm increments till no change is observable or you run out

of track (whichever comes first). As you move the sensor back, adjust your source to keep the light centered on the sensor.

  - What is the qualitative relationship between the variables of distance (d) and intensity(I)?
  - Plot distance vs. intensity and use the curve fitting tool to get an equation of the line.
  - How do I plot these variables to get a straight line graph?

Part 3: <u>Incandescent source with one and two polarizers</u>



Above: Set up for start of Part 3

- Fix the distance between source and sensor to be 30cm
- Place 1 polarizer between the source and sensor and set the polarizer so that the axis of polarization(located at 0º) is vertical.
- Measure the intensity from 0 º to 360 º in 15 º increments
  - Plot intensity(I) vs. angle(θ)
- Place a second polarizer between the first polarizer and the sensor. You may move the first polarizer to accommodate the second but do not move the source or the sensor.
- Set both polarizers so that both polarization axis are vertical
  - Leave one polarizer at such that the 0 º mark stays at the vertical and rotate the second in 15 º increments and measure intensity at each angle.
  - Plot intensity(I) vs. angle(θ) for this set up.
  - Why is there a difference between the one polarizer and two? How has the light of the source changed when going from the first polarizer to the second?

Part 4: Laser light

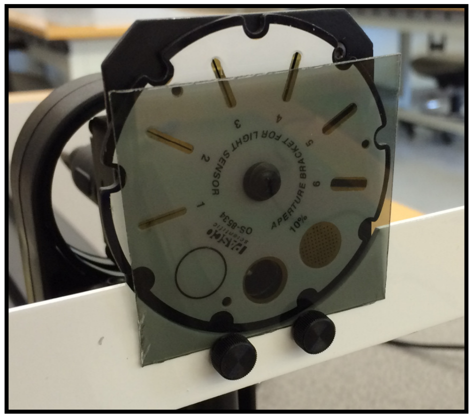
- Replace the incandescent source with the laser source
    - **NOTE: Please turn off the laser when you are not measuring**
- With the aperture closed, place the sensor 30cm away from the laser source and make sure the light falls on the sensor.
    - You can use the small screws on the back of the laser mount to adjust the direction of the beam
- Open the sensor aperture so that it is completely unblocked.
- Starting from this position, measure the intensity as a function of distance in 10cm increments till no change is observable or you run out of track, whichever comes first. As you move the sensor back, adjust to keep the laser centered on the sensor.
    - What is the qualitative relationship between the variables of distance (d) and intensity(I)?
    - If I said that a laser is a 'coherent' light source and that the incandescent bulb is not, what do you think coherent means?

Part 5: Laser with two polarizers

- Fix the distance between laser and sensor to be 30cm
- Place 1 polarizer between the laser and sensor and set the polarizer so that its axis of polarization is vertical.
- Measure the intensity from 0 º to 360 º in 15 º increments
    - Plot intensity(I) vs. angle(θ)
    - What can account for the difference between the laser and incandescent behavior with one polarizer?
- Place a second polarizer between the first polarizer and the sensor. You may move the first polarizer to accommodate the second but do not move the source or the sensor.
- Set both polarizers so that their axis of polarization are vertical
    - Leave one polarizer vertically oriented and rotate the second in 10 º increments and measure intensity at each angle.
    - Plot intensity(I) vs. angle(θ) for this set up.
    - What is the angle of maximum intensity?
    - Is there a difference between the one polarizer and two? How has the light of the source changed when going from the first polarizer to the second?

<u>Part 6: Laser with three polarizers</u>

- Fix the distance between laser and sensor to be 30cm
- Place 2 polarizers between the laser and the detector. Orient both of their polarization axis so that they are vertical.
- Add a polarizer sheet directly in front of the sensor(see image). You can use the screws on the front to gently hold the sheet in place.



Above: A small polarizer sheet being clipped in place in front of the sensor

- Orient the sheet so that the sensor detects the laser light.
    - What does that tell you about the axis of polarization of the sheet?
- If you rotate the sheet by 90 what do you expect to measure?
    - Rotate the sheet by 90 and measure the intensity.
    - Why is the intensity at this value?
- If you rotate the first polarizer (closest to the laser), what intensity do you expect to measure?
    - Rotate the first polarizer and note the change in intensity if there is any?
    - Why do you see a change or no change in intensity?
- If you rotate the second polarizer (between the one closest to the laser ad the detector), what intensity do you expect to measure?
    - Rotate the second polarizer and note the change in intensity if there is any?
    - Why do you see a change or no change in intensity?

<u>Part 7 – General Questions</u>

- Does your intensity ever go to zero? Should it? Why does/doesn't it?
- Do your findings demonstrate the law of Malus? Prove this with an appropriate graph.