Faraday Effect

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Abstract

In this experiment, We tried to investigate the Faraday effect, which involves measuring the change in the polarization direction of a linearly polarized light beam as it passes through a magnetic medium under the influence of an external magnetic field.

1 Aim

- To calculate the verdet constant of olive oil.

2 Method

- Align the laser and set up the table as shown in the schematic diagram(Figure 1).
- Put the sample inside the solenoid such that it's entire length is encompassed by the solenoid. It should be aligned axially with the direction of the magnetic field as well as the laser.
- Turn on the laser and note the reading on the multimeter. Then turn on the power source connected to the solenoid and note the reading.
- There should be sufficient difference in the readings so as to rule out laser and power source fluctuations. If not, check for any systematic error or try increasing the strength of the magnetic field.

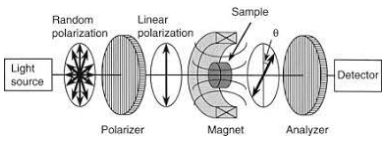

Figure 1: Set up of the experiment

The angle of rotation and the applied magnetic field varies as follows:

$$\phi = vlB$$

3 Observation and Analysis

3.1 Data

S. No	Applied Current (Amps)	Voltage detected in Photodiode(mV)
1	0	7.0
2	0.5	7.0
3	1	7.0
4	1.5	7.2
5	2	7.1
6	2.5	7.0
7	3	7.3
8	3.5	7.1
9	4	7.5

Table 1: Observations of Voltage vs current applied

3.2 Calculations

At 0 Amps, the crossed orientation of polarizers results in a 7 mV photodiode reading from background light. Applying current induces a polarization rotation (ϕ), causing an intensity increase of $I_0 \sin^2(\phi)$. The magnetic field (B) generated by the current (I) in coils is

$$B = \mu_0 n I$$

with μ_0 as permeability and n as coils per unit length.

The change in intensity (δ) is given by

$$\delta = I_0 \sin^2(\phi) = I_0 \sin^2(vl\mu_0 nI)$$

.

for $I_0 = 70$ mV, $l = 10$ cm , $v \approx 100$ rads $\cdot\ m^{-1} \cdot T^{-1}$ and $n = 5000$

$$\delta = 70 \sin^2(100 \cdot 0.1 \cdot 4\pi \cdot 10^{-7} \cdot 500 \cdot 4) = 4.31mV$$

which is off from the observed δ (for 4 Amps) by ≈ 88 %.

For small Verdet constants, an expected linear increase in δ w.r.t the applied current was not observed.

4 Discussion

Based on the experimental data collected, it can be said that no effect was observed.

The observations did not show a clear correlation between the change in intensity before and after applying the magnetic field. Any differences observed were of the order 0.1mV which can be attributed to the fluctuation in the power source, the laser or background light.

Possible reasons for failure:
1. The length of the sample was too short.
2. Weak power source due which a strong magnetic field could not be produced.
3. Small solenoid with little capacity to withstand a strong current.