Physics Experiment I

Lab   Report

Experiment Title:	Polarized Light
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Date Performed:	2018.04.14
Final Mark:	

Score

Abstract (About 100 words, 10 points)

This experiment studied the concept of polarized light. The main purpose is to lead us to analyze the phenomenon and principle of the polarization of light by using the polarizer, analyzer, and retarders. We observed different photocurrents by changing the position of polarizer successively. Beside, we analyzed the Brewster angle , and verified the law of Malus, the function of quarter-wave plate and half-wave plate. The experiment also told me how to analyze the polarization state among linearly polarized, circularly polarized and elliptically polarized.

Score

Calculations and Results (Calculations, data tables and figures; 15 points)

(1)Data Tables

DATA TABLE 7-1 (*purpose:* To verify the law of Malus)

P_1=___358___ , P_2=__46__

Angle starting from the position of P_2, θ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
photocurrent, I_θ	238	234	226	214	194	165	111	56	16	0
Angle starting from the position of P_2, θ	100°	110°	120°	130°	140°	150°	160°	170°	180°	
photocurrent, I_θ	8	39	93	152	189	211	226	236	239	

DATA TABLE 7-2 (*purpose:* To verify the function of quarter-wave plate)

P_1=___358___ , P_2=___316___ , C_1=___200___

Change the position of λ/4 plate starting at C_1	0°		15°		30°		45°		60°		75°		90°	
How many times of maximum and minimum intensity can you observe when you rotate the analyzer in a circle?	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
	2	2	2	2	2	2	2	2	2	2	2	2	2	2
The maximum and minimum intensities	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
	194	0	190	13	173	55	149	101	183	62	204	15	227	0
What is the polarization state of the light after λ/4 plate?	linear		elliptical		elliptical		circular		elliptical		elliptical		linear	

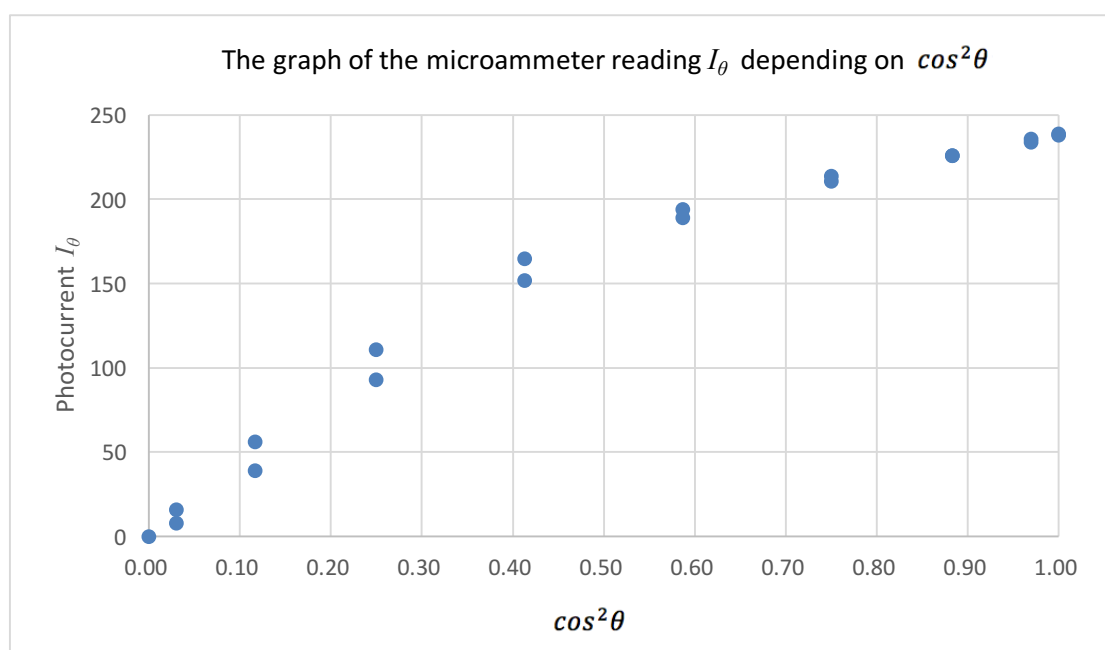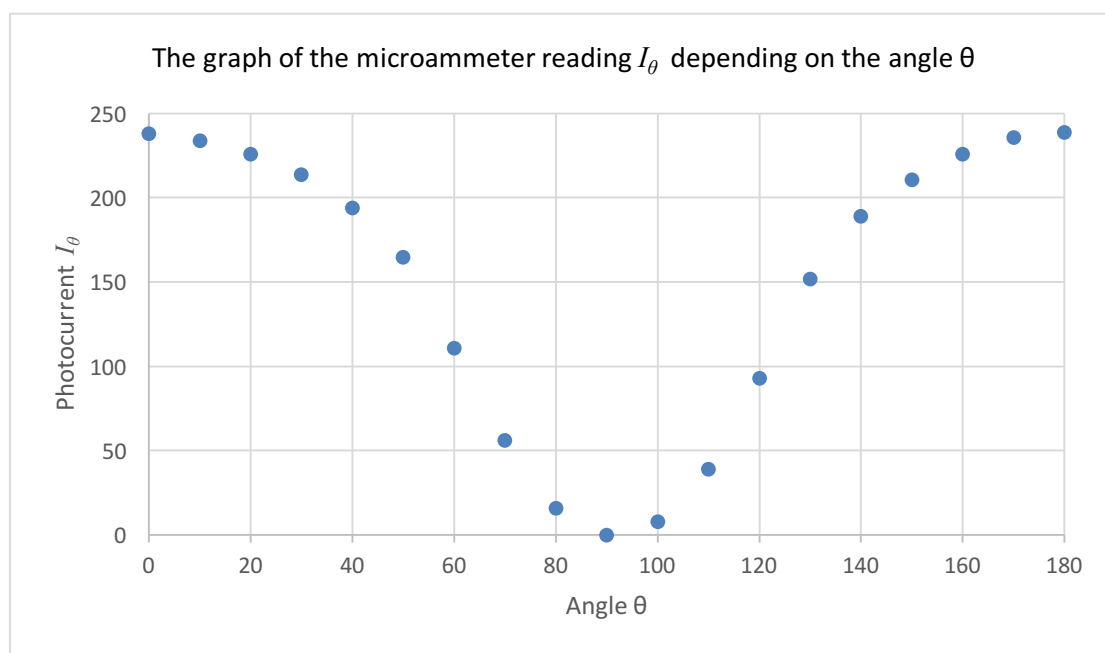DATA TABLE 7-3 (*purpose:* To verify the function of half-wave plate)

1) How many times of extinction can you observe when rotating the half-wave plate

from 0 to 360°?_____4_____

2) How many times of extinction can you observe when rotating the analyzer from 0 to 360°? _____2_____

$P_1=$___358___ , $P_2=$___316___ , $C_2=$___182___

Change the position of λ/2 plate starting at C_2		0°	15°	30°	45°	60°	75°	90°
Rotate the analyzer in a circle and record its positions where you can observe extinction	Position 1	137	351	201	46	263	106	318
	Position 2	316	166	18	226	77	288	140

The graph of the microammeter reading I_θ depending on the angle θ

The graph of the microammeter reading I_θ depending on $cos^2\theta$

(2)Summarize the function of quarter-wave plate based on the entries in Data Table 3.7-2.

Solution: It emerges with a phase difference of $\frac{\pi}{2}$ corresponding to a $\frac{\lambda}{4}$ wavelength delay. And the function of quarter-wave plate is to change linearly polarized light into different polarized light. If linearly polarized light is incident at 45°, it produces circularly polarized light; if it is incident at 0° or 90°,it produces linearly polarized light; if it is not incident at 0° or 45°or 90°, it produces elliptically polarized light.

(3)Summarize the function of half-wave plate based on the entries in Data Table 3.7-3.

Solution: It emerges with a phase difference of π corresponding to a $\frac{\lambda}{2}$ wavelength delay. And the function of half-wave plate is to change the direction of linearly polarized light.

Score

Conclusions (About 100 words, 5 points)

In the past we only knew theoretical knowledge but did not know the phenomenon and principle of theory like: light is a transverse wave and polarized light may be linearly polarized, circularly polarized or elliptically polarized. Through this experiment, we analyzed the Brewster angle, and verified the law of Malus, the function of quarter-wave plate and half-wave plate by measuring the transmitted light for different relative angles (every specific degree from 0° to 180°) by rotating the polarizer and inserting plates. Besides, we digested the property of light and how to distinguish different lights.

Answers to Questions (10 points)

(1) Explain how polarization phenomenon indicate that light is a transverse wave.

Solution: As we know, waves may have longitudinal vibrations or transverse vibrations, and longitudinal waves can not be polarized. In fact, light can be polarized, so the polarization of light phenomenon indicates that light is a transverse wave.

(2) In the step 3 of 3.7.4.3, how many times of extinction can you observe when rotating the half-wave plate from 0 to 360 degree? State the reasons.

Solution: When rotating the half-wave plate from 0 to 360 degree, I observed the extinction for four times. The reason why is caused by the property of the half-wave plate: changing an angle θ into 2θ, so that rotating by an angle θ from $0°$ to $360°$, and it rotated from $0°$ to $720°$ actually. The extinctions are shown when $\theta=90°/180°/270°/360°$, that is, $2\theta=180°/360°/540°/720°$.

(3) How can you distinguish between an unpolarized light and a circularly polarized light?

Solution: By using a diode laser, a detector, a microammeter, a quarter-wave plate, and polarizers, I an distinguish these two lights. Firstly, insert a quarter-wave plate between the polarizer and analyzer on the bench. Secondly, rotate the polarizer, if the intensity of light changes, which means it is an unpolarized light. But if the intensity of light changes and there are two times extinctions, which means it is a circularly polarized light.

Appendix

(Scanned data sheets)

3.7.5 Experimental Data

Data Table 3.7-1 *Purpose*: To verify the law of Malus

What is the possible polarization state for the laser light source? __linear__

P_1 = _358_ , P_2 = _45_

Angle starting from the position of P_2, θ	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Photocurrent, I_θ	238	234	226	214	194	165	111	56	16	0

Angle starting from the position of P_2, θ	100°	110°	120°	130°	140°	150°	160°	170°	180°
Photocurrent, I_θ	8	39	93	152	189	211	226	236	239

Data Table 3.7-2 *Purpose*: To verify the function of quarter-wave plate

P_1 = _358_ , P_2 = _316_ , C_1 = _200_

Change the position of λ/4 plate starting at C_1 in steps of 15°	0°		15°		30°		45°		60°		75°		90°	
How many times of maximum and minimum intensity can you observe when you rotate the analyzer in a circle?	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
	2	2	2	2	2	2	2	2	2	2	2	2	2	2
The maximum and minimum intensities	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
	194	0	190	13	173	55	149	101	189	62	204	15	227	0
What is the polarization state of the light emerging from the λ/4 plate?	linear		elliptical		elliptical		circular		elliptical		elliptical		linear	

Data Table 3.7-3 *Purpose*: To verify the function of half-wave plate

1) How many times of extinction can you observe when rotating the half-wave plate from 0 to 360°? __4__
2) How many times of extinction can you observe when rotating the analyzer from 0 to 360°? __2__

P_1 = _358_ , P_2 = _316_ , C_2 = _182_

Change the position of λ/2 plate starting at C_2		0°	15°	30°	45°	60°	75°	90°
Rotate the analyzer in a circle and record its positions where you can observe extinction	Position 1	137	351	201	46	263	106	318
	Position 2	316	166	18	226	77	288	140

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